JANUARY 2007

THE REPORT OF
THE BP U.S. REFINERIES INDEPENDENT SAFETY REVIEW PANEL

From left to right: Glenn Erwin, Sharon Priest, Paul V. Tebo, James A. Baker, III, Isadore "Irv" Rosenthal, Frank L. "Skip" Bowman, Dennis Hendershot, Nancy Leveson, L. Duane Wilson.

Not pictured: Slade Gorton and Douglas A. Wiegmann

James A. Baker, III

Nancy Leveson

Frank L. "Skip" Bowman

Sharon Priest

Glenn Erwin

Isadore "Irv" Rosenthal

Slade Gorton

Paul V. Tebo

Dennis Hendershot

Douglas A. Wiegmann

L. Duane Wilson

PANEL STATEMENT

Process safety accidents can be prevented.

On March 23, 2005, the BP Texas City refinery experienced a catastrophic process accident. It was one of the most serious U.S. workplace disasters of the past two decades, resulting in 15 deaths and more than 170 injuries.

In the aftermath of the accident, BP followed the recommendation of the U. S. Chemical Safety and Hazard Investigation Board and formed this independent panel to conduct a thorough review of the company's corporate safety culture, safety management systems, and corporate safety oversight at its U.S. refineries. We issue our findings and make specific and extensive recommendations. If implemented and sustained, these recommendations can significantly improve BP's process safety performance.

Throughout our review, we focused on being thorough and then letting the chips fall where they may. As our charter contemplates, we allowed BP to comment on our report to ensure its factual accuracy. However, we are solely responsible for our report's final content.

Although we necessarily direct our report to BP, we intend it for a broader audience. We are under no illusion that deficiencies in process safety culture, management, or corporate oversight are limited to BP. Other companies and their stakeholders can benefit from our work. We urge these companies to regularly and thoroughly evaluate their safety culture, the performance of their process safety management systems, and their corporate safety oversight for possible improvements. We also urge the same companies to review carefully our findings and recommendations for application to their situations.

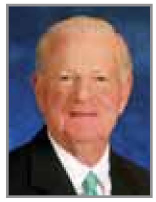
Preventing process accidents requires vigilance. The passing of time without a process accident is not necessarily an indication that all is well and may contribute to a dangerous and growing sense of complacency. When people lose an appreciation of how their safety systems were intended to work, safety systems and controls can deteriorate, lessons can be forgotten, and hazards and deviations from safe operating procedures can be accepted. Workers and supervisors can increasingly rely on how things were done before, rather than rely on sound engineering principles and other controls. People can forget to be afraid.

When systems and controls deteriorate, everything can come together in the worst possible way. Equipment malfunctions and controls fail. An explosion and fire occur. People lose their lives or suffer horrible injuries. Families and communities are devastated.

The burden of these catastrophes is uniquely and unfairly borne by the victims, their families, and their friends. This was the case for the Texas City victims—men and women who were providing a livelihood for themselves and their families. These victims were fathers and mothers, husbands and wives, sons and daughters, and friends. We dedicate our report to the survivors of this tragedy and the memory of those who lost their lives.

This report is dedicated to the survivors of the Texas City tragedy and the memory of those who lost their lives.

PANEL MEMBERS



JAMES A. BAKER, III has served in senior government positions under three United States presidents. He served as the nation's 61st Secretary of State from January 1989 through August 1992 under President George Bush. During his tenure at the State Department, Mr. Baker traveled to 90 foreign countries as the United States confronted the unprecedented challenges and opportunities of the post-Cold War era. Mr. Baker's reflections on those years of revolution, war and peace—*The Politics of Diplomacy*—was published in 1995.

Mr. Baker served as the 67th Secretary of the Treasury from 1985 to 1988 under President Ronald Reagan. As Treasury Secretary, he was also Chairman of the President's Economic Policy Council. From 1981 to 1985, he served as White House Chief of Staff to President Reagan. Mr. Baker's record of public service began in 1975 as Under Secretary of Commerce to President Gerald Ford. It concluded with his service as White House Chief of Staff and Senior Counselor to President Bush from August 1992 to January 1993.

Long active in American presidential politics, Mr. Baker led presidential campaigns for Presidents Ford, Reagan and Bush over the course of five consecutive presidential elections from 1976 to 1992.

A native Houstonian, Mr. Baker graduated from Princeton University in 1952. After two years of active duty as a Lieutenant in the United States Marine Corps, he entered the University of Texas School of Law at Austin. He received his J.D. with honors in 1957 and practiced law with the Houston firm of Andrews and Kurth from 1957 to 1975.

Mr. Baker's memoir—*Work Hard, Study…and Keep Out of Politics! Adventures and Lessons from an Unexpected Public Life*—was published in October 2006.

Mr. Baker received the Presidential Medal of Freedom in 1991 and has been the recipient of many other awards for distinguished public service, including Princeton University's Woodrow Wilson Award, The American Institute for Public Service's Jefferson Award, Harvard University's John F. Kennedy School of Government Award, The Hans J. Morgenthau Award, The George F. Kennan Award, the Department of the Treasury's Alexander Hamilton Award, the Department of State's Distinguished Service Award, and numerous honorary academic degrees.

Mr. Baker is presently a Senior Partner in the law firm of Baker Botts. He is Honorary Chairman of the James A. Baker III Institute for Public Policy at Rice University and serves on the board of the Howard Hughes Medical Institute. From 1997 to 2004, Mr. Baker served as the Personal Envoy of United Nations Secretary-General Kofi Annan to seek a political solution to the conflict over Western Sahara. In 2003, Mr. Baker was appointed Special Presidential Envoy for President George W. Bush on the issue of Iraqi debt. In 2005, he was Co-chair, with former President Jimmy Carter, of the Federal Commission on Election Reform. Mr. Baker and former U.S. Congressman Lee H. Hamilton served as the Co-chairs of the Iraq Study Group, a bi-partisan blue-ribbon panel examining a forward-looking approach to Iraq.

Mr. Baker was born in Houston, Texas in 1930. He and his wife, the former Susan Garrett, currently reside in Houston, and have eight children and seventeen grandchildren.

RETIRED ADMIRAL FRANK L. "SKIP" BOWMAN is a longtime naval officer and former Director of the Naval Nuclear Propulsion Program, and is currently President and Chief Executive Officer of the Nuclear Energy Institute.

Admiral Bowman was born in Chattanooga, Tennessee. He graduated from Duke University in 1966 and immediately began his naval career. In 1973, he completed a dual masters program in nuclear engineering and naval architecture/marine engineering at Massachusetts Institute of Technology (M.I.T), where he was elected to the Society of Sigma Xi. He currently serves on the Engineering Board of Visitors at Duke, the Nuclear Engineering Department Advisory Committee at the University of Tennessee, and on the Visiting Committee for Nuclear Engineering at M.I.T. In March 2006, Admiral Bowman was made an Honorary Knight Commander of the Most Excellent Order of the British Empire in recognition of his support of the Royal Navy nuclear submarine program.

Over the course of his nearly 39-year navy career, Admiral Bowman served aboard six ships, five of which were nuclear submarines, and he commanded the submarine USS City of Corpus Christi and the tender USS Holland. A flag officer since 1991, Admiral Bowman served as Deputy Director of Operations, Joint Staff; Director for Political-Military Affairs, Joint Staff; and Chief of Naval Personnel.

Admiral Bowman was appointed Director, Naval Nuclear Propulsion from 1996 to 2004, during which time he held a joint appointment as Deputy Administrator for Naval Reactors in the National Nuclear Security Administration of the Department of Energy. In that position he was responsible for the operation of more than 100 nuclear reactors aboard Navy aircraft carriers and submarines and in its training and research facilities. Throughout its history—including during Admiral Bowman's tenure—the nuclear navy's safety record has been exemplary. Since 1953, U.S. nuclear warships have logged over 128 million miles in defense of our country.

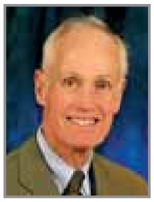
In his role as Director, Naval Nuclear Propulsion, Admiral Bowman testified before the House Science Committee investigating the Columbia Space Shuttle accident. Admiral Bowman's testimony focused on "the organizational culture of safety" that has made naval reactors a safety success.

GLENN ERWIN is the Project Director of the Triangle of Prevention (TOP) Program at the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW) and monitors refinery safety nationwide for the USW.

Mr. Erwin has over 35 years of experience within the petrochemical industry, including working at the Texas City Chemical Plant when it was run by Amoco from 1970 until 1994.

In 1994, Mr. Erwin took leave from Amoco to work in the Health and Safety Department of the Oil, Chemical and Atomic Workers International Union (OCAW). In that capacity, Mr. Erwin assisted in developing the TOP Program and became Director of the program.

Mr. Erwin has extensive experience in accident investigation within the petrochemical industry, and he is very knowledgeable in the area of health and safety. In 2005 he testified before the U.S. Senate Homeland Security and Government Affairs Committee in its examination of the appropriate role of the federal government in efforts to better protect the nation's chemical facilities from terrorist attacks.



SLADE GORTON is a former U.S. Senator from Washington State and member of the 9/11 Commission.

Mr. Gorton's career in public service began in the United States Army from 1945 until 1946. He served in the United States Air Force from 1953 until 1956, and in the Air Force reserves until 1980. Meanwhile, Mr. Gorton practiced law, and was elected to the Washington State House of Representatives in 1958. Mr. Gorton served in the Washington State legislature for 10 years, including two as Majority Leader.

In 1968, Mr. Gorton was elected Attorney General of Washington State, where he served three terms and argued 14 cases before the U.S. Supreme Court. He was elected as a Republican to the United States Senate in 1980, but was defeated for re-election in 1986. He was then elected to his state's other U.S. Senate seat in 1988 and re-elected in 1994. Mr. Gorton was defeated in 2000 in one of the nation's closest contests, losing by only 2,000 votes.

Mr. Gorton served on the National Commission on Federal Election Reform from 2001 to 2002. He also served as a member of the National Commission on Terrorist Attacks upon the United States, popularly known as the 9/11 Commission.

He is currently of counsel at the law firm of Preston Gates Ellis, but served on the Panel in his personal capacity.

Mr. Gorton graduated *magna cum laude* from Dartmouth College in 1950 and earned a law degree from Columbia in 1953.

DENNIS HENDERSHOT is a chemical engineer and has more than 35 years of experience in chemical process research and development, plant design and operation, and process safety. He is currently a Principal Process Safety Specialist at Chilworth Technologies, Inc. and serves as a Staff Consultant to the American Institute of Chemical Engineers' Center for Chemical Process Safety.

Mr. Hendershot recently retired from his position as Senior Technical Fellow in the Process Hazard Analysis Department of the Rohm and Haas Company Engineering Division in Bristol, Pennsylvania. Mr. Hendershot worked at Rohm and Haas for 35 years, starting as a Research Process Engineer there in 1970.

Mr. Hendershot is a Fellow of the American Institute of Chemical Engineers (AIChE) and previously served on the AIChE Board of Directors (2001-2003), as an AIChE Foundation Trustee (2002-2004), and chaired AIChE's Safety and Health Division. In addition to serving as a Staff Consultant to AIChE's Center for Chemical Process Safety, he chairs the Center's Undergraduate Education and Inherently Safer Process Subcommittees. Mr. Hendershot also served on the American Chemistry Council Distribution Risk Task Group from 1997 to 1998 and is a member of the American Chemical Society and its Division of Chemical Health and Safety.

Mr. Hendershot serves on the Editorial Review Boards of *Chemical Engineering Progress, Process Safety Progress, Journal of Loss Prevention in the Process Industries*, and *Chemical Health and Safety*. Author of the chapter "Inherently Safer Plants" in the CCPS book *Guidelines for Engineering Design for Process Safety* (1993) and co-author of *Inherently Safer Chemical Processes: A Life Cycle Approach* (1996), Mr. Hendershot has published extensively on the topics of inherently safer processes and plants, process hazard analysis, risk analysis and risk management, and has published case studies, incident reports, and incident investigations.

In 2000, Mr. Hendershot was recognized by the Mary Kay O'Connor Process Safety Center at Texas A&M University for significant contributions to chemical process safety.

Mr. Hendershot earned his B.S. in chemical engineering from Lehigh University in 1970 and his M.S. in chemical engineering from the University of Pennsylvania in 1978.

DR. NANCY LEVESON is a Professor of Aeronautics and Astronautics and Professor of Engineering Systems at Massachusetts Institute of Technology.

Dr. Leveson works in the field of system safety engineering and pioneered the subdiscipline of software system safety, which considers how to build complex, software-intensive, human-operated systems that can potentially endanger humans, property, or the environment. She authored the book *Safeware: System Safety and Computers* and a new book soon to be published titled *System Safety Engineering: Back to the Future*.

Dr. Leveson has served as a consultant to the NASA Aerospace Safety Advisory Panel, which reports directly to the NASA Administrator and Congress on safety issues. She has also been a member of various committees, including National Research Council panels, on topics such as nuclear power plant safety, automated highways, Space Shuttle upgrades, air traffic management, and various aerospace systems.

Dr. Leveson has served on the blue ribbon task force to investigate a Navy Osprey accident and a blue ribbon task force for the first flight of the Boeing Delta IV. She also served as a consultant to the Columbia Accident Investigation Board and her paper, *What System Safety Engineering Can Learn from the Columbia Accident,* was awarded Best Paper at the 2004 International Conference of the System Safety Society.

Dr. Leveson is a member of the National Academy of Engineering and a Fellow of the Association for Computing Machinery. She has been an elected member of the Boards of Directors of the International Council on Systems Engineering and the Computing Research Association, a member of the National Research Council Advisory Committee to the Division on Engineering and Physical Systems, a member of the ACM Committee on Computers and Public Policy, and Editor-in-Chief of *IEEE Transactions on Software Engineering*.

Dr. Leveson is a recipient of the 1995 AIAA Information Systems Award, the ACM 1999 Allen Newell Award, and the 2004 ACM Sigsoft Award for Outstanding Software Research. In 2003, she was named a Distinguished Professor by the Computer Research Association in recognition of her commitment to advancing women in computer science and engineering and received the CRA Haberman Award.

Dr. Leveson has a B.A. in mathematics, an M.S. from the Graduate School of Management, and a Ph.D. in computer science—all from UCLA.

SHARON PRIEST was the first woman elected Arkansas Secretary of State and is a former President of the National Association for Secretaries of State. She is currently the Executive Director of the Downtown Little Rock Partnership, a non-profit organization devoted to developing downtown Little Rock, Arkansas.

Ms. Priest was first elected to public office as a member of the Little Rock Board of Directors in 1986. She subsequently served as the Vice Mayor of Little Rock from 1989 to 1990 and as Mayor from 1991 to 1992. Ms. Priest was elected Arkansas Secretary of State in 1994 and served for two four-year terms.

Prior to her work as an elected official, Ms. Priest was the founder and owner of the Devlin Company, a property management firm. She also worked as Director of Membership for the Little Rock Chamber of Commerce.

Ms. Priest was named a Toll Fellow in 1995 and has been the recipient of several distinctions, including the Excellence in Leadership Fellowship from the National Women Executives in State Government and the TIME/NASBE Award for Outstanding Leadership in Voter Education.

Ms. Priest is a member of the Commission on Federal Election Reform, co-chaired by former President Jimmy Carter and former Secretary of State James Baker, III. She currently serves on the Board of Directors for the Federal Reserve Bank of St. Louis, Little Rock Branch and the Good Shepherd Ecumenical Retirement Center.

Born in Montreal, Canada, Ms. Priest became a U.S. citizen in 1981.

ISADORE "IRV" ROSENTHAL is a former board member of the U.S. Chemical Safety and Hazard Investigation Board and currently is Senior Research Fellow at the Wharton Risk Management and Decision Processes Center.

Prior to joining Wharton, Dr. Rosenthal was employed at Rohm and Haas for 38 years in a variety of research, business unit and staff positions and was Corporate Director of Health, Safety, Environment and Product Integrity at the time of his retirement from the company in 1990.

Upon his retirement, Dr. Rosenthal joined the Wharton Risk Management and Decision Processes Center to conduct research on low-probability high-consequence chemical process accidents.

In 1998, President William J. Clinton nominated and the Senate confirmed Dr. Rosenthal to serve a five-year term on the U.S. Chemical Safety and Hazards Investigation Board. At the expiration of his term as a board member, Dr. Rosenthal returned to the Wharton Risk Management and Decision Processes Center as a Senior Research Fellow. Dr. Rosenthal's research focuses on designing safety and health management systems that can prevent catastrophic accidents, and he has published numerous papers on this subject.

Dr. Rosenthal currently serves on the Advisory Committee of the USW Tony Mazzocchi Health and Safety Center and the OSHA Reactive Alliance. He previously served as the official U.S. industry delegate to the ILO Convention that developed the Guidelines for the Prevention of Major Industrial Accidents. Dr. Rosenthal has been a member of the Philadelphia Solid Waste Advisory Committee, the OSHA Reform Committee of the American Industrial Hygiene Association (AIHA), the Philadelphia Emergency Response Committee, the Technical Advisory Committee of the Environmental Management Division of the Los Alamos National Laboratory, the OECD Risk Terminology Project Steering Group, the University of California Presidents Council's Environment, Safety & Health Panel, and the EPA Accident Prevention Subcommittee of the Clean Air Act Advisory Committee.

Dr. Rosenthal holds a B.A. with honors from New York University, an M.S. in physical chemistry from Purdue, and a Ph.D. in physical chemistry from Pennsylvania State University.

PAUL V. TEBO is a retired DuPont Vice President and a respected environmental leader who is widely credited with transforming DuPont's environmental stewardship practices. At DuPont, Mr. Tebo also oversaw the company's highly praised safety program, considered by many to be among the industry's best.

Mr. Tebo spent over 35 years at DuPont, working in various positions in research, engineering, and planning, ultimately serving as Vice President and General Manager for DuPont's global petrochemicals business unit. In 1993, he was appointed DuPont's Vice President for Safety, Health and the Environment, a role in which he oversaw DuPont's widely-respected safety operations. In this role, Mr. Tebo also undertook to radically reshape DuPont's environmental practices toward a program of "sustainable growth" and "zero" emission operations.

Mr. Tebo retired in 2004 and is now President of the Tebo Group in West Chester, Pennsylvania.

Mr. Tebo has served as National Director of the American Institute of Chemical Engineers (AIChE), and served as Chair of the Board of Trustees of The Keystone Center and as a member of the Board of Directors of the Stroud Water Research Center. He has received the Environmental Leadership, Conservation Leadership and Spirit of Keystone Awards, as well as the Management Division Award from the American Institute of Chemical Engineers.

Mr. Tebo received a bachelor's degree in chemical engineering from Tufts University in 1965, and a doctorate, also in chemical engineering, from Lehigh University in 1968.

DR. DOUGLAS A. WIEGMANN, Ph.D. is the Director of Human Factors and Patient Safety Research within the Division of Cardiovascular Surgery at the Mayo Clinic.

Prior to coming to Mayo, he was an Associate Professor of Human Factors at the University of Illinois in Urbana-Champaign.

Dr. Wiegmann received his Ph.D. in psychology in 1992 from Texas Christian University and formerly served as an aviation psychologist for both the National Transportation Safety Board and the United States Navy.

He has officially consulted on many major accident investigations of national significance, including the crash of TWA 800, the Columbia Space Shuttle accident, and the August 2003 east coast blackout.

Dr. Wiegmann has published extensively on the topics of human factors and system safety, including a book entitled *A Human Error Approach to Aviation Accident Analysis*. He has twice received the Williams E. Collins Award for outstanding publications in the field of human factors that is conferred by the Aerospace Human Factors Association, of which he is past President. Other major awards include the Flight Safety Foundation's Admiral Louis de Florez Award and the Aerospace Medical Association's Harry G. Moseley Award, both for significant contributions to aviation safety. He has also received the American Psychological Association's prestigious Earl A. Alluisi Award for early career achievement in the field of applied experimental and engineering psychology.

L. DUANE WILSON is the retired Vice President of Refining, Marketing, Supply & Transportation (RMS&T)-Fuels Technology, for ConocoPhillips.

Mr. Wilson joined Conoco Inc. in 1962 and held a series of engineering, supervisory, and executive positions. Early in his career, he served as Assistant Manager and as Director of Conoco's Refining Division of Process Engineering. From 1975 to 1982, he served as Manager of Process Engineering. From 1982 to 1985, he worked for Conoco's former parent company, DuPont, at the Corporate Engineering Department in Wilmington, Delaware. In 1985, he returned to Conoco, Inc., working briefly as Manager of the Maintenance Engineering Department and in 1986, he was named Vice President of Engineering.

Mr. Wilson became Vice President of Research and Engineering in 1988, leading a large organization of scientific, engineering, technical, and support people. In 1994 he was named Vice President, RMS&T—Technology with responsibility for research and development, worldwide engineering and construction, and technical support. He was also the functional leader of the global manufacturing team for the company's refining, marketing, supply and transportation operations.

Mr. Wilson was named Vice President of Fuels Technology in 2001 where he was responsible for leading the company's strategic efforts in the areas of emerging fuels, engine technologies, and manufacturing capabilities. He retired from that position at the end of 2002. Prior to his retirement, Mr. Wilson played an important role in the merger between Conoco, Inc. and Phillips Petroleum Co.

Mr. Wilson currently serves on The University of Tulsa Board of Trustees and on the Board of Directors of i2E, Inc., a not-for-profit corporation focused on growing the technology-based entrepreneurial economy in Oklahoma. He has also served on Governor Keating's Science and Technology Advisory Council Technology Summit, on Oklahoma's Economic Development Generating Excellence (EDGE) Advanced Materials Committee, and as the Chairman of AdMat Oklahoma, affiliated with the Oklahoma Center for the Advancement of Science and Technology.

Mr. Wilson earned a bachelor's degree in chemical engineering from The University of Tulsa and also completed the Advanced Management Program at Harvard Business School.

EXECUTIVE SUMMARY

Background of the Panel's Review

On March 23, 2005, the BP Texas City refinery experienced one of the most serious U.S. workplace disasters of the past two decades, resulting in 15 deaths, more than 170 injuries, and significant economic losses. The U.S. Chemical Safety and Hazard Investigation Board (CSB), an independent federal agency charged with investigating industrial chemical accidents, promptly began an accident investigation that is ongoing.

On August 17, 2005, the CSB issued an urgent safety recommendation to the BP Global Executive Board of Directors that it commission an independent panel to assess and report on the effectiveness of BP North America's corporate oversight of safety management systems at its refineries and its corporate safety culture. In making its urgent recommendation, the CSB noted that the BP Texas City refinery had experienced two other fatal safety incidents in 2004, a major process-related hydrogen fire on July 28, 2005, and another serious incident on August 10, 2005. Based on these incidents and the results of the first few months of its preliminary investigation, the CSB cited serious concerns about:

- the effectiveness of the safety management system at the BP Texas City refinery,
- the effectiveness of BP North America's corporate safety oversight of its refining facilities, and
- a corporate safety culture that may have tolerated serious and longstanding deviations from good safety practice.

The Panel's charter directs it to make a thorough, independent, and credible assessment of the effectiveness of BP's corporate oversight of safety management systems at its five U.S. refineries and its corporate safety culture. The charter further directs the Panel to produce a report examining and recommending needed improvements to BP's corporate safety oversight, corporate safety culture, and corporate and site safety management systems.

BP embraced the urgent recommendation of the CSB to form an independent panel. In a press release issued on August 17, 2005, the company noted that the Texas City explosion was the worst tragedy in BP's recent history and that it would "do everything possible to ensure nothing like it happens again." The company also said it would act promptly to deal with the independent panel's recommendations.

On October 24, 2005, BP announced the formation of the BP U.S. Refineries Independent Safety Review Panel. Former Secretary of State James A. Baker, III chairs the Panel, which includes the following additional members:

- Retired Admiral Frank L. "Skip" Bowman, President and Chief Executive Officer of the Nuclear Energy Institute;
- Glenn Erwin, who monitors refinery safety nationwide for the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union;
- Slade Gorton, former U.S. Senator from Washington State and member of the 9/11 Commission;

- Dennis C. Hendershot, Principal Process Safety Specialist at Chilworth Technologies, Inc., and a Staff Consultant to the American Institute of Chemical Engineers' Center for Chemical Process Safety;
- Nancy G. Leveson, Professor of Aeronautics and Astronautics and Professor of Engineering Systems at the Massachusetts Institute of Technology;
- Sharon Priest, former Arkansas Secretary of State and currently the Executive Director of the Downtown Partnership, a non-profit organization devoted to developing downtown Little Rock, Arkansas;
- Isadore 'Irv' Rosenthal, former board member of the CSB and current Senior Research Fellow at the Wharton Risk Management and Decision Processes Center;
- Paul V. Tebo, former Vice President for Safety, Health, and the Environment of DuPont;
- Douglas A. Wiegmann, Director of the Human Factors and Patient Safety Research Program within the Division of Cardiovascular Surgery at Mayo Clinic in Rochester, Minnesota; and
- L. Duane Wilson, former Vice President, Refining, Marketing, Supply & Transportation—Fuels Technology of ConocoPhillips.

The Panel's Review

PURPOSES AND LIMITATIONS

It is important to emphasize the primary purposes—and also some of the primary limitations—of the Panel's work.

The Panel's charter directs it to make a thorough, independent, and credible assessment of the effectiveness of BP's corporate oversight of safety management systems at its five U.S. refineries and its corporate safety culture. The charter further directs the Panel to produce a report examining and recommending needed improvements to BP's corporate safety oversight, corporate safety culture, and corporate and site safety management systems. The charter does not contemplate that the Panel review environmental issues or general site security issues. A copy of the Panel's charter is attached as Appendix A.

Significantly, the charter also provides that the Panel should not "seek to affix blame or apportion responsibility for any past event" and "should avoid duplicating the efforts of the CSB to determine the specific root causes of the accident at Texas City on March 23, 2005." Both the CSB and BP have investigated the March 23, 2005 accident at Texas City. The Panel understands that the CSB expects to issue the final report on its investigation in the first part of 2007. In addition, on December 9, 2005, BP issued its own investigation report on the Texas City accident.

Since the Panel was not charged to conduct an investigation into the causes of the Texas City accident and did not seek to affix blame or apportion responsibility for that accident, the Panel's focus and the scope of its review have differed from that of the CSB and from the civil litigation relating to that accident. The Panel's review related to all five of BP's U.S. refineries, not just the Texas City refinery. The Panel examined BP's corporate safety oversight, corporate safety culture, and its process safety management systems and not the Texas City accident or any particular incident. The Panel's examination also was not limited to the period preceding the Texas City accident.

Rather than attempting to determine the root cause of, or culpability for, any particular incident, the Panel wanted to understand BP's values, beliefs, and underlying assumptions about process safety, corporate safety oversight, and safety management systems in relation to all of BP's U.S. refineries. The Panel has focused on how these values, beliefs, and underlying assumptions interact with the company's corporate structure, management philosophy, and other systems that operate within that structure to affect the control or management of process hazards in these refineries. The Panel has sought to understand the "why" behind observed deficiencies in process safety performance in order to make recommendations that can enable BP to improve performance at all its refineries. In effect, the Panel's review looked back primarily as a basis for looking forward to improve future process safety performance and to reduce the likelihood of accidents such as the Texas City tragedy.

While the Panel necessarily directs to BP the Panel's recommendations contained in this report, the Panel believes that a broader audience including companies in refining, chemicals, and other process industries should carefully consider the Panel's recommendations.

For a more detailed discussion of the purposes and limitations of the Panel's work, see Section I.

THE PANEL'S ACTIVITIES

As described in more detail in Section I, the Panel developed and followed a multifaceted plan to accomplish the mandate of its charter and the CSB's urgent recommendation. The plan included:

- visits by the Panel and its staff to BP's U.S. refineries;
- public meetings that the Panel conducted in the local communities where the refineries are located;
- interviews of refinery-level personnel and corporate-level managers;
- process safety reviews that technical consultants conducted at BP's U.S. refineries;
- a process safety culture survey conducted among the workforce at BP's U.S. refineries;
- frequent interaction with BP representatives, including periodic briefings by representatives of BP;
- a targeted document review; and
- meetings with other companies relating to their management of process safety.

FOCUS ON PROCESS SAFETY

Not all refining hazards are caused by the same factors or involve the same degree of potential damage. *Personal* or *occupational* safety hazards give rise to incidents—such as slips, falls, and vehicle accidents—that primarily affect one individual worker for each occurrence. *Process* safety hazards can give rise to major accidents involving the release of potentially dangerous materials, the release of energy (such as fires and explosions), or both. Process safety incidents can have catastrophic effects and can result in multiple injuries and fatalities, as well as substantial economic, property, and environmental damage. Process safety refinery incidents can affect workers inside the refinery and members of the public who reside nearby. Process safety in a refinery involves the prevention of leaks, spills, equipment malfunctions, over-pressures, excessive temperatures, corrosion, metal fatigue, and other similar conditions. Process safety programs focus on the design and engineering of facilities, hazard assessments, management of change, inspection, testing, and maintenance of equipment, effective alarms, effective process control, procedures, training of personnel, and human factors. The Texas City tragedy in March 2005 was a process safety accident.

The Panel has focused on *process* safety rather than *personal* safety. The Panel believes that its charter and the CSB's August 2005 urgent recommendation require this focus.

The Panel's Findings

The Panel focused on deficiencies relating to corporate safety culture, process safety management systems, and performance evaluation, corrective action, and corporate oversight.

QUALIFICATIONS RELATING TO THE PANEL'S FINDINGS

The Panel's charter calls for assessments of effectiveness and recommendations for improvement, not for findings related to legal compliance. In making its findings and recommendations, the Panel's objective was excellence in process safety performance, not legal compliance. As a result, the Panel's report and specifically the Panel's findings are not intended for use in legal proceedings to which BP is or may become a party. Rather, the Panel's findings provide a basis for recommendations to BP for making improvements in BP's corporate safety culture, process safety management systems, and corporate safety oversight. The Panel's report focuses primarily on identified deficiencies that might be corrected through the implementation of its recommendations rather than BP's positive attributes that the Panel observed during the course of its review.

The Panel often based its findings and recommendations on general principles of industry best practices or other standards for reducing process risks. Observance of these standards should result in improved safety performance even though many of these standards do not necessarily have legal effect. The Panel's findings are based not only on the information developed during the course of the Panel's review, but also on the collective experience and expertise of the Panel members.

Finally, the Panel's findings are based on its assessment that occurred during 2006. Since the Texas City accident, BP has undertaken or announced a number of measures, including dedicating significant resources and personnel, that are intended to improve the process safety performance at BP's five U.S. refineries. Taken at face value, these measures represent a major commitment to an improved process safety regime. For a brief listing of the measures that BP has undertaken or announced since March 2005, see "BP Post-Texas City Measures" in Appendix F.

In making its findings and recommendations, the Panel's objective was excellence in process safety performance, not legal compliance.

The Panel often based its findings and recommendations on general principles of industry best practices or other standards for reducing process risks.

SUMMARY OF THE PANEL'S FINDINGS

The findings of the Panel are summarized below under three headings: Corporate Safety Culture; Process Safety Management Systems; and Performance Evaluation, Corrective Action, and Corporate Oversight. This summary of findings should be read in conjunction with, and is qualified by, the more detailed discussion of the findings contained in Sections VI.A, B, and C.

Corporate Safety Culture

A positive safety culture is important for good process safety performance. As discussed more fully in Section VI.A, the Panel made findings about BP's process safety leadership, employee empowerment, resources and positioning of process safety capabilities, incorporation of process safety into management decision-making, and the process safety cultures at BP's five U.S. refineries.

Process safety leadership. The Panel believes that leadership from the top of the company, starting with the Board and going down, is essential. In the Panel's opinion, it is imperative that BP's leadership set the process safety "tone at the top" of the organization and establish appropriate expectations regarding process safety performance. Based on its review, the Panel believes that BP has not provided effective process safety leadership and has not adequately established process safety as a core value across all its five U.S. refineries. While BP has an aspirational goal of "no accidents, no harm to people," BP has not provided effective leadership in making certain its management and U.S. refining workforce understand what is expected of them regarding process safety performance. BP has emphasized personal safety in recent years and has achieved significant improvement in personal safety performance, but BP did not emphasize process safety. BP mistakenly interpreted improving personal injury rates as an indication of acceptable process safety performance at its U.S. refineries. BP's reliance on this data, combined with an inadequate process safety understanding, created a false sense of confidence that BP was properly addressing process safety risks. The Panel further found that process safety leadership appeared to have suffered as a result of high turnover of refinery plant managers.

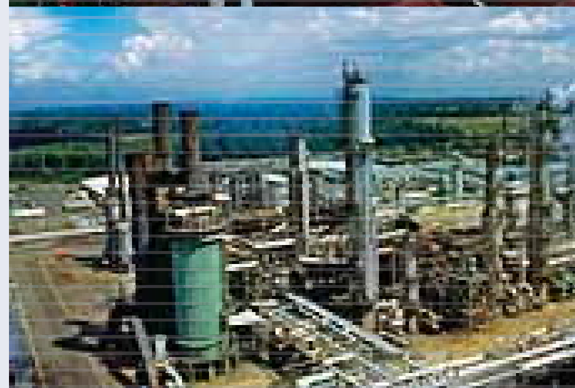
During the course of its review, the Panel has observed a shift in BP's understanding of process safety. As discussed in this report, BP has undertaken a number of measures intended to improve process safety performance. The Panel also recognizes that BP executive management and corporate-level management have more visibly demonstrated their commitment to process safety in recent months.

Employee empowerment. A good process safety culture requires a positive, trusting, and open environment with effective lines of communication between management and the workforce, including employee representatives. Cherry Point has a very positive, open, and trusting environment. Carson appears to have a generally positive, trusting, and open environment with effective lines of communication between management and the workforce, including employee representatives. At Texas City, Toledo, and Whiting, BP has not established a positive, trusting, and open environment with effective lines of communication between management and the workforce, although the safety culture appears to be improving at Texas City and Whiting.

Resources and positioning of process safety capabilities. BP has not always ensured that it identified and provided the resources required for strong process safety performance at its U.S. refineries. Despite having numerous staff at different levels of the organization that support process safety, BP does not have a designated, high-ranking leader for process safety dedicated to its refining business. During the course of its review, the Panel did not develop or identify sufficient information to conclude whether BP ever intentionally withheld resources on any safety-related assets or projects for budgetary or cost reasons. The Panel believes, however, that the company did not always ensure that adequate resources were effectively allocated to support or sustain a high level of process safety performance. In addition, BP's corporate management mandated numerous initiatives that applied to the U.S. refineries and that, while well-intentioned, have overloaded personnel at BP's U.S. refineries. This "initiative overload" may have undermined process safety performance at the U.S. refineries. In addition, operations and maintenance personnel in BP's five U.S. refineries sometimes work high rates of overtime, and this could impact their ability to perform their jobs safely and increases process safety risk. BP has announced plans to increase both funding and hiring at its U.S. refineries.

Incorporation of process safety into management decision-making. The Panel also found that BP did not effectively incorporate process safety into management decision-making. BP tended to have a short-term focus, and its decentralized management system and entrepreneurial culture have delegated substantial discretion to U.S. refinery plant managers without clearly defining process safety expectations, responsibilities, or accountabilities. In addition, while accountability is a core concept in BP's Management Framework for driving desired conduct, BP has not demonstrated that it has effectively held executive management and refining line managers and supervisors, both at the corporate level and at the refinery level, accountable for process safety performance at its five U.S. refineries. It appears to the Panel that BP now recognizes the need to provide clearer process safety expectations.

Process safety cultures at BP's U.S. refineries. BP has not instilled a common, unifying process safety culture among its U.S. refineries. Each refinery has its own separate and distinct process safety culture. While some refineries are far more effective than others in promoting process safety, significant process safety culture issues exist at all five U.S. refineries, not just Texas City. Although the five refineries do not share a unified process safety culture, each exhibits some similar weaknesses. The Panel found instances of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks at each refinery.



Process Safety Management Systems

Section VI.B discusses more thoroughly the Panel's findings relating to the effectiveness of process safety management systems that BP utilized for its five U.S. refineries. These findings relate to BP's process risk assessment and analysis, compliance with internal process safety standards, implementation of external good engineering practices, process safety knowledge and competence, and general effectiveness of BP's corporate process safety management system.

Process risk assessment and analysis. While all of BP's U.S. refineries have active programs to analyze process hazards, the system as a whole does not ensure adequate identification and rigorous analysis of those hazards. The Panel's examination also indicates that the extent and recurring nature of this deficiency is not isolated, but systemic.

Compliance with internal process safety standards. The Panel's technical consultants and the Panel observed that BP does have internal standards and programs for managing process risks. However, the Panel's examination found that BP's corporate safety management system does not ensure timely compliance with internal process safety standards and programs at BP's five U.S. refineries. This finding relates to several areas that are addressed by BP internal standards: rupture disks under relief valves; equipment inspections; critical alarms and emergency shut-down devices; area electrical classification; and near miss investigations.

Implementation of external good engineering practices. The Panel also found that BP's corporate safety management system does not ensure timely implementation of external good engineering practices that support and could improve process safety performance at BP's five U.S. refineries. Such practices play an important role in the management of process safety in refineries operating in the United States.

Process safety knowledge and competence. Although many members of BP's technical and process safety staff have the capabilities and expertise needed to support a sophisticated process safety effort, the Panel believes that BP's system for ensuring an appropriate level of process safety awareness, knowledge, and competence in the organization relating to its five U.S. refineries has not been effective in a number of respects. First, BP has not effectively defined the level of process safety knowledge or competency required of executive management, line management above the refinery level, and refinery managers. Second, BP has not adequately ensured that its U.S. refinery personnel and contractors have sufficient process safety knowledge and competence. The information that the Panel reviewed indicated that process safety education and training needs to be more rigorous, comprehensive, and integrated. Third, the Panel found that at most of BP's U.S. refineries, the implementation of and over-reliance on BP's computer-based training contributes to inadequate process safety training of refinery employees.

Effectiveness of BP's corporate process safety management system. BP has an aspirational goal and expectation of "no accidents, no harm to people, and no damage to the environment," and is developing programs and practices aimed at addressing process risks. These programs and practices include the development of new standards, engineering technical practices, and other internal guidance, as well as the dedication of substantial resources. Despite these positive changes, the Panel's examination indicates that BP's corporate process safety management system does not effectively translate corporate expectations into measurable criteria for management of process risk or define the appropriate role of qualitative and quantitative risk management criteria.

The findings above, together with other information that the Panel obtained during its examination, lead the Panel to conclude that material deficiencies in process safety performance exist at BP's five U.S. refineries. Some of these deficiencies are common among multiple refineries, and some of the deficiencies appear to relate to legacy systems in effect prior to BP's acquisition of the refineries.

BP appears to have established a relatively effective personal safety management system by embedding personal safety aspirations and expectations within the U.S. refining workforce. However, BP has not effectively implemented its corporate-level aspirational guidelines and expectations relating to process risk. Therefore, the Panel found that BP has not implemented an integrated, comprehensive, and effective process safety management system for its five U.S. refineries.

Panel observations relating to process safety management practices. The Panel observed several positive notable practices or, in the case of BP's process safety minimum expectation program, an excellent process safety management practice. The notable practices relate to creation of an engineering authority at each refinery and several other refinery-specific programs that are described in more detail in Section VI.B.

Performance Evaluation, Corrective Action, and Corporate Oversight

Maintaining and improving a process safety management system requires the periodic evaluation of performance and the correction of identified deficiencies. As discussed more fully in Section VI.C, significant deficiencies existed in BP's site and corporate systems for measuring process safety performance, investigating incidents and near misses, auditing system performance, addressing previously identified process safety-related action items, and ensuring sufficient management and board oversight. Many of the process safety deficiencies are not new but were identifiable to BP based upon lessons from previous process safety incidents, including process incidents that occurred at BP's facility in Grangemouth, Scotland in 2000.

Measuring process safety performance. BP primarily used injury rates to measure process safety performance at its U.S. refineries before the Texas City accident. Although BP was not alone in this practice, BP's reliance on injury rates significantly hindered its perception of process risk. BP tracked some metrics relevant to process safety at its U.S. refineries. Apparently, however, BP did not understand or accept what this data indicated about the risk of a major accident or the overall performance of its process safety management systems. As a result, BP's corporate safety management system for its U.S. refineries does not effectively measure and monitor process safety performance.

The process safety performance metrics that BP uses are evolving. BP now monitors at the corporate level several leading and lagging process safety metrics. BP also is working with external experts to review process safety performance indicators across the company and the industry.

Incident and near miss investigations. BP acknowledges the importance of incident and near miss investigations, and it employs multiple methods at different levels of the organization to distribute information regarding incidents and lessons learned. Although BP is improving aspects of its incident and near miss investigation process, BP has not instituted effective root cause analysis procedures to identify systemic causal factors that may contribute to future accidents. When true root or system causes are not identified, corrective actions may address immediate or superficial causes, but not likely the true root causes. The Panel also believes that BP has an incomplete picture of process safety performance at its U.S. refineries because BP's process safety management system likely results in underreporting of incidents and near misses.

Process safety audits. The Panel found that BP has not implemented an effective process safety audit system for its U.S. refineries based on the Panel's concerns about auditor qualifications, audit scope, reliance on internal auditors, and the limited review of audit findings.

The Panel also is concerned that the principal focus of the audits was on compliance and verifying that required management systems were in place to satisfy legal requirements. It does not appear, however, that BP used the audits to ensure that the management systems were delivering the desired safety performance or to assess a site's performance against industry best practices. BP is in the process of changing how it conducts audits of safety and operations management systems, including process safety audits.

Timely correction of identified process safety deficiencies. BP expends significant efforts to identify deficiencies and to correct many identified deficiencies, which BP often does promptly. BP, however, has sometimes failed to address promptly and track to completion process safety deficiencies identified during hazard assessments, audits, inspections, and incident investigations. The Panel's review, for example, found repeat audit findings at BP's U.S. refineries, suggesting that true root causes were not being identified and corrected. This problem was especially apparent with overdue mechanical integrity inspection and testing. Although BP regularly conducts various assessments, reviews, and audits within the company, the follow through after these reviews has fallen short repeatedly. This failure to follow through compromises the effectiveness of even the best audit program or incident investigation.

In addition, BP does not take full advantage of opportunities to improve process operations at its U.S. refineries and its process safety management systems. BP does not effectively use the results of its operating experiences, process hazard analyses, audits, near misses, or accident investigations to improve process operations and process safety management systems.

Corporate oversight. BP acknowledges the importance of ensuring that the company-wide safety management system functions as intended. The company's system for assuring process safety performance uses a bottom-up reporting system that originates with each business unit, such as a refinery. As information is reported up, however, data is aggregated. By the time information is formally reported at the Refining and Marketing segment level, for example, refinery-specific performance data is no longer presented separately.

The Panel's examination indicates that BP's executive management either did not receive refinery-specific information that suggested process safety deficiencies at some of the U.S. refineries or did not effectively respond to the information that it did receive. According to annual reports on health, safety, security, and environmental assurance that BP management provided to the Environment and Ethics Assurance Committee of BP's Board of Directors for 1999 through 2005, management was monitoring process safety matters, including plant and operational integrity issues. The reports identify safety and integrity management risks that various levels of the organization confronted and describe management actions proposed to address and mitigate those risks. From 2001 to 2003, for example, BP developed and implemented standards for process safety and major accident risk assessments and increased monitoring and reporting of action item closure, sharing of lessons learned, overdue planned inspections, and losses of containment. The reports and other documents that the Panel examined indicate, however, that issues persisted relating to assurance of effective implementation of BP's policies and expectations relating to safety and integrity management.

For these reasons, the Panel believes that BP's process safety management system was not effective in evaluating whether the steps that BP took were actually improving the company's process safety performance. The Panel found that neither BP's executive management nor its refining line management has ensured the implementation of an integrated, comprehensive, and effective process safety management system.

BP's Board of Directors has been monitoring process safety performance of BP's operations based on information that BP's corporate management presented to it. A substantial gulf appears to have existed, however, between the actual performance of BP's process safety management systems and the company's perception of that performance. Although BP's executive and refining line management was responsible for ensuring the implementation of an integrated, comprehensive, and effective process safety management system, BP's Board has not ensured, as a best practice, that management did so. In reviewing the conduct of the Board, the Panel is guided by its chartered purpose to examine and recommend any needed improvements. In the Panel's judgment, this purpose does not call for an examination of legal compliance, but calls for excellence. It is in this context and in the context of best practices that the Panel believes that BP's Board can and should do more to improve its oversight of process safety at BP's five U.S. refineries.

The Panel's Recommendations

The Panel was charged with making recommendations to improve BP's corporate safety culture, corporate oversight of process safety, and process safety management systems. For each recommendation below, the Panel has developed commentary that is an integral part of the recommendation and that provides more specific guidance relating to implementation of the recommendation. See Section VII for a discussion of the recommendations and the related commentary. Each recommendation below should be read in conjunction with the related commentary.

RECOMMENDATION # 1 – PROCESS SAFETY LEADERSHIP

The Board of Directors of BP p.l.c, BP's executive management (including its Group Chief Executive), and other members of BP's corporate management must provide effective leadership on and establish appropriate goals for process safety. Those individuals must demonstrate their commitment to process safety by articulating a clear message on the importance of process safety and matching that message both with the policies they adopt and the actions they take.

RECOMMENDATION #2 – INTEGRATED AND COMPREHENSIVE PROCESS SAFETY MANAGEMENT SYSTEM

BP should establish and implement an integrated and comprehensive process safety management system that systematically and continuously identifies, reduces, and manages process safety risks at its U.S. refineries.

RECOMMENDATION #3 – PROCESS SAFETY KNOWLEDGE AND EXPERTISE

BP should develop and implement a system to ensure that its executive management, its refining line management above the refinery level, and all U.S. refining personnel, including managers, supervisors, workers, and contractors, possess an appropriate level of process safety knowledge and expertise.

RECOMMENDATION #4 – PROCESS SAFETY CULTURE

BP should involve the relevant stakeholders to develop a positive, trusting, and open process safety culture within each U.S. refinery.

RECOMMENDATION #5 – CLEARLY DEFINED EXPECTATIONS AND ACCOUNTABILITY FOR PROCESS SAFETY

BP should clearly define expectations and strengthen accountability for process safety performance at all levels in executive management and in the refining managerial and supervisory reporting line.

RECOMMENDATION #6 – SUPPORT FOR LINE MANAGEMENT

BP should provide more effective and better coordinated process safety support for the U.S. refining line organization.

RECOMMENDATION #7 – LEADING AND LAGGING PERFORMANCE INDICATORS FOR PROCESS SAFETY

BP should develop, implement, maintain, and periodically update an integrated set of leading and lagging performance indicators for more effectively monitoring the process safety performance of the U.S. refineries by BP's refining line management, executive management (including the Group Chief Executive), and Board of Directors. In addition, BP should work with the U.S. Chemical Safety and Hazard Investigation Board and with industry, labor organizations, other governmental agencies, and other organizations to develop a consensus set of leading and lagging indicators for process safety performance for use in the refining and chemical processing industries.

RECOMMENDATION #8 – PROCESS SAFETY AUDITING

BP should establish and implement an effective system to audit process safety performance at its U.S. refineries.

RECOMMENDATION #9 – BOARD MONITORING

BP's Board should monitor the implementation of the recommendations of the Panel (including the related commentary) and the ongoing process safety performance of BP's U.S. refineries. The Board should, for a period of at least five calendar years, engage an independent monitor to report annually to the Board on BP's progress in implementing the Panel's recommendations (including the related commentary). The Board should also report publicly on the progress of such implementation and on BP's ongoing process safety performance.

RECOMMENDATION #10 – INDUSTRY LEADER

BP should use the lessons learned from the Texas City tragedy and from the Panel's report to transform the company into a recognized industry leader in process safety management.

The Panel believes that these recommendations, together with the related commentary in Section VII, can help bring about sustainable improvements in process safety performance at all BP U.S. refineries.

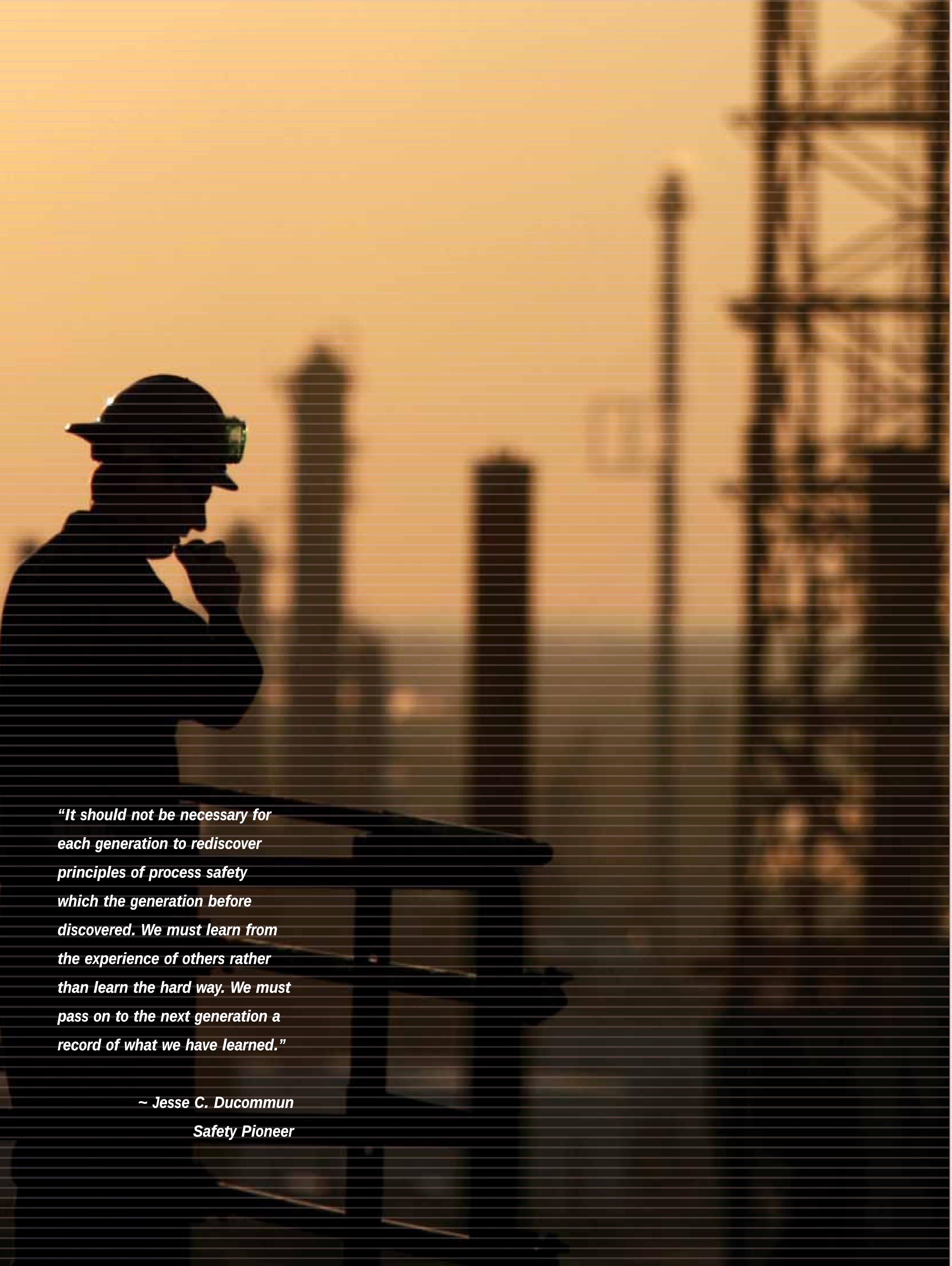
The Panel's recommendations are based on findings developed during 2006. Since March 2005, BP has expressed a major commitment to a far better process safety regime, has committed significant resources and personnel to that end, and has undertaken or announced many measures that could impact process safety performance at BP's five U.S. refineries. For a brief listing of the measures that BP has undertaken or announced since March 2005, see "BP Post-Texas City Measures" in Appendix F. In making its findings and recommendations, the Panel is not attempting to deny the beneficial effect on process safety that these measures may have. BP is a large corporation, and the Panel recognizes that it is especially challenging to make dramatic and systemic changes in short time frames. Whether measures already undertaken or announced will be effective, and whether BP will promptly and thoroughly implement the Panel's recommendations, remains to be seen. The ultimate effectiveness and sustainability of BP's intended improvements to its process safety performance can be determined only over time. The Panel believes that BP has much work remaining to improve the process safety performance at its U.S. refineries. BP should assess its future steps, including actions already planned as of the date of this report, against the Panel's findings and recommendations (and related commentary) contained in this report.

The Panel's recommendations and related commentary contain elements designed to ensure that measures taken will sustain improvement in process safety performance. The Panel believes this emphasis on sustainability is particularly important given BP's failure to fully and comprehensively implement across BP's U.S. refineries the lessons from previous serious accidents, including the process incidents that occurred at BP's facility in Grangemouth, Scotland in 2000. The Panel's recommendations, and the process safety excellence that those recommendations contemplate, should not be abandoned or neglected. They should not become lesser priorities as changes occur in the economic, business, or regulatory climate for the U.S. refining industry; as refinery margins decline from their current high levels; as changes occur at BP, including changes in management; or as mergers and acquisitions take place.

The Panel believes that the investments in BP's refining business and its refining workforce that this report suggests can benefit the company in many ways over time. Such investments should help reduce the economic or opportunity costs associated with a refinery operating at less than full capacity or not operating at all. Other potential benefits of investments in operations and process safety, such as improved workforce morale and increased productivity, may be difficult to measure but are no less important. The Panel believes that as process safety is embedded in all aspects of corporate culture, management systems, and operations relating to BP's U.S. refineries, BP's U.S. refining business will benefit.

The Panel recognizes that the task ahead of BP is significant and will take a concerted and lasting effort. It will not be easy, especially as time passes and the collective recognition of the importance of the task begins to fade. The ultimate effectiveness and sustainability of many measures intended to improve process safety performance can be determined only over time. The Panel believes, however, that the BP refining workforce is ready, willing, and able to participate in a sustained, corporate-wide effort to move BP towards excellence in process safety performance as called for in this report. Over the past twelve months, the Panel interacted with a large number of BP employees, contractors, managers, and executives. The Panel generally came away with favorable impressions of these people. As a group, they appear hardworking and conscientious. Most importantly, they appear sincerely interested in improving BP's management of process safety to prevent future incidents like the Texas City tragedy. This was the case at the Carson, Cherry Point, Texas City, Toledo, and Whiting refineries and in BP's corporate offices in Chicago and London.

Finally, the Panel believes that all companies in the refining, chemical, and other process industries should give serious consideration to its recommendations and related commentary. While the Panel made no findings about companies other than BP, the Panel is under no illusion that the deficiencies in process safety culture, management, or corporate oversight identified in the Panel's report are limited to BP. If other refining and chemical companies understand the Panel's recommendations and related commentary and apply them to their own safety cultures, process safety management systems, and corporate oversight mechanisms, the Panel sincerely believes that the safety of the world's refineries, chemical plants, and other process facilities will be improved and lives will be saved.



"It should not be necessary for each generation to rediscover principles of process safety which the generation before discovered. We must learn from the experience of others rather than learn the hard way. We must pass on to the next generation a record of what we have learned."

~ Jesse C. Ducommun
Safety Pioneer

TABLE OF CONTENTS

I. THE PANEL'S REVIEW

A. Scope and Methodology

The Panel developed and followed a multifaceted plan of review designed to accomplish the broad mandate of its charter[1] and the August 2005 urgent recommendation of the Chemical Safety and Hazard Investigation Board (CSB).[2] The plan of review included

- visits by the Panel and its staff to BP's U.S. refineries;
- public meetings that the Panel conducted in the local communities where the refineries are located;
- interviews of refinery-level personnel and corporate-level management;
- process safety reviews that technical consultants conducted at BP's U.S. refineries;
- a process safety culture survey conducted among the workforce at BP's U.S. refineries;
- frequent interaction with BP representatives, including periodic briefings by BP representatives;
- a targeted document review; and
- meetings with other companies relating to their management of process safety.

The Panel's efforts have necessarily been intrusive to BP's U.S. refining operations in many respects. Nevertheless, it has been apparent to the Panel that BP values the Panel's efforts to make sustained improvements to BP's process safety performance at its U.S. refineries. BP has devoted substantial time and resources to support these efforts, including facilitating Panel visits to refineries, making BP personnel and facilities available to the Panel for interviews, providing briefings on selected topics, providing documents for examination, and making personnel, documents, and facilities available for the process safety technical reviews. The Panel acknowledges BP's cooperation and assistance throughout the review process.

VISITS TO THE REFINERIES AND PUBLIC MEETINGS

As part of its review, the Panel made formal visits to each of BP's U.S. refineries. These visits included a physical tour of the refinery, as well as a meeting with the refinery leadership team. At these meetings, refinery leadership made presentations to the Panel, and the Panel asked questions of the leadership team about topics relevant to the Panel's review. These meetings typically lasted several hours.

During its visit to each of the refineries, the Panel also conducted a public meeting to provide an opportunity for members of the refinery workforce and the local community to communicate directly with the Panel about topics relevant to the Panel's review. The Panel held a public meeting at Texas City, Texas in December 2005; at Carson, California in January 2006; at Whiting, Indiana in February 2006; at Toledo, Ohio in April 2006; and at Cherry Point, Washington in May 2006. In advance of each meeting, the Panel placed advertisements in local newspapers announcing the time and place of the meeting and inviting anyone to attend and make a statement to the Panel. These meetings were scheduled in the early evening in an effort to make attendance as convenient as possible.

Secretary James A. Baker, III chaired each public meeting, which Panel members attended and which typically lasted approximately two hours. Those wanting to address the Panel were provided time to make a statement. Panel members then asked follow-up questions.

INTERVIEWS OF BP REFINERY PERSONNEL AND CORPORATE-LEVEL MANAGEMENT

During 2006, the Panel and its staff interviewed more than 700 people including, hourly workers, refinery management, and other personnel at each of BP's U.S. refineries. The Panel and its staff also interviewed BP corporate-level managers in Houston, Chicago, London, and elsewhere. One or more Panel members attended and participated in most corporate-level interviews, while the Panel's staff conducted most on-site refinery interviews. Finally, the Panel also interviewed several retired executives from BP and BP-heritage companies and met with representatives of various regulatory agencies. The interviews encompassed a broad range of topics relating to BP's corporate safety oversight, corporate safety culture, and corporate and site safety management systems.

> Interviews with hourly workers

The Panel's staff interviewed hourly workers at the refineries, both BP employees and contractors, who for the most part were operations and maintenance personnel. At BP's Carson, Texas City, Toledo, and Whiting refineries, the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW) represents the vast majority of such BP employees, while other unions often represent the contractors. The BP hourly employees at Cherry Point are not unionized.

At each of the five refineries, the Panel's staff interviewed a broad cross-section of hourly employees who were believed to be representative of the general hourly workforce, including employees of different positions, crafts, and seniority. The Panel's staff selected BP hourly employees at the Carson, Texas City, Toledo, and Whiting refineries from lists that BP and the USW compiled jointly and at Cherry Point from a list that BP compiled individually.

The Panel's staff attended each of these interviews. Neither an attorney nor any other representative of BP or the USW attended these interviews. A court reporter did not attend, and a transcript was not made. The interviewee was not placed under oath, and the interviewee's cooperation was entirely voluntary.

An interview typically lasted between 60 and 90 minutes. Each interview began with the Panel's staff member informing the interviewee that he or she did not represent the individual interviewee, BP, or the USW. Panel staff also communicated to each interviewee that while the Panel could provide no guarantees, the Panel would do everything in its power to protect the confidentiality of the interviewee. Additionally, each interviewee was assured that the substance of the interview would not be shared with BP and was offered anonymity in the interview process, if he or she so desired.

The interviews generally took place over the course of a full week at each of the refineries. The Panel's staff interviewed 55 BP hourly employees and 5 contractors at Carson; 69 BP hourly employees and 6 contractors at Cherry Point; 81 BP hourly employees and 10 contractors at Texas City; 52 BP hourly employees and 6 contractors at Toledo; and 67 BP hourly employees and 9 contractors at Whiting. The Panel and its staff acknowledge BP's cooperation and assistance in scheduling and making BP personnel available for these interviews. The Panel believes that, in general, the hourly workers were candid during their interviews.

> Interviews with refinery managers, supervisors, and professionals

The Panel's staff also interviewed a cross-section of refinery-level managers, supervisors, and professionals. These interviewees included senior-level managers, who are sometimes referred to as the Extended Leadership Team; most, if not all, of the personnel in the Health, Safety, Security, and Environment (HSSE)[3] department; other professional and technical personnel, including those with responsibility for process safety and engineering matters; and a broad cross-section of superintendents, shift foremen, and first level leaders across different operating units. The Panel's staff selected the interviewees based upon its review of refinery organizational charts, documents that the Panel's staff had reviewed, and information obtained from hourly interviews.

The interviews spanned one full week at Cherry Point, Toledo, and Whiting, and more than a week at Carson and Texas City. The interviews generally ranged from about 90 minutes for first level leaders to three or four hours for refinery managers. The Panel's staff conducted each interview, and at least one attorney for BP attended the interviews of Extended Leadership Team members for each refinery, as well as the interview of any other BP manager who wished to have company counsel present. BP managers were not questioned under oath, no court reporter was present, no transcript was made, and the Panel's staff necessarily relied on the voluntary cooperation of the interviewees.

The Panel's staff interviewed 88 managers, supervisors, and professionals at Carson; 45 at Cherry Point; 88 at Texas City; 68 at Toledo; and 60 at Whiting. The Panel received a high degree of cooperation from BP in scheduling these interviews. The Panel believes that, in general, the BP refinery managers, supervisors, and professionals were candid during their interviews.

> Interviews with corporate-level management

The Panel and its staff interviewed a number of BP corporate-level managers who were outside of the refineries. These interviews included both refining line managers and managers with staff positions that support overall management of process safety performance in the U.S. refineries. The interviews also included executive-level management, namely John Browne, Group Chief Executive, and John Manzoni, Chief Executive, Refining and Marketing. The Panel and its staff also interviewed corporate-level managers in the Refining and Marketing segment, as well as Group-level managers who provide functional support to the U.S. refineries in areas such as integrity management, technology and engineering, and safety and operations. BP made every corporate-level manager available whom the Panel requested to interview. The BP corporate-level interviewees included the individuals listed below.

Executive Management

John Browne—Group Chief Executive, BP p.l.c.

John Manzoni—Chief Executive, Refining and Marketing

U.S. Region Management

Ross Pillari—President and Chief Executive Officer, BP America, Inc. (at time of interview)

Refining Line Management

Mike Hoffman—Group Vice-President, Refining

Pat Gower—Refining Vice-President, U.S. Region

Group Level Support Staff

Safety and Operations

John Mogford—Senior Group Vice-President

Jim O'Brien—Vice-President, Safety and Operations Audit

Michael Broadribb—Director, Process Safety

Gill Morrison—Vice-President, Organization Capability

Technology

Tony Meggs—Group Vice-President, Technology

John Baxter—Group Engineering Director

Peter Elliott—Head of Integrity Management

Mike Considine—Head of Major Hazards and Fire

Other

Greg Coleman—former Group Vice-President, HSSE

Refining and Marketing Segment Support Staff

HSSE and Technology

C.J. Warner—Group Vice-President, HSSE and Technology, Refining and Marketing

Chris London—former Head of Projects and Integrity Management, Refining and Marketing (at time of interview); currently Technology Vice-President, Projects and Engineering, Refining and Marketing

Krish Raju—Vice-President, HSSE Refining and Marketing

Lee Valentine—HSSE Program Director, Refining and Marketing (at time of interview); currently Manager Process Safety Management (within Operations Management System program)

Pat King—former Vice-President, HSSE Refining and Marketing; currently HSSE Manager, Texas City refinery

Refining Support Staff

Technology

Paul Maslin—Technology Vice-President, Refining

Hugh Parsons—Manufacturing Excellence Manager, Refining

Tom Cerwinske—Engineering Authority Manager, Refining

Kim Bucek—HSSE Network Leader, Refining

Mark Preston—Process Safety Advisor, Refining (at time of interview)

HRO Manager

Colin Reid—HRO

Other

Terry Perardi—Financial Controller, Refining-U.S. Region

U.S. Program Office

Jonathan Mills—Director, U.S. Refining Program Office

Bob Wallace—Manager Initiative Delivery, U.S. Refining Program Office

The corporate-level interviews were conducted in Houston, Chicago, New York, Washington, D.C., Los Angeles, and London, and they generally lasted between two and five hours. In addition to the Panel's staff, Panel members frequently attended and participated in these interviews. Counsel for BP also attended these interviews. No court reporter was present, no transcript was made of the interviews, and the interviewees were not questioned under oath. Accordingly, the Panel necessarily relied upon the voluntary cooperation of the interviewees. The Panel received a high degree of cooperation from BP in scheduling these interviews, and the Panel was satisfied with the interviewees' candor.

PROCESS SAFETY REVIEWS

The CSB's urgent recommendation provides that the Panel should examine and recommend improvements not only to BP's corporate safety oversight and corporate safety culture, but also to specific corporate and site safety-management systems, including

- near miss reporting and investigation programs;
- mechanical integrity programs;
- hazard analysis programs, management-of-change programs, and up-to-date operating procedures for processes with catastrophic potential; and
- siting policies for occupied structures near hazardous operating units.

The Panel developed a scope of work for its examination of these and other process safety management programs at BP's U.S. refineries. This examination was accomplished primarily through independent technical consultants, ABSG Consulting Inc. and J.L. McCavit Consulting, LLC, that conducted process safety management reviews at BP's U.S. refineries. ABSG Consulting is a global process safety and risk management firm headquartered in Houston, Texas that has been providing process safety services in the refining industry for more than 25 years and that has significant experience as an independent third-party auditor. Jack L. McCavit, a process safety consultant who specializes in process safety management systems, has more than 35 years of industrial experience with technical, operations, and process safety management. Mr. McCavit served as the Panel's technical project manager, participated in the technical reviews, and coordinated the review teams' efforts with other Panel activities. For a listing of the names of the individual technical consultants and information about the process safety review team leaders, see the technical consultants' report to the Panel attached as Appendix E.

Under the scope of work that the Panel developed, the consultants reviewed, among other things, process safety management programs, procedures, and actual performance at BP's U.S. refineries. In evaluating BP's process safety programs, the technical consultants compared these programs to applicable regulations including the process safety management standard, 29 C.F.R. § 1910.119, issued by the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA) promulgated, and the risk management program requirements, 40 C.F.R. Part 68 established by the U.S. Environmental Protection Agency (EPA). In addition, the technical consultants compared BP's process safety management systems against selected external codes, standards, industry best practices, recommended practices, and other external guidance, including guidance from the American Petroleum Institute (API), the Center for Chemical Process Safety of the American Institute of Chemical Engineers (CCPS), and the American Chemistry Council. The technical consultants also evaluated each refinery's compliance with applicable BP internal standards, policies, and procedures.

In defining the scope of the consultants' technical reviews, the Panel emphasized that the reviews should focus not only on the process safety management systems in place at each refinery, but also on actual performance and documentation of performance. While the Panel wanted to ensure that each refinery had appropriate process safety management systems in place, it was equally concerned with determining whether these systems were followed in practice or were merely "paper systems."

The Panel did not intend for the technical reviews to represent "wall-to-wall" audits or inspections of the refineries. The Panel did not view such extensive activities as necessary to fulfill its mandate of reviewing the effectiveness of process safety management systems or to be reasonable given the combined size and complexity of BP's U.S. refineries. Instead, the Panel directed the technical consultants to review representative aspects of process safety performance and management systems at the refineries. The Panel believed that such a representative review involving a sampling of items would provide an appropriate foundation for conclusions about the effectiveness of BP's overall process safety management system.

Consequently, the depth and breadth of the technical reviews varied. The technical consultants reviewed the process safety management systems at BP's U.S. refineries against applicable OSHA process safety management and EPA risk management program regulatory requirements. However, the technical consultants did not attempt to review all units at any particular refinery. Similarly, they did not attempt to review BP's process safety management programs, procedures, and actual performance against all external guidance, which includes standards, recommended practices, best practices, and good engineering practices. Instead, the technical consultants reviewed BP programs, procedures, and performance only against selected external guidance. Specifically, the technical consultants reviewed BP's U.S. refineries' adherence to applicable codes and practices relating to safety shut-down systems, area electrical classification, fired heaters, and facility siting. After the technical consultants identified what in their professional judgment represented an area of deficiency, they moved on to another aspect of their review. For this reason, the technical consultants did not attempt to catalog every potential process safety issue or concern at BP's U.S. refineries. Rather, the technical consultants sampled a sufficient number of items to permit them to express a view on the effectiveness of various aspects of BP's process safety management system.

> Technical reviews at Carson, Cherry Point, Toledo, and Whiting

The Panel's technical consultants performed process safety management reviews at the Carson, Cherry Point, Toledo, and Whiting refineries from February through June 2006. A five- or six-person team conducted each of the reviews during two-week site visits. BP generally made relevant documents available to the technical consultants either in advance of or during the site visit. The technical consultants also interviewed personnel at the site, including BP refinery management, supervisors, hourly employees, and contractors. BP's legal counsel attended interviews of the refinery manager at each refinery, as well as interviews of those who directly report to the refinery manager.

As part of their reviews, the Panel's technical consultants followed a general practice of coordinating with refinery personnel at the end of each day to confirm factual information and to review plans for the next day. If the consultants identified a condition that they considered an imminent hazard, they immediately informed refinery personnel of their concerns. The technical consultants identified one such imminent hazard during their review—the Whiting rupture disk situation discussed elsewhere in this report, including Appendix D. The Panel subsequently provided BP with written preliminary factual findings that the technical consultants compiled from their reviews. These communications allowed BP to consider and address factual findings from the reviews without waiting until the Panel issued its final report. As a result, BP was afforded the opportunity to take immediate steps to address the findings.

> Additional review related to Whiting rupture disks

As discussed in greater detail elsewhere in this report, during the course of their review at the Whiting refinery in March 2006, the technical consultants discovered pressure between several rupture disks and pressure relief valves on a fractionator tower of a particular unit. The technical consultants reviewed quarterly operator logs for the previous two years for that tower, and each log indicated higher than intended pressure for seven of eight rupture disks/relief valves. The technical consultants immediately notified Whiting refinery management of the discovery. BP quickly corrected the condition, issued a high potential incident announcement (HiPo) within its refinery system, and launched an investigation into the root causes of the incident. For the purpose of conducting their own root cause analysis, the technical consultants made a return visit to the Whiting refinery. Appendix D summarizes the results of this follow-up examination.

> Technical review at Texas City

The Panel's technical review at the Texas City refinery differed from the reviews at the other refineries. Under a September 2005 Settlement Agreement between BP Products North America, Inc. and OSHA, BP retained a separate process safety consulting firm to audit process safety management systems at Texas City. The OSHA settlement, which resolved allegations of safety-related violations that OSHA had identified after the Texas City incident, required this audit to be comprehensive and conducted in accordance with industry best practices.

BP requested that the Panel use the OSHA settlement audit and related field work instead of having a separate team of the Panel's own process safety consultants conduct a similar on-site review at Texas City at approximately the same time. BP stated that its principal reason for this request was to avoid any additional disruption at the Texas City refinery that could result from a second, similar review of process safety systems conducted so close in time to the work of the auditor under the OSHA settlement. The Panel agreed to BP's request, subject to several conditions designed to ensure, from the Panel's perspective, the integrity and thoroughness of the work of the other auditor. For instance, the Panel obtained commitments that BP would provide the auditor under the OSHA settlement with full and unfettered access to the Texas City refinery. The Panel also required that one or more of its independent process safety consultants have the opportunity to be present on site to observe the work the other auditor was doing and to conduct any additional process safety review and/or audit work at the Texas City refinery that the Panel deemed necessary. The auditor under the OSHA settlement completed its review in early June 2006.

PROCESS SAFETY CULTURE SURVEY

To assess the beliefs and attitudes of BP's workforce concerning process safety culture and process safety management systems, the Panel developed and supervised the administration of a process safety culture survey among BP's U.S. refinery employees and contractors. The Panel selected International Survey Research, L.L.C. (ISR) to assist with the survey. ISR is a global employee research and consulting firm that designs and implements employee, management, and customer surveys. ISR provided consulting support and assistance to the Panel in conducting and coordinating survey administration, compiling survey responses, and analyzing survey results.

The survey was conducted concurrently at all of BP's U.S. refineries in May 2006. Approximately 7,500 of the employees and contractors at the refineries participated voluntarily and on an anonymous basis.

Throughout Sections VI.A, VI.B, and VI.C, the Panel uses data from the process safety culture survey. The Panel believes that its review, findings, and recommendations relating to process safety have been informed by, and improved through, the responses received from refinery employees and contractors who participated in the survey. The Panel wishes to thank all survey participants for taking part in the survey and joining in the Panel's efforts to make BP's U.S. refineries safer places to work.

> The survey instrument

After considering a number of existing survey assessment tools previously used to evaluate safety culture in a variety of industries, the Panel determined that an appropriately tailored process safety survey or other benchmarking tool did not exist. As a result, the Panel developed its own survey instrument, drawing in particular on the expertise of those Panel members with experience in developing and administering workforce surveys. Consistent with its focus on process safety, the Panel developed a survey instrument that focused on process safety rather than personal safety or safety generally. A copy of the survey instrument is attached as Appendix G.

The survey instrument solicited employment and background information from each survey participant, including current job position and work history. This background information allowed the Panel to compare the responses of different groups of employees and contractors as part of the Panel's overall analysis of process safety culture at BP's U.S. refineries. To alleviate potential concerns about anonymity, the survey instructions made clear that summary or statistical reports would not be prepared for any group of fewer than 15 people. The survey instructions also emphasized the anonymous nature of the survey and provided that neither the Panel nor BP would attempt to determine the identity of any survey participant.

The survey solicited each participant's views on 65 statements or survey items related to process safety culture at the participant's workplace. None of the statements described a culture as being good or bad overall. Instead, the statements were designed to invoke participants' perceptions regarding various aspects of process safety culture in their workplace. The statements were grouped into six categories: process safety reporting, safety values/commitment to process safety, supervisory involvement and support, procedures and equipment, worker professionalism/empowerment, and process safety training. A survey participant could choose one of five responses for each statement: "Agree"; "Tend to Agree"; "?" ("do not know or do not have an opinion"); "Tend to Disagree"; or "Disagree."

> Survey administration

On behalf of the Panel, ISR administered the survey concurrently at each of BP's five U.S. refineries during the two-week period beginning May 8, 2006. Prior to administration of the survey, the Panel and ISR provided the refineries with information relating to the upcoming survey. This information included a video that educated the refinery workforce about the Panel, announced the upcoming survey and its importance to the Panel's work, and encouraged refinery workers to participate in the survey. The video included statements from Secretary Baker, the Panel's Chairman; Carolyn W. Merritt, Chairman of the CSB; and Leo W. Gerard, USW President. ISR encouraged potential participants to view the video before completing the survey instrument.

During the administration period, two-person (or, in the case of Texas City, four-person) teams from ISR

- introduced the survey, addressing (1) steps taken to promote the integrity of the survey and the anonymity of survey respondents and (2) how the survey differed from surveys administered previously by or on behalf of BP;
- described the Panel's intent in conducting the survey;
- showed the video; and
- responded to potential participants' questions or needs relating to the survey.

For the convenience of refinery workers and to facilitate the Panel's goal of a high response rate, ISR administered the survey in both paper- and Web-based formats. A refinery worker with Internet access could complete the survey in either format. To maintain the integrity of the survey results, the survey system permitted submission of only one completed survey from each refinery worker. Finally, ISR team members scheduled sessions at each refinery site for completion of the survey in paper format. A majority (61 percent) of survey respondents completed surveys in paper format.

> Survey response rates

The overall survey response rate was 72 percent, with 7,451 of 10,298 refinery employees and contractors taking the survey. The response rate was 67 percent at Carson (1,031 of 1,544); 74 percent at Cherry Point (1,078 of 1,450); 76 percent at Texas City (3,467 of 4,553); 71 percent at Toledo (531 of 751); and 65 percent at Whiting (1,292 of 2,000).

> Description of survey responses

The wording of each survey item determined whether a particular response to the item was positive or negative from a process safety culture perspective. Some survey items were worded positively, and others were worded negatively, from both a grammatical and a process safety standpoint. As a result, an "agree" or "tend to agree" response to a survey item was not always positive from a process safety culture perspective, and a "disagree" or "tend to disagree" response was not always negative from a process safety culture perspective. Some examples of actual survey items illustrate this point.

- Survey Item 1: "This refinery provides adequate training on hazard identification, control and reporting." This item is worded positively, both from a grammatical and a process safety culture standpoint. As a result, responding "agree" or "tend to agree" would be positive from a process safety culture perspective, and responding "disagree" or "tend to disagree" would be negative from a process safety culture perspective.

- Survey Item 4: "In general, workers don't bother to report minor process-related incidents, accidents, or near misses." This item is worded negatively, both from a grammatical and a process safety culture standpoint. As a result, responding "agree" or "tend to agree" would be negative from a process safety culture perspective, and responding "disagree" or "tend to disagree" would be positive from a process safety culture perspective.
- Survey Item 20a: "Workers at this refinery feel pressure to work considerable overtime from: Co-workers." Although this item is worded positively from a grammatical standpoint, it is worded negatively from a process safety culture standpoint. Responding "agree" or "tend to agree" would therefore be negative from a process safety culture perspective, and responding "disagree" or "tend to disagree" would be positive from a process safety culture perspective.

For clarity, when discussing survey results in this report, the Panel typically indicates whether a particular response is positive or negative from a process safety culture perspective.

> Considerations and limitations relating to survey data

Because survey data differ in some respects from other information that the Panel gathered, the Panel highlights certain considerations and limitations relating to survey data generally and to the survey data included in this report specifically. These considerations and limitations are summarized below.

Nature of survey data. Survey data generally reflect impressions, beliefs, and opinions of the group being surveyed. Responses to the survey conducted on the Panel's behalf reflect impressions, beliefs, and opinions of approximately 72 percent of the workforce at BP's U.S. refineries about the process safety cultures existing at those refineries. Survey responses, however, do not necessarily reflect facts regarding the subject matter of the survey items, in part because of the possibility that not all respondents had first-hand knowledge regarding that subject matter. As discussed in more detail below, the Panel focused mainly on survey data from refinery personnel whose job functions likely involved some degree of familiarity with process hazards and process safety practices. The Panel believes that this focus increased the likelihood that respondents would be familiar with the subject matter of survey items related to process safety. Nonetheless, the Panel does not construe survey responses as facts, but as data providing insights into perceptions of refinery personnel concerning process safety culture in their refineries.

Absence of external benchmark data or baseline. As discussed above, the Panel developed the survey instrument used to assess process safety perspectives of BP's U.S. refinery workforce. Prior to such development, a substantially similar survey instrument did not exist. As a result, two limitations relating to analysis of the survey data should be noted. First, no normative standards or external benchmark data exists against which the BP U.S. refinery workforce survey results can be measured. In other words, survey data do not exist from any group that had taken the same survey, and thus the Panel cannot use the survey data it obtained to conclude whether BP's U.S. refineries are perceived to have a more or less positive safety culture than other refineries. While the Panel acknowledges this limitation, the Panel believes that the survey data nonetheless provide valuable insights into and opportunities for BP to improve the process safety cultures at its five U.S. refineries. For example, with the survey data from BP's U.S. refining workforce, the Panel can compare survey results between one refinery and another or between one job function and another. The Panel believes that these types of comparisons provide valuable information for possible process safety culture improvement.

Second, the survey was not conducted previously among BP's refining workforce. As a result, the Panel does not have baseline survey data against which it can compare current data to conclude whether process safety cultures are improving, worsening, or stabilizing at BP's U.S. refineries. The Panel acknowledges this limitation but nevertheless believes that the "snapshot picture" that the survey data reveal provides valuable insights into the process safety cultures at BP's U.S. refineries as of May 2006, when the survey was conducted.

The Panel is also mindful, as readers of this report should be, that no specific response percentage for any survey item can be regarded as a definitive indicator of a strong or weak process safety culture. The Panel acknowledges that for some non-safety-related workforce surveys, achieving positive response rates of more than 60 percent might be viewed favorably. The Panel believes, however, that response rates to a survey relating to process safety, which involves potentially catastrophic accidents, should be viewed differently from workforce surveys generally. To some extent, this is intuitive. For example, negative responses to survey items on whether workers like their bosses or whether workers are happy in their jobs have different implications than do negative responses about whether workers believe that a culture exists that encourages raising process safety concerns. Given the importance of process safety to the well-being of a refinery workforce and the community in which a refinery is located, the Panel believes that it should use more stringent criteria, or effectively "raise the bar," in its evaluation of the process safety culture survey data. Rather than starting with a view that 60 percent or 75 percent positive response rates are acceptable, favorable, or "good enough," the Panel believed it was important to review more critically departures from 100 percent positive response rates.

The Panel generally viewed positive response rates greater than 80 percent and negative response rates less than 20 percent as indicating an overall positive perception of the process safety culture characteristic at issue. However, the Panel tended to view negative response rates approaching or exceeding 20 percent as deserving of increased attention and focus from BP management. The Panel believes that BP management's particular attention and focus is warranted when negative response rates exceed 25 percent. The Panel does not believe that definitive guidance exists to define for BP a level of negative survey responses that should trigger an immediate response. The Panel believes, however, that it is important to share survey data with BP for its consideration and possible use in achieving its stated goal of continuous risk reduction, even when the data may be viewed as presenting concerns of a more moderate, rather than critical, nature. As a result, the Panel has chosen to err on the side of providing more, rather than less, process safety culture survey data for BP's consideration.

Groupings by job functions and process safety functional groups. In this report, the Panel sometimes presents survey data on the basis of job functions of the respondents. For analytical purposes, the Panel generally presents survey data for certain respondents: contractors and one or more of nine employee groups whose job functions likely involve some degree of on-site exposure to process safety hazards and process safety practices at BP's U.S. refineries. The Panel sometimes refers to the employee groups as the "process safety functional groups," which include

- operators,
- operations management,
- maintenance/craft technicians,
- maintenance/turnaround planners,
- maintenance management,
- full-time HSSE employees,
- learning and development/training employees,
- engineering professionals, and
- project management (engineering).

The Panel generally elected not to report survey data on an individual basis for three of these groups—maintenance/turnaround planners, learning and development/training employees, and project management (engineering). This decision was driven in large part by the relatively small (fewer than 15) number of respondents in some of these groups at some of the refineries. The Panel's guidelines developed to preserve anonymity prevented that data from being available, and, as a result, the Panel's ability to make inter-refinery comparisons for these groups was hindered. When referring to survey data based on individual employee groups, the Panel sometimes refers to the remaining six employee groups as the "six process safety functional groups" or similar words.

Reporting of positive and negative responses. The survey data indicate both positive and negative aspects of process safety culture at each of the five refineries. In many discussions of survey data presented in this report, the Panel presents data indicating both positive and negative aspects. On the other hand, as is the case for the entirety of the report, the Panel has focused necessarily on identified shortcomings that one or more of the Panel's recommendations might address. In this focus, the Panel does not intend to present an unbalanced view of process safety culture at BP's U.S. refineries, but rather to highlight areas for potential improvement.

Throughout this report, the Panel has elected to report either positive or negative responses, or both positive and negative responses. The determination of what to report depended in part on the percentage of respondents who answered positively or negatively, as well as on the percentage of respondents who selected "?" ("do not know" or "do not have an opinion") in response to a survey item. For example, consider the following scenarios:

- Scenario 1: 95 percent positive response, 0 percent "?" response, and 5 percent negative response;
- Scenario 2: 75 percent positive response, 25 percent "?" response, and 0 percent negative response; and
- Scenario 3: 75 percent positive response, 0 percent "?" response, and 25 percent negative response.

Under Scenario 1, reporting either the positive or negative response rate would convey a highly positive process safety culture perspective. Under Scenario 2, however, the overall positive process safety culture perspective could be revealed by reporting either the negative response rate only or both the positive and negative response rates. Finally, under Scenario 3, the negative (and potentially troubling) perception of process safety culture could be conveyed either by reporting the negative response rate only or by reporting both the positive and negative response rates.

Finally, in its analysis of survey data, the Panel did not distinguish between "agree" and "tend to agree" responses or between "disagree" and "tend to disagree" responses. For analytical purposes, the Panel instead grouped "agree" and "tend to agree" responses, as well as "disagree" and "tend to disagree" responses.

BP BRIEFINGS

At the Panel's request, from time to time BP provided briefings for the Panel and its staff on topics that the Panel had selected. Senior corporate officers or other BP personnel appropriately knowledgeable about the selected topics conducted these briefings. BP provided supporting documents and relevant materials to the Panel in connection with these briefings. These additional materials were a valuable supplement to the Panel's efforts to gather information.

TARGETED DOCUMENT REVIEW

The Panel and its staff reviewed more than 340,000 pages of documents and other materials that BP provided or that the Panel otherwise obtained. Throughout its review, the Panel submitted numerous document requests to BP. In addition, BP provided the Panel with various other documents and materials that BP believed would be pertinent.

The Panel understands that BP's counsel interviewed more than 60 BP employees at the refineries and corporate offices in an effort to ensure that BP identified and produced documents that the Panel requested. BP and the Panel's staff had regular discussions concerning the status of BP's efforts to locate and produce documents that were responsive to the Panel's requests. BP also produced a limited number of documents that the Panel's staff did not request but that BP thought were relevant to the Panel's work. In general, the documents that BP produced to the Panel came from BP's U.S. refineries and BP's corporate offices, primarily in Chicago and London.

BP declined to produce certain documents that the Panel requested. In general, BP declined to produce documents relating to specific individuals, including performance contracts, personnel evaluations, and individual disciplinary records. BP nonetheless provided the Panel, its staff, or its technical consultants with certain examples of these documents or oral briefings covering the substance of these documents in a manner that allowed the Panel to obtain the information needed to accomplish its objectives.

Additionally, BP did not provide the Panel with privileged documents, a limited number of documents that BP characterized as sensitive, and certain email. While the Panel's staff had no means to challenge BP's assertion of the attorney-client privilege, the Panel's staff also had no basis to believe that BP lacked legitimate grounds for claiming the privilege. BP did not produce a small number of documents on the grounds of sensitivity. However, the substance of some of these documents—consisting largely of compensation, financial, budgetary, commercial, and competitive matters—was communicated to the Panel's staff through various means, including oral briefings. Additionally, the Panel's staff determined the information contained in some of these types of documents was not relevant to the Panel's review. While BP produced various emails to the Panel, a general forensic email search was not conducted in connection with the Panel's document requests.

During the course of the Panel's review, BP produced, and the Panel and its staff examined, approximately 25,000 pages of documents related to the Carson refinery; 24,000 pages of documents related to the Cherry Point refinery; 175,000 pages of documents related to the Texas City refinery; 43,000 pages of documents related to the Toledo refinery; 30,000 pages of documents related to the Whiting refinery; and 44,000 pages of documents from BP's corporate offices. In addition, BP produced to the Panel and its staff all of the documents that BP produced to the plaintiffs in the Texas City civil litigation.

In addition to requests for documents, the Panel periodically asked BP for written briefings on a variety of topics, as well as for written responses to targeted requests for information. BP informed the Panel that some of the requests called for data that BP did not routinely maintain or track in the manner or at the level of detail that the Panel had requested. For example, headcounts of particular types of workers with process safety responsibilities or budgets for process safety-related expenditures generally were not available. BP advised the Panel that such information typically was aggregated with more general information that included environmental or other non-process safety-related information. The Panel believes that BP's briefings and responses to information requests were of great assistance.

The Panel appreciates the effort that BP made to identify, locate, and produce requested documents. Although the Panel did not receive all the documents it requested, the Panel does not doubt that BP acted in good faith.

MEETINGS WITH OTHER COMPANIES ABOUT PROCESS SAFETY

In conducting the review that its charter contemplated, the Panel believed it important to consider the manner in which other companies engaged in the energy, chemical, and other process industries manage process safety performance and attempt to cultivate a strong process safety culture. For this reason, the Panel talked with several current and former employees with responsibility for health and safety at a variety of large public companies of this type. The Panel believes that these discussions provided it with a valuable perspective as it reviewed various aspects of BP's refinery operations.

B. Qualifications and Limitations

PURPOSES AND LIMITATIONS OF THE PANEL'S REVIEW

The Panel's charter directs it to make a thorough, independent, and credible assessment of the effectiveness of BP's corporate oversight of safety management systems at its five U.S. refineries and its corporate safety culture. The charter further directs the Panel to produce a report examining and recommending needed improvements to BP's corporate safety oversight, corporate safety culture, and corporate and site safety management systems. The charter does not contemplate that the Panel review environmental issues or general site security issues. A copy of the Panel's charter is attached as Appendix A.

Significantly, the charter also provides that the Panel should not "seek to affix blame or apportion responsibility for any past event" and "should avoid duplicating the efforts of the CSB to determine the specific root causes of the accident at Texas City on March 23, 2005." Both the CSB and BP have investigated the March 23, 2005 accident at Texas City. The Panel understands that the CSB expects to issue the final report on its investigation in the first part of 2007. In addition, on December 9, 2005, BP issued its own investigation report on the Texas City accident.

Since the Panel was not charged to conduct an investigation into the causes of the Texas City accident and did not seek to affix blame or apportion responsibility for that accident, the Panel's focus and the scope of its review have differed from that of the CSB and from the civil litigation relating to that accident. Consistent with its charter and the CSB's urgent recommendation, the Panel did not conduct the kind of exhaustive incident investigation that is typically undertaken following a major accident. Accordingly, the CSB likely reviewed more detailed information related to the Texas City accident than the Panel did. Because the Panel did not seek to affix blame or apportion responsibility for the Texas City accident, the Panel's examination also differs from the civil litigation relating to that accident. Because of this difference, the information produced in the litigation is likely to be more detailed in relation to the March 2005 accident than information that the Panel gathered.

In many respects, the scope of the Panel's review is broader than the scope of the CSB's investigation and of the civil litigation relating to Texas City. The Panel's review related to all five of BP's U.S. refineries, not just the Texas City refinery. The Panel examined BP's corporate safety oversight, corporate safety culture, and its process safety management systems and not the Texas City accident or any particular incident. The Panel's examination also was not limited to the period preceding the Texas City accident.

Rather than attempting to determine the root cause of, or culpability for, any particular incident, the Panel wanted to understand BP's values, beliefs, and underlying assumptions about process safety, corporate safety oversight, and safety management systems in relation to all of BP's U.S. refineries. The Panel has focused on how these values, beliefs, and underlying assumptions interact with the company's corporate structure, management philosophy, and other systems that operate within that structure to affect the control or management of process hazards in these refineries. The Panel has sought to understand the "why" behind observed deficiencies in process safety performance in order to make recommendations that can enable BP to improve performance at all its refineries. In effect, the Panel's review looked back primarily as a basis for looking forward to improve future process safety performance and to reduce the likelihood of accidents such as the Texas City tragedy.

While the Panel necessarily directs to BP the Panel's recommendations contained in this report, the Panel believes that a broader audience including companies in refining, chemical, and other process industries should carefully consider the Panel's recommendations.

FOCUS ON PROCESS SAFETY

Not all refining hazards are caused by the same factors or involve the same degree of potential damage. *Personal* or *occupational* safety hazards give rise to incidents—such as slips, falls, and vehicle accidents—that primarily affect one individual worker for each occurrence. *Process* safety hazards can give rise to major accidents involving the release of potentially dangerous materials, the release of energy (such as fires and explosions), or both. Process safety incidents can have catastrophic effects and can result in multiple injuries and fatalities, as well as substantial economic, property, and environmental damage. Process safety refinery incidents can affect workers inside the refinery and members of the public who reside nearby. Process safety in a refinery involves the prevention of leaks, spills, equipment malfunctions, over-pressures, excessive temperatures, corrosion, metal fatigue, and other similar conditions. Process safety programs focus on the design and engineering of facilities, hazard assessments, management of change, inspection, testing, and maintenance of equipment, effective alarms, effective process control, procedures, training of personnel, and human factors. The Texas City tragedy in March 2005 was a process safety accident.

The Panel has focused on *process* safety rather than *personal* safety. The Panel believes that its charter and the CSB's August 2005 urgent recommendation require this focus.

QUALIFICATIONS RELATING TO THE PANEL'S FINDINGS

At the outset, the Panel seeks to clarify what its findings do and do not represent. Because of the legal and regulatory context in which the Panel's report is being delivered, the Panel believes that additional explicit cautionary guidance is appropriate relating generally to the Panel's report and specifically to the Panel's findings.

The Panel's charter calls for assessments of effectiveness and recommendations for improvement, not for findings related to legal compliance. In making its findings and recommendations, the Panel's objective was excellence in process safety performance, not legal compliance. As a result, the Panel's report and specifically the Panel's findings are not intended for use in legal proceedings to which BP is or may become a party. Rather, the Panel's findings provide a basis for recommendations to BP for making improvements in BP's corporate safety culture, process safety management systems, and corporate safety oversight. The Panel's report focuses primarily on identified deficiencies that might be corrected through the implementation of its recommendations rather than BP's positive attributes that the Panel observed during the course of its review.

Because the Panel's findings are not designed or intended to assign blame or to apportion responsibility for any prior events, the Panel did not attempt generally to develop evidence that would be legally admissible or to draw conclusions about compliance with legal standards. In making its findings, the Panel is neither making objective determinations nor acting in a role comparable to a finder of fact in a legal proceeding. For example, the Panel did not have subpoena power to compel the production of information or documents, and Panel interviews were not taken under oath. Data from the process safety culture survey that the Panel conducted are subject to the limitation that such data reflect the opinions, beliefs, and impressions of the respondents, but are not legally admissible evidence of facts underlying those opinions, beliefs, and impressions. For these and other reasons, the information that the Panel considered sometimes reflects varying degrees of ambiguity and interpretation on the part of the Panel. In carrying out the responsibilities under its charter and in developing its recommendations, the Panel did not believe it necessary to try to eliminate all factual ambiguities encountered during its review.

The Panel often based its findings and recommendations on general principles of industry best practices or other standards for reducing process risks. Observance of these standards should result in improved safety performance even though many of these standards do not necessarily have legal effect. The Panel's findings are based not only on the information developed during the course of the Panel's review, but also on the collective experience and expertise of the Panel members.

Additional qualifications should also be noted. First, the Panel has not attempted to address possible legal defenses or objections that BP might have if one or more parts of this report were to become the subject of a legal proceeding, including the separateness of and limited liability attributes of various legal entities in the BP organizational structure. Second, the Panel notes that it has a limited basis for comparing BP to other companies with respect to the matters at issue in this assessment. Process safety incidents and performance data are not tracked, reported, or benchmarked in the same way as incidents and performance data relating to personal safety. Moreover, the types of data on which the Panel relied in making its findings—interviews of different levels of refinery personnel and corporate-level managers, a process safety culture survey, process safety management technical reviews, and the review of hundreds of thousands of pages of documents—were available to the Panel for only BP and not for any other company. While the Panel believes that the deficiencies in process safety performance observed at BP are likely not limited to BP, the Panel cannot assess BP's process safety performance as being better, generally the same as, or worse than that of any other company.

For all these reasons, the Panel's findings should not be construed as suggesting or determining that any particular individual, whether a refinery employee or contractor, refinery manager, corporate-level manager or BP board member, failed to meet any applicable legal standard, was negligent, otherwise committed wrongful or tortious conduct, or breached any duties owed to BP, BP's shareholders, or anyone else. Any such finding or determination is outside the scope of the Panel's charter. The Panel simply did not seek to develop the type of data and evidence that would be necessary to make such a finding or determination. The Panel observes, however, that during the course of its review, it saw no information to suggest that anyone—from BP's board members to its hourly workers—acted in anything other than good faith.

Finally, the Panel's findings are based on its assessment that occurred during 2006. Since the Texas City accident, BP has undertaken or announced a number of measures, including dedicating significant resources and personnel, that are intended to improve the process safety performance at BP's five U.S. refineries. Taken at face value, these measures represent a major commitment to an improved process safety regime. For a brief listing of the measures that BP has undertaken or announced since March 2005, see "BP Post-Texas City Measures" in Appendix F.

ENDNOTES FOR SECTION I[4]

[1] The Panel's charter calls for the Panel to make a thorough, independent and credible assessment of the effectiveness of BP Products North America Inc.'s corporate oversight of safety management systems at its five U.S. refineries and its corporate safety culture. BP is a large and complex organization comprised of various corporate entities that own and operate assets in countries throughout the world. The complexity of the organization affects the manner in which the company oversees its businesses, as well as its corporate culture. Executive management for BP p.l.c., executive management for the Refining and Marketing segment, and the most senior line management for Refining are located in London. Because these levels of management affect corporate oversight and corporate culture relating to BP's U.S. refineries, the Panel also considered the effect of such management on oversight and culture. This report refers generically to "BP," not in reference to particular legal entities, but rather for convenience to include all parts of the BP organization that have some operational, managerial, or oversight involvement with BP's U.S. refineries. By such generic references, the Panel does not intend to attribute legal significance to statements made to any particular entities.

[2] The CSB, which is authorized by the Clean Air Act Amendments of 1990, is a federal agency charged with investigating industrial chemical accidents, including the review of the effectiveness of federal regulations and regulatory enforcement. Designed by Congress to be independent, the CSB is not a regulatory agency. Rather it collaborates with OSHA, the EPA, and other federal agencies in investigations pursuant to memorandums of understanding.

[3] This report uses "HSSE" (Health, Safety, Security, and Environment) and "HSE" (Health, Safety, and Environment) interchangeably. Over time, BP has transitioned from using "HSE" to using "HSSE," and the documents provided to the Panel use both acronyms.

[4] The endnotes in this report cite only to publicly available documents or sources.

II. PRECIPITATING EVENTS FOR THE PANEL'S ASSESSMENT AND REPORT

The Texas City refinery experienced three significant events related to process safety that precipitated the Panel's report. On March 23, 2005, an explosion and fire at the refinery killed 15 persons and injured more than 170 others. This accident was one of the most serious workplace disasters in the United States in nearly two decades.

Four months later, on July 28, 2005, the refinery experienced a major process-related hydrogen fire that had the potential to cause additional deaths and injuries and resulted in a Level 3 community alert. A Level 3 alert, which is the second highest emergency classification under Texas City refinery plant procedures, applies when an incident has occurred, the situation is not under control, and protective action may be necessary for the surrounding or off-site area.

On August 10, 2005, the refinery experienced another Level 3 incident involving the gas oil hydrotreater. This incident resulted in a community order to stay indoors.

A. CSB Urgent Recommendations

The CSB is investigating the March 2005 disaster at the Texas City refinery.

On August 17, 2005, the CSB made an urgent safety recommendation to BP to commission an independent panel to assess and report on the effectiveness of BP's corporate oversight of safety management systems at its U.S. refineries and its corporate safety culture.

In the recitals relating to the urgent recommendation, the CSB stated its belief that the circumstances preceding the recommendation raised serious concerns about (1) the effectiveness of the safety management system at the Texas City refinery, (2) the effectiveness of BP's corporate safety oversight of its refining facilities, and (3) a corporate safety culture that may have tolerated serious and longstanding deviations from good safety practice. The CSB also reiterated its belief that organizations using large quantities of highly hazardous substances must exercise rigorous process safety management and oversight and should instill and maintain a safety culture that prevents catastrophic accidents.

On October 25, 2005, the CSB made two additional urgent safety recommendations related to the Texas City accident. First, the CSB recommended that the API develop new industry guidance to ensure the safe placement of occupied trailers and similar temporary structures away from hazardous areas of process plants. Second, the CSB recommended that both the API and the National Petrochemical and Refiners Association issue safety alerts to their members to take prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants while the new API safety guidance was being completed.

B. CSB's Preliminary Findings Related to Texas City

On October 27, 2005, the CSB released to the public its preliminary findings concerning the March 2005 Texas City accident. The CSB identified six key safety issues:

(1) Trailers were placed in an unsafe location, too close to an isomerization process unit that handled highly hazardous materials. All of the fatalities occurred in and around trailers that were as close as 121 feet from the release. One trailer located 600 feet from the explosion was heavily damaged, and 39 other trailers were damaged or destroyed.

(2) The raffinate splitter on the isomerization unit should not have been started up because of existing malfunctions of the level indicator, level alarm, and a control valve.

(3) The raffinate splitter tower had a history of abnormal start-ups that included recurrent high liquid levels and pressures.

(4) On March 23, 2005, the blowdown drum on the isomerization unit vented highly flammable material directly into the atmosphere. Since its construction in the 1950s, the drum had never been connected to a flare. Amoco, the previous owner of the refinery, had replaced the blowdown drum and stack in 1997 with identical equipment. Amoco refinery safety standards recommended connecting the drum to a flare when such major changes were undertaken, but the drum was never connected to a flare system.

(5) Between 1995 and March 23, 2005, there were four other serious releases of flammable material from the isomerization unit's blowdown drum and stack that led to ground-level vapor clouds. Fortunately, none ignited.

(6) In 1992, OSHA cited a similar blowdown drum and stack at the refinery as unsafe because it vented flammable material directly into the atmosphere. However, OSHA dropped the citation, and the drum was never connected to a flare system.

C. OSHA'S Investigation of the Texas City Accident

OSHA, the federal agency that oversees workplace safety, investigated the Texas City accident. On September 22, 2005, BP agreed to a record $21 million fine to settle more than 300 violations that OSHA identified. Under the terms of the settlement agreement, BP also agreed to reinforce health and safety training given to refinery workers, to hire both a process safety management expert and an organizational expert to review conditions at the refinery, and to make recommendations for correcting deficiencies.

D. BP'S Investigation of the Texas City Accident—the Mogford Report

BP formed a fatality investigation team shortly after the Texas City accident. The team consisted of both BP employees and contractors, including a BP Group executive (John Mogford) who led the team, three salaried employees from the Texas City refinery, three hourly workers from the Texas City refinery, and three persons from other BP businesses.

The team's tasks were to investigate the circumstances surrounding the accident, determine the root causes, make recommendations to prevent a recurrence, and identify lessons learned. During its investigation, the team used the BP root cause methodology supplemented with guidance from the CCPS.

On May 17, 2005, the BP team issued its interim report, which presented an analysis of the events leading up to the accident, identified provisional critical factors for the accident, and made early recommendations to prevent a recurrence until a root cause analysis could be completed. After more than six additional months of gathering, researching, and analyzing other evidence and information, the team issued its final report—the Mogford Report—on December 9, 2005.

According to the Mogford Report, the accident would not have happened, or would have had a significantly lower impact, but for four critical factors:

(1) loss of containment,

(2) raffinate splitter start-up procedures and application of knowledge and skills,

(3) control of work and trailer siting, and

(4) design and engineering of the blowdown stack.

As the Mogford Report explains, the failure to institute liquid rundown from the raffinate tower, and the failure to take effective emergency action, resulted in the loss of containment that preceded the explosion. The report also identifies a failure to follow established policies and procedures, as well as inadequate supervision. The congregation of many people in or near temporary trailers, which were sited too close to the isomerization unit, contributed to the severity of the accident. Moreover, the report indicates that the likelihood of the accident could have been reduced if the use of the blowdown stack for light-end hydrocarbon service had been discontinued and if inherently safer options had been installed when they were available. Despite these process failures, the Mogford Report found no evidence that anyone consciously or intentionally took actions or made decisions to put others at risk.

In addition to those four critical factors, the Mogford Report identifies the following underlying five cultural issues that were present in the refinery at the time of the accident:

(1) **Business Context:** The working environment had eroded over time to one that was characterized by resistance to change and by lack of trust, motivation, and a sense of purpose. This environment, coupled with unclear expectations about supervisory and management behaviors, led to rules not being followed consistently, a lack of rigor, and individuals feeling disempowered from suggesting or initiating improvements.

(2) **Safety as a Priority:** Management did not set or consistently reinforce process safety, operations performance, and systematic risk-reduction priorities.

(3) **Organizational Complexity and Capability:** Many changes in an already complex organization led to the lack of clear accountabilities and to poor communication, which together resulted in confusion in the workforce over roles and responsibilities.

(4) **Inability to See Risk:** People accepted levels of risk that were considerably higher than levels accepted at comparable installations because of a poor level of hazard awareness and understanding of process safety. For example, temporary office trailers were placed within 150 feet of a blowdown stack that vented heavier-than-air hydrocarbons to the atmosphere without anyone questioning established industry practice.

(5) **Lack of Early Warning:** Given the poor vertical communication and performance-management process, there was neither an adequate early warning system of problems, nor any independent means of understanding the deteriorating standards in the plant.

The Mogford Report also made numerous proposals for corrective actions. Many of these proposals had been documented previously in existing policies and procedures, but either were not followed or were not specific enough.

E. The Stanley Report

In addition to the Mogford investigation, BP commissioned a team composed of BP and external experts to conduct a process and operational audit review of the Texas City refinery shortly after the March 2005 accident. BP commissioned this review to provide enhanced assurance of safe operations at Texas City. James W. Stanley, former Deputy Assistant Secretary of Labor for Occupational Safety and Health, served as the team leader.

The team audited the Texas City refinery based upon a four-part inquiry:

(1) processes and operations;

(2) incident management, control of work, risk assessment, and compliance assessment;

(3) people and contractor management; and

(4) maintenance, reliability, and integrity.

In performing its audit review, the team conducted interviews, performed inspections, reviewed documents, and made observations at various units of the refinery.

The team's final audit report (the Stanley Report), dated June 15, 2005, opined that although the Texas City refinery generally had well-designed and documented processes and procedures for operations and maintenance, as well as a workforce that was capable of delivering good performance, significant changes to the behaviors and performance of the senior and extended leadership teams would be necessary to ensure that delivery achieved reality.

The Stanley Report identifies issues in five main areas that were preventing the successful execution of key work processes: leadership, risk awareness, control of work, workplace conditions, and contractor management. The Stanley Report also made multiple recommendations in each of these five major areas of concern.

III. OVERVIEW OF PROCESS SAFETY, PERSONAL SAFETY, AND CORPORATE SAFETY CULTURE

Under its charter, the Panel is charged to examine and to recommend any needed improvements to the corporate safety culture within BP's U.S. refineries, including the degree to which

- corporate officials exercise appropriate leadership to promote adherence to safety management systems;
- process safety is effectively incorporated into management decision-making at all levels;
- employees at all levels are empowered to promote improved process safety; and
- process safety programs receive adequate resources and are appropriately positioned within organizational structures.

As discussed in Section I, in its assessment the Panel has focused on *process* safety, rather than *personal* safety. The Panel believes that its charter and the CSB's August 2005 urgent recommendation require this focus. In order to understand the significance of the Panel's focus on process safety, rather than personal safety, the Panel elaborates in this section on some of the key distinctions between the two concepts.

A. Comparison of Process Safety and Personal Safety

Types of risk. In the context of refining operations, "process safety" refers to the prevention and mitigation of unintentional releases of potentially dangerous materials or energy from the refining process.[1] Process safety management involves a particular type of risk management—identifying and controlling the hazards arising from refining processes, such as the prevention of leaks, spills, equipment malfunctions, over-pressures, excessive temperatures, corrosion, metal fatigue, and other similar conditions.[2] Process safety programs focus on, among other things, the design and engineering of facilities; hazard assessments; management of change; inspection, testing, and maintenance of equipment; effective alarms; effective process control; procedures; training of personnel; and human factors.[3]

Process safety management is critical in refining operations because process accidents can have catastrophic effects and result in multiple fatalities and substantial economic, property, and environmental damage. Process hazards at a refinery can give rise to accidents that affect both workers inside the refinery and members of the public who reside nearby.

Typically, process safety risks arise from complex systems with a large number of control measures referred to as hard or soft controls. Hard controls are physical elements within the facility, such as barriers, alarms, and improved system design. Soft controls are internal procedures and best practices, such as standards, operating procedures, training, administrative controls, supervisory oversight, and the experience and knowledge of frontline operators.[4] Generally speaking, process safety relates to the quantity, quality, and variety of controls or protective features that protect people, the environment, and property from process hazards.[5]

On the other hand, "personal safety," which is sometimes referred to as occupational safety, focuses on hazards that are more directly related to individual workers. Typically, personal safety programs address risks of various types of physical injuries, including slips, falls, struck-by incidents, physical strains, electrocution, and auto incidents. Such accidents are usually associated with a hazard that is close to workers. Protection against a personal safety hazard is both relatively simple and, for the most part, at least nominally under the control of the potentially affected worker. Personal safety protections or controls against these types of hazards tend to be fairly simple in nature and limited in number. For example, personal safety controls place a heavy emphasis on training individual workers to recognize hazards, installing personal protective guards on dangerous machinery, and providing personal protective equipment to workers.

The literature[6] suggests, and the Panel believes, that the underlying or "root" causes of the large majority of personal and process accidents are deficiencies in the systems that a facility uses to prevent these two classes of accidents. The literature also suggests, and the Panel believes, that the presence of an effective personal safety management system does not ensure the presence of an effective process safety management system. As discussed elsewhere in this report, BP's personal injury rates were not predictive of process safety performance at BP's five U.S. refineries.

Regulatory systems. Process safety in the United States is subject to a dual regulatory regime administered by OSHA, for worker safety matters, and by the EPA, for public health and environmental impact matters. The cornerstone of this regulatory regime is OSHA's performance-oriented process safety management standard, which includes 14 different elements relating to the management of process safety risks. See Section V for a brief discussion of this standard.

Unlike process safety, worker personal safety in the United States is subject to a regulatory regime that only OSHA administers. OSHA has adopted many specific health and safety standards designed to protect workers; OSHA's process safety management standard is only one such standard. OSHA's regulatory regime includes a system for reporting personal injuries on OSHA Form 300. One of the items of information that OSHA Form 300 requires is "days away from work," which is a common lagging indicator for personal safety. Another personal injury metric is "recordable injury frequency." To facilitate comparison from one facility to another, this metric is normalized by expressing the number of OSHA recordable injuries and illnesses at a facility for each 200,000 hours worked, which is approximately equivalent to 100 employees working a normal year.

B. Leading and Lagging Indicators for Safety Management Systems

In order to measure safety performance, many companies have incorporated leading and lagging indicators, also known as "metrics" or "key performance indicators," into their safety management systems. Managers use these metrics to track safety performance, to compare or benchmark safety performance against the performance of other companies or facilities, and to set goals for continuous improvement of safety performance. The Panel notes that regulatory agencies, industry groups, and labor organizations have undertaken efforts to advance the state of the art in terms of developing process safety indicators. The USW, for example, developed one such indicator in 1996. The U.K. Health and Safety Executive (UK HSE) regulates workplace health and safety in the United Kingdom and has been at the forefront of developing process safety indicators. The UK HSE recently published Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries.[7] In the United States, beginning in 1995, the CCPS conducted initial industry research into process safety leading indicators. This work culminated in the development of a process safety management performance measurement software tool called ProSmart,[8] which was released in 2001. Subsequently, in 2005, CCPS conducted industry benchmarking on the use of process safety management performance measurement and the use of leading indicators. This effort has led to lists of leading indicators that will be included in CCPS's Guidelines for Risk Based Process Safety,[9] which is expected to be published in April 2007. Additionally, the CCPS recently began a project relating to the development of process safety metrics.

REACTIVE MONITORING: USE OF LAGGING INDICATORS

Reactive monitoring of process safety includes the identification, reporting, and investigation of process-related injuries, incidents, and property damage.[10] Reactive monitoring allows an organization to identify and correct deficiencies in response to specific incidents or trends. Reactive monitoring uses lagging indicators to measure historical, after-the-fact performance.[11] These indicators show when the desired safety outcome has not been achieved and the safety control system has failed to prevent an incident. Examples of lagging indicators include the number of unexpected loss-of-containment incidents and failures of safety critical instrumentation/alarms.[12] Because of their nature, lagging indicators of process safety performance suffer from the disadvantage that they suggest corrective actions only after an accident.

Personal safety lagging indicators, or injury rates, are prevalent in the refining industry. Largely derived from OSHA reporting, injury rates such as days away from work and recordable injury frequency have become well established and generally accepted measures of performance. Companies collect and report these metrics at regular intervals. Additionally, many companies set goals based upon reducing lagging indicators such as recordable injury frequency. Although companies may set performance targets based upon reducing lagging indicators related to personal safety performance, the Panel believes (as BP aspires) that the ultimate goal for safety performance should be zero incidents.

Well-recognized and generally accepted lagging indicators exist in the United States for personal safety, but not for process safety. Because process safety accidents occur infrequently and are often unrelated to each other in their causal factors, past process safety accidents have limited value in predicting future process-related incidents. Consequently, for purposes of managing process risks, organizations should develop leading process safety performance indicators that, if monitored, can be used to limit or prevent process-related incidents.

ACTIVE MONITORING: USE OF LEADING INDICATORS

Active monitoring[13] evaluates the present state of a facility through the routine and systematic inspection and testing of work systems, premises, plant, and equipment, including rotating equipment, pressure vessels, piping, relief valves, and other safety-related equipment.[14] Some organizations use requirements around active monitoring as leading indicators to provide feedback on performance before an accident or incident occurs.[15]

As the term implies, leading indicators attempt to measure some variable that is believed to be an indicator or precursor of future safety performance, so that the desired safety outcome (*i.e.*, no incidents) can be achieved. While useful in predicting future process safety performance, leading indicators are not absolutely predictive. For example, the percentage of equipment that is past due for inspection can be considered a process safety leading indicator because the metric relates to the physical condition of the facility as well as the effectiveness of oversight systems. However, even if equipment inspections are current, equipment failures can still occur.

USING BOTH LEADING AND LAGGING INDICATORS

Effective measuring and evaluation systems utilize both leading and lagging indicators. The UK HSE recently proposed using a system of "dual assurance" with both leading and lagging indicators.[16] The UK HSE believes that employing both sets of indicators will provide assurances around the effectiveness of a site's risk-control systems.[17] Trends in these indicators may provide advance notice of problems.

C. Corporate Safety Culture

The safety literature contains a number of definitions of the terms "culture" and "safety culture."[18] A 2003 research report on best practices in corporate safety and health among a number of U.S. companies highlighted the importance of the "shared" element of safety culture.

> Safety and health are (or have become) part of the company culture—and frequently part of the management system. "Culture" is traditionally defined as "a shared set of beliefs, norms, and practices, documented and communicated through a common language." The key word here is *shared.* Companies have found that if safety and health values are not consistently (and constantly) shared at all levels of management and among *all* employees, any gains that result from declaring safety and health excellence a "priority" are likely to be short-lived.[19]

An organization's safety culture expresses itself within its own organizational structure, which may be simple or complex. A safety culture evolves over time in response to various events, including changes in leadership and in management systems. Accordingly, an organization's safety culture at any point in time may be viewed as reflecting prior events or prior defining periods in the history of the organization, such as mergers and acquisitions, reorganizations, financial difficulties, technological changes, and management changes.

Some of these prior events or defining periods may be common to similar organizations in the same industry or in similar situations. Others may be unique to a particular organization. Local conditions and factors also affect safety cultures as expressed at a particular site.[20] As a result, values, beliefs, and underlying assumptions can vary—from one work group, or even one work site, to another—within the same organization.[21]

Additionally, commercial considerations, including cost control and production, play a role in defining the safety culture of an organization. All organizations that produce goods and services not only face limitations on resources, including money, but also must effectively manage the tension that exists between the operational demands relating to production and those relating to safety. One author summarized this natural tension:

> It is clear from in-depth accident analyses that some of the most powerful pushes towards local [culture] traps come from an unsatisfactory resolution of the inevitable conflict that exists (at least in the short-term) between the goals of safety and production. The cultural accommodation between the pursuit of these goals must achieve a delicate balance. On the one hand, we have to face the fact that no organization is just in the business of being safe. Every company must obey both the 'ALARP' principle (keep the risks as low as reasonably practicable) and the 'ASSIB' principle (and still stay in business).[22]

What an organization believes is the appropriate balance between safety and production considerations, and how it organizes itself to accomplish this balance, serves in part to define the organization's safety culture. An organization should recognize that a wide variety of stakeholders, including owners/shareholders, managers, workers, and the public at large, have interests in its safety culture. Moreover, an organization with a strong safety culture does not lose sight of the fact that the stakeholders with the most to lose—their lives—are workers and members of the public living or working near hazardous operating units.

ENDNOTES FOR SECTION III

[1] 29 C.F.R. § 1910.119 (2006).

[2] *See* 29 C.F.R. § 1910.119, Appendix C (2006).

[3] Isadore Rosenthal et al., "Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks," *Process Safety Progress*, Vol. 25, No. 2 (June 2006), pp. 137-38, 150.

[4] James Reason, *Managing the Risks of Organizational Accidents* (Burlington, Vermont: Ashgate Publishing Ltd., 1997), p. 8.

[5] James Reason, "Achieving a Safe Culture: Theory and Practice," *Work & Stress*, Vol. 12, No. 3 (1998), p. 295.

[6] Isadore Rosenthal et al., "Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks," *Process Safety Progress*, Vol. 25, No. 2 (June 2006), p. 147.

[7] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006).

[8] Center for Chemical Process Safety, "ProSmart—The tool you need to improve process safety," *accessed at* http://www.aiche.org/CCPS/Publications/Software/ProSmart/index.aspx on December 29, 2006.

[9] Center for Chemical Process Safety, *Guidelines for Risk-Based Process Safety* (New York: American Institute of Chemical Engineers, publication expected April 2007).

[10] International Labour Office—Geneva, *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14.

[11] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006), p. 2.

[12] *Ibid*, p. 47.

[13] International Labour Office—Geneva, *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14.

[14] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 18.

[15] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006), pp. 2-6.

[16] *Ibid*, p. 2.

[17] *Ibid*.

[18] Various definitions of the terms "culture," "organizational culture," or "safety culture" have been proposed. *See* S. Gadd, "Safety Culture: A Review of the Literature" (2002), p. 2 *accessed at* http://www.hse.gov.uk/research/hsl_pdf/2002/hsl02-25.pdf on November 16, 2006 (noting that many definitions of safety culture (*e.g.*, ASCNI, 1993) present a view of employees having a shared set of safety values and beliefs). A number of these definitions are set forth below.

- "Organizational culture refers to the basic values, norms, beliefs, and practices that characterize the functioning of a particular institution. At the most basic level, organizational culture defines the assumptions that employees make as they carry out their work; it defines 'the way we do things here.' An organization's culture is a powerful force that persists through reorganizations and the departure of key personnel." Columbia Accident Investigation Board, "Report Volume 1," August 2003, *accessed at* http://anon.nasa-global.speedera.net/anon.nasa-global/CAIB/CAIB_lo wres_full.pdf on November 16, 2006, p. 101.
- "The safety culture of an organization is the product of individual group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management." HSC Advisory Committee on the Safety of Nuclear Installations, *ACSNI Study Group on Human Factors, Third Report* (London, United Kingdom: HSE Books, 1993), p. 2.

- "The attitudes, beliefs and perceptions shared by natural groups as defining norms and values, which determine how they act and react in relation to risks and risk control systems." A.R. Hale, "Culture's Confusions," *Safety Science*, Vol. 34, No. 1-3 (2000), p. 7.
- "The safety culture of an organization is the artifacts, values, and assumptions that people hold in common." Thomas R. Krause et al., *The Behavior-Based Safety Process: Managing Involvement for an Injury-Free Culture* (United States: John Wiley & Sons, Inc., 2d ed. 1997), p. 122.
- "Shared values and beliefs that interact with an organization's structures and control systems to produce behavioural norms." Bro Uttal, "The Corporate Culture Vultures*," Fortune Magazine*, October 17, 1983.

[19] Meredith Armstrong Whiting and Charles J. Bennett, The Conference Board, *Driving Toward '0': Best Practices in Corporate Safety and Health* (Research Report No. R-1334-03-RR) (2003), p. 7 (emphasis in original). The Conference Board is a non-profit business that is best known for publishing the Consumer Confidence Index and the Leading Economic Indicators. The mission of the Conference Board is to create and disseminate knowledge about management and the marketplace to help businesses strengthen their performance and better service society.

[20] James Reason, "Achieving a Safe Culture: Theory and Practice," *Work & Stress*, Vol. 12, No. 3 (1998), p. 293.

[21] M.D. Cooper, "Towards a Model of Safety Culture," *Safety Science*, Vol. 36 (2000), pp. 111-36.

[22] James Reason, "Achieving a Safe Culture: Theory and Practice," *Work & Stress*, Vol. 12, No. 3 (1998), p. 301.

IV. OVERVIEW OF BP'S ORGANIZATIONAL STRUCTURE AND ITS FIVE U.S. REFINERIES

BP is one of the world's largest companies. As of January 7, 2007, it had a market capitalization exceeding $225 billion.[1] BP operates in more than 100 countries across six continents and employs more than 96,000 people.[2]

BP's corporate structure has been complex for many years. In the last two years, BP has made significant changes to its corporate and refining organizations, creating new positions, changing various job responsibilities, and establishing several new reporting lines. BP made some of these changes directly in response to the March 2005 Texas City accident. In many instances, the contours of these new lines and relationships remain undefined. While the BP organizational chart is constantly evolving, BP regards its organizational philosophy as immutable and one of the pillars of its corporate success.[3]

A. BP Management Framework

BP's workforce grew to nearly 100,000 employees as a result of several mergers and acquisitions in the late 1990s. To address governance issues arising out of this rapid growth and consolidation of different heritages, in 2003 BP issued its Management Framework, colloquially referred to within BP as the "Green Book." The Management Framework, which was revised in 2004 and is soon to be revised again, is intended to articulate BP's corporate governance system but not to describe BP's organizational structure in detail. The Management Framework conveys the notion that while BP's organizations will necessarily change, its corporate governance should not.

John Browne, BP's Group Chief Executive, developed the three primary foundations of BP's organizational philosophy when he was in charge of BP's exploration and production business.[4] First, BP operates in a decentralized manner, with individual business unit leaders (such as refinery plant managers) given broad latitude for running the business and direct responsibility for delivering performance. Second, the corporate organization provides support and assistance to the business units (such as individual refineries) through a variety of functions, networks, and peer groups. Third, BP relies upon individual performance contracts to motivate people.[5]

Accountability for BP's refining performance—whether profitability, safety, environmental, or otherwise—runs "down the line" from the Board of Directors through the Group Chief Executive to the refinery plant managers. Refinery plant managers are not merely operations managers but also business or commercial managers because they have direct profit-and-loss responsibility for the refinery. Authority and accountability for particular aspects of a refinery's business are cascaded below the refinery plant manager.

BP'S SYSTEM OF DELEGATIONS AND ACCOUNTABILITIES

The foundation of the Management Framework consists of BP's concepts of authority, delegation, and accountability. Under the Management Framework, authority is delegated, but accountability is not. Delegations of authority flow from the shareholders to the Board of Directors to the Group Chief Executive and down throughout BP. BP's philosophy is to delegate authority to the lowest appropriate point in the organization—a single point of accountability. The single point of accountability is always a person, as opposed to an organization, committee, or other group of people, who manages performance through monitoring and intervention. Those higher in the chain of delegation monitor this performance and report up the line of delegation to meet their accountabilities. This structure reflects BP's philosophy that leadership monitors but does not supervise the business; leadership only supervises the people who report directly to them. BP's Management Framework is evident at every level of the organization. Its concepts of delegation and accountability begin with the shareholders and extend through each level of the organization.

Shareholders own BP, a public company. The shareholders annually elect BP's Board of Directors and delegate authority to the directors for direction and oversight of the company's business. The shareholders receive annual reports that highlight BP's financial performance, among other things.

BP's Board of Directors is made up of both BP executives (executive directors) and outside directors (non-executive directors). Each director is accountable to the shareholders, and all directors stand for re-election each year. The Board establishes goals, makes broad policy decisions, and monitors the Group Chief Executive's performance, but it does not manage BP's businesses. The Board delegates authority and responsibility for the management of BP's businesses to a single point: the Group Chief Executive.

Board committees perform much of the Board's monitoring activities. BP's board has five committees, composed entirely of outside directors, which monitor various aspects of BP's activities and performance. For example, the Safety, Ethics, and Environmental Assurance Committee—formerly known as the Ethics and Environmental Assurance Committee (EEAC)—oversees all non-financial risks, including safety. The EEAC monitors management's performance on environmental, health and safety, security, and ethical behavior issues.[6] It reviews management's annual Health, Safety, and Environment report, along with other periodic reports. The EEAC also reviews non-financial performance against BP's annual plan and endorses BP's Annual Sustainability Report that BP publishes to shareholders.

The Board delegates all executive management authority to the Group Chief Executive, Browne, who is in turn accountable to the Board. Under the Management Framework, the Group Chief Executive delegates various functions and responsibilities throughout BP's organization while remaining ultimately accountable to the Board. Constraints on the Group Chief Executive's authority are set forth in the Board's Executive Limitations. These limitations are quite general insofar as safety is concerned; they prohibit the Group Chief Executive from not taking into account the health, safety, and environmental consequences of any action, and they prohibit anyone from substituting his own risk preferences for those of the shareholders. The Group Chief Executive is required to report to and advise the Board on all material matters currently or prospectively affecting BP.

The Group Chief Executive delegates authority in two broad areas. First, the Group Chief Executive delegates responsibility for Group functions (such as Finance, Legal, Internal Audit, and Tax) to Group executive officers, such as the Chief Financial Officer, the Group Chief of Staff, and the Group General Counsel. Second, the Group Chief Executive delegates authority to the chief executive of each of BP's three operating business segments for the respective activities of each of those business segments. These accountabilities are routinely delegated throughout each business segment to a single point of accountability. Through performance monitoring, review of systematic reports, and dialogues on all matters that the delegation of authority encompasses, each level satisfies its accountability obligations.

PLANNING AND PERFORMANCE MANAGEMENT

While BP's Board sets forth the company's goals, the Group Chief Executive is responsible for presenting the five-year and annual Group plans to the Board for approval. These plans articulate the manner in which the Board's goals will be pursued, including the resources required, risks identified, metrics to be measured, and milestones to be achieved. Group plans are prepared with input from the segments, functions, and regions. The goals, metrics, and milestones in Group plans are cascaded down in the plans for each of the segments, functions, and regions.

Some of these same goals and metrics are reflected in individual performance contracts. A performance contract outlines the key results and milestones an employee is expected to achieve that year.[7] Progress against targets and milestones in an employee's performance contract plays an integral part in annual bonus determinations.[8] BP regards performance contracts as an essential component in delegating commitments for BP's annual plans to individual leaders. In performance contracts, BP attempts to set the goals high, but not so high that they cannot be reached.[9] The head of Refining, with input from HSSE personnel, determines the metrics and milestones that are cascaded down throughout the Refining business. The metrics, targets, and milestones encompass financial, HSSE, and strategic objectives, with HSSE factors generally accounting for about 30 percent of a bonus determination. In general, all executives and group managers of BP enter into a performance contract each year with the person to whom he or she directly reports. At the refinery level, performance contracts typically cascade down to the superintendents, two levels beneath the refinery plant manager.

Although lower levels of supervisors and professionals in the refineries do not have performance contracts, all BP refinery employees participate in BP's variable pay program (VPP). Each refinery has an annual VPP containing a set of metrics, milestones, and targets relating to financial, availability, and safety objectives for that refinery. Many of these metrics contain both "base" and "stretch" targets for the year. While the VPP includes some milestones unique to each refinery, each refinery's program mirrors a broad framework that Global refining sets. Typically, 30 percent of the VPP is contingent upon safety performance, 40 percent upon business performance, and 30 percent upon site-specific milestones. Exceeding VPP targets generally leads to greater VPP pay. As employees progress up the BP refinery hierarchy, the percentage of base pay that an employee can earn in VPP pay increases. For example, VPP pay typically equals about six percent of base pay for hourly employees, with percentages increasing all the way up to a refinery plant manager's VPP target of 40 percent of base pay. The VPP is applied to all refinery employees without consideration of an individual employee's performance.

B. BP's Global Structure

BP is organized into three business segments, about 20 Group functions, and four regions. The three segments are subdivided into numerous strategic performance units, which in turn are subdivided into business units. BP ascribes different roles and responsibilities at the Group level (the centralized corporate office for the BP Group of companies), the business segment level (such as Refining and Marketing), the strategic performance unit level (such as Refining), and the business units (such as the individual refineries).

BP assists the line in delivering performance through the support of a number of functions, networks, and peer groups.[10] Some people in the line have dual reports, both directly up the line and indirectly to someone in their functional organization. These functions, networks, and peer groups "removed the need for micro-management and command-and-control methods to achieve performance within the boundaries set by BP's policies."[11] As Browne explained in an academic paper, "the whole purpose is to release the creativity of the very talented individuals who work for us. We want them to be entrepreneurs, not bureaucrats doing exactly what they are told from above."[12]

BP GROUP

BP Group provides centralized direction to ensure that Group values, policies, and standards are consistent and shared across the BP group of companies. Group functions are corporate activities and capabilities that serve the three business segments. Certain functions are centralized, meaning that they operate without any influence from the business segments, regions, or other functions. Centralized functions include Finance, Financial Control and Accounting, Internal Audit, Legal, and Tax.

BP also has decentralized functions. Decentralized functions are implemented largely within a business segment, region, or other functions and include HSSE, Marketing, Planning, and Technology. After the Texas City accident, BP established another decentralized function, Safety and Operations.

In addition to centralized and decentralized functions, the Group has promulgated 18 aspirational core "Group values" that "underpin all that BP does." BP also has articulated four "brand values" related to positioning the company to the outside world. These brand values—being green, progressive, innovative, and performance driven—are more brand attributes than core values.

The Group also is responsible for the issuance of Group standards. BP develops Group standards to address Group-level risks, not risks that are unique to any particular business segment. The Functional Coordinating Group, composed of the relevant Group executive officer, the heads of the relevant functions, the Group vice-president from each business segment, and other staff, determines whether a Group standard is needed. The Group Chief Executive is the only person authorized to approve a Group standard. Because Group standards apply broadly across a diverse group of businesses, they are more like principles than specific guidelines or directions. While Group standards set forth specific elements that each of BP's business segments must put in place, they do not specify how these elements should be developed or implemented. BP has issued three Group standards with a safety focus: integrity management, control of work, and driving.

REGIONS

BP's activities are divided into four broad geographic regions: (1) Europe; (2) the Americas; (3) Africa, the Middle East, Russia, and the Caspian; and (4) Asia, the Indian sub-continent, and Australasia. Some regions are subdivided further. For example, the Americas region includes two subregions: (1) the United States and (2) Canada, Central America, and South America.

The head of each region is not only responsible for ensuring regional consistency of the activities of the business segment and functions, but also represents BP to governments and other external parties. Each business segment, however, is managed on a global basis.

Prior to a reorganization announced in the summer of 2006, the head of BP in the Americas had essentially no role with respect to refining. The President and Chief Executive Officer of BP America, Inc. from 2001 until his retirement in the summer of 2006 confirmed that he had no operating responsibilities because all responsibility for operations was with line management, and he was separate organizationally from line management. Instead, his role consisted of being the senior representative of BP in North America; handling external and government relations for BP in the region; satisfying certain administrative functions relating to matters, such as the filing of BP's tax returns and pension plan forms; and applying internal coherence to matters that are common to different BP operations in North America (*e.g.*, pensions, medical coverage, and energy policy). He was completely outside of line reporting with respect to BP's U.S. refineries, and he did not monitor the performance or safety of the refineries.

In July 2006, BP announced a restructuring of this position and named Bob Malone chairman of BP America, Inc.[13] Malone is a long-time BP executive with operations and HSSE experience, and he most recently headed BP's shipping operations. Unlike his predecessor, who had responsibility for the entire Western Hemisphere, Malone is concerned only with BP's operations in the United States. BP elevated Malone's position to Executive Vice-President. He reports directly to the Group Chief Executive (Browne) and is a member of the Group Chief Executive Meeting.[14]

In addition to the roles his predecessor performed with respect to BP's operations in the United States, Malone has an additional focus on safety, compliance, and regulatory affairs. Unlike his predecessor, Malone has direct reports for the Safety and Operations function and the Compliance and Ethics function. Malone confirmed to the Panel that while he does not have line authority, he has the "ultimate veto" on safety, operations, and compliance matters in the United States. Additionally, Malone is in the process of forming several advisory groups:

(1) an Operational Advisory Board, to be composed of between two and five of the U.S. business unit leaders from each of the three business segments;

(2) a Functional Advisory Board, to be composed of representatives of each of BP's functions; and

(3) an External Advisory Board, to be composed of about seven experts outside of BP in the areas of safety, operations, politics, and media relations, to give Malone advice outside of day-to-day operations.

As Malone acknowledged to the Panel, many of his responsibilities and reports are yet to be resolved.

BUSINESS SEGMENTS

Under BP's organizational philosophy, a segment is a collection of related businesses. BP has three operating business segments: (1) Exploration and Production; (2) Refining and Marketing; and (3) Gas, Power, and Renewables.[15] Each of BP's business segments is responsible for delivering all aspects of performance, including safety. The Exploration and Production segment includes oil and natural gas exploration, development, and production, along with related pipeline transportation and processing activities. The Refining and Marketing segment includes the manufacturing and marketing of petroleum products. The Gas, Power, and Renewables segment includes the marketing and trading of natural gas, natural gas liquids, and liquefied natural gas along with low-carbon power development, solar power, and other activities.[16]

The Refining and Marketing segment is a very diverse organization consisting of three strategic performance units: Refining, Fuels Marketing, and Strategic Businesses. The segment has a very thin management structure, largely because of the diversity of businesses within the segment.

In recent years, the Refining and Marketing segment has been very profitable. In 2005, it had a profit of nearly $7 billion before interest and taxes.[17] Since 2000, BP's global refining business has contributed an average of about $3 billion per year to net income and about $2 billion per year to cash generation. It also represented about 13 percent of capital employed companywide and about nine percent of BP's estimated pre-tax income in 2005. The refining business employs approximately 12,000 people.

Business segments provide input in the development of Group standards, as well as support and challenge to the performance units in implementing those standards. Once the Group Chief Executive approves a standard, the business segments are responsible for its implementation. An individual business segment monitors the safety performance of all of its businesses. Each business segment also prepares plans that become part of the Group plans.

STRATEGIC PERFORMANCE UNITS

Strategic performance units are individual businesses with strategic coherence. These performance units are responsible for preparing their own budgets and plans, which in turn are incorporated into the business segment plans. The refining strategic performance unit supports the refineries in delivering their objectives and monitors the refineries' performance.

The Refining strategic performance unit consists of a portfolio of 23 refineries worldwide that BP owns or has an interest in, and these refineries have eight different heritages. BP routinely adjusts its refining portfolio when it purchases, sells, or closes refineries based upon strategic considerations. BP also is constantly reworking and expanding units in some of its refineries. BP has closed or sold more than ten refineries during the last decade. During that same period, largely as a result of BP's acquisitions of Amoco and ARCO, BP's refining capacity increased 45 percent globally and more than doubled in the United States.

A strategic performance unit also initiates minimum expectations. Unlike standards, which are relatively immutable, minimal expectations are continuously revised and updated. Minimum expectations with respect to a particular discipline are not a best practice—they are minimum expectations. They provide for greater detail and specificity than a standard, and they apply across the strategic performance unit. BP Refining has issued 15 process safety-related minimum expectations.

Additionally, Refining coordinates the implementation of engineering technical practices (ETPs) for its business. ETPs, which are generated by Group Technology and are translated into site operating practices, are intended to standardize BP's practices across business units. Like minimum expectations, ETPs apply throughout the strategic performance unit and are periodically expanded and revised. To date, BP has issued more than 460 ETPs related to Refining. Certain ETPs apply to some businesses but not others, and some are unique to Refining. Prior to implementing ETPs, BP used the heritage engineering standards and practices at each of its sites, and sometimes used contractor standards.

BUSINESS UNIT (REFINERY)

Each refinery represents an individual business unit. The refinery plant manager is responsible for a host of activities and objectives relating to numerous aspects of the business, including safety.[18] Refinery plant managers also are responsible for identifying site risks; implementing Group standards, minimum expectations, and ETPs; and delivering the refinery's objectives.[19] Each refinery develops a strategic, long-term plan and then prepares annual plans or objectives consistent with the longer-term plan. The annual plan contains aspirations, targets, key performance indicators, and historical data, as well as a discussion of key risks, including safety-related risks. Refineries also prepare and maintain their own procedures and technical practices in recognition of the different vintages, conditions, technologies, equipment, and processes in each of the refineries, as well as unique local rules and regulations.

C. U.S. Refining Organizational Chart

BP's overarching philosophy is that safety accountability always runs through the line, with support and challenges from a variety of functions. Accordingly, several strands of BP's organizational chart have a material impact on process safety management and culture in the U.S. refineries. First and foremost is refining line management, which runs from the senior managers for the Refining strategic performance unit to the refinery plant managers. This line is highlighted in pink on the organizational chart that appears in Appendix C. (For simplicity, the chart ends with the plant manager of each refinery, although additional layers of management and supervision exist beneath the plant manager.) While BP's executive management above the refining strategic performance unit—the Group Chief Executive and the Chief Executive, Refining and Marketing—are accountable for the safety of the U.S. refineries, they do not actively manage refinery operations. Beyond line management, seven other strands on the BP organizational chart influence process safety management and safety culture in the U.S. refineries:

- the new Safety and Operations function, which is centralized at the BP Group level (highlighted in green);
- the Group Technology function, including Engineering and Integrity Management (highlighted in purple);
- the Group Vice-President HSSE and Technology, Refining and Marketing segment and personnel reporting to her (highlighted in yellow);
- the Refining Technology function (highlighted in light blue);
- the HRO Manager (highlighted in brown);
- the new position of Vice-President OMS/PSM Program Implementation (highlighted in red); and
- BP America personnel (highlighted in gold).

In addition to the relationships described above, two informal staff support organizations operating within Refining Technology are relevant: the HSSE Network and the Process Safety Community of Practice. Finally, BP is creating a new informal engineering authority reporting line that will cut across four of these organizational strands. The roles of executive management, line management, and each of these seven other strands of the corporate organization are discussed below.

EXECUTIVE MANAGEMENT

Under BP's Management Framework, the Board delegates accountability for all of BP's operations to the Group Chief Executive, John Browne, who is based in London. In his interview with the Panel, Browne acknowledged his accountability for all aspects of BP's operations, including safety. Browne in turn delegates responsibility for managing BP's operations to the respective segment chief executives.

Browne, who has a diverse background, has been instrumental in shaping BP's corporate culture. Browne has a degree in physics and an M.B.A. He is a Chartered Engineer and President of the Royal Academy of Engineering. He rose through the Exploration and Production segment of BP before his appointment as Group Chief Executive in 1995.[20] Given the significance of the Exploration and Production segment to BP, it is hardly surprising that the Group Chief Executive would come from that part of the company or that he would not have any meaningful refining experience.

Browne has been a director of BP since 1991.[21] He was knighted in 1998 and made a life peer in 2001.[22] In July 2006, BP announced that Browne will retire at the end of 2008.[23]

Browne delegates authority for all aspects of the Refining and Marketing segment including safety to John Manzoni, the Chief Executive, Refining and Marketing, who is also based in London. In this position, Manzoni is responsible for all activities in the Refining and Marketing Segment's strategic performance units, including Refining. While Manzoni is accountable for BP's refining operations, he does not manage them.

Manzoni is a petroleum engineer by education and, like Browne, rose through BP's Exploration and Production segment. Manzoni has also served in a number of planning, strategic, and regional positions before his appointment as Chief Executive, Refining and Marketing in April 2002. BP appointed Manzoni to this position upon the retirement of an Amoco-heritage refining and marketing executive. Manzoni had no refining experience before this appointment.

CORPORATE REFINING LINE MANAGEMENT

The Group Vice-President, Refining is accountable to the Chief Executive, Refining and Marketing for determining refining strategy, priorities, and organization; agreeing to high-level financial targets; entering into performance contracts with refining vice-presidents and refinery plant managers; conducting planning and performance reviews; and improving leadership and management skills for senior refining managers. He is, in effect, the most senior line manager of BP's refining operations.

Mike Hoffman, the Group Vice-President, Refining, has been responsible for BP's Global refining operations. He reports to the Chief Executive, Refining and Marketing (Manzoni) and has been based in London. Prior to his appointment to this position in 2002 after the retirement of an Amoco-heritage refining executive, Hoffman held various engineering, supervisory, and management positions.

Hoffman is a chemical engineer by education, and he held a variety of positions in refining at ARCO from 1980 through 1995. ARCO named Hoffman the refinery plant manager at the Carson refinery in 1998, following a three-year rotation in planning positions. Under the ARCO management structure, the refinery plant manager was responsible for refining operations, but not for financial performance. Many people credit Hoffman for dramatically improving Carson's safety performance and culture.

Prior to 2003, BP configured its refineries into "peer groups," and all of the refinery plant managers worldwide reported directly to the Group Vice-President, Refining. In 2003, BP determined that the Group Vice-President, Refining had too many direct reports, so BP created three new regional vice-president positions: North America, Rhine, and International. These three new positions report directly to the Group Vice-President, Refining, with the refinery plant managers reporting directly to the appropriate regional vice-president. BP named Pat Gower as the Refining Vice-President, U.S. Region at that time.

Gower manages the business of BP's U.S. refineries. He reports to the Group Vice-President, Refining, and he is accountable for, among other things, managing the performance of refineries in the region; ensuring that refinery-specific priorities are challenged and aligned across the region; creating both top-down and "rigorous" peer challenges to the refineries; promoting the identification and sharing of best practices; and supporting the development of performance contracts with refinery plant managers. While regions create focused groups for support and challenge, BP does not set regional budgets, aggregate financial data for regions, or have substantial staffing at the regional level.

Like Hoffman, Gower has a refining background. He worked in a variety of refining positions at Amoco since 1976. BP appointed him refinery plant manager for the Toledo refinery in 2001, a position he held until October 2003, when he was appointed to his current position. Gower's degree is in civil engineering, and he is based in Chicago.

On December 19, 2006, BP announced that Hoffman would leave the company on April 30, 2007 to return to the United States.

REFINERY MANAGEMENT, SUPERVISORS, AND WORKFORCE

Refinery plant managers are the leaders of the refineries and are accountable for all aspects of the refinery's performance, including commercial, environmental, public affairs, safety, and human resources. The refinery plant manager is not responsible for certain support services that centralized Group functions provide. Specific accountabilities of a refinery plant manager include

- development and management of refining plans, priorities, budgets, and proposals;
- delivery of appropriate HSSE processes, procedures, and behaviors;
- oversight of financial and cost-management processes to ensure delivery against targets; and
- oversight of people processes, such as resourcing, development, performance management, reward, and succession planning.

The plant managers of the U.S. refineries report directly to the Refining Vice-President, U.S. Region (Gower), and they in turn have a number of direct reports, including those with functional responsibility within the refinery for operations, maintenance, engineering, and HSSE. In addition, BP expects refinery plant managers to work closely with the regional vice-president and other plant managers on a variety of challenges, regional issues, and decisions.

While BP purportedly recognizes the importance of stability in the refinery plant manager position, most of the U.S. refineries have experienced significant plant manager turnover. Carson has had three plant managers since 2000, Cherry Point has had three since 1997, Texas City has had eight since 2000,[24] Toledo has had five since 2000, and Whiting has had four since 2000.

Although BP has not articulated specific qualifications that a person must have to be a refinery plant manager, it has detailed a "bottom-up" succession planning program that applies to all levels of senior management, including plant managers. This process begins with nominating people who have the potential to hold certain positions. BP uses a "refining assessment tool" to appraise a candidate's experiences and competencies, and BP develops a pool of candidates for the refinery plant manager and the manager's direct reports. These experiences and competencies, however, are more conceptual than sharp-edged.[25] BP's assessment tool does not qualitatively evaluate a candidate's refinery experience, process safety understanding, or commitment to safety. Most, but not all, of BP's refinery plant managers have had substantial prior refining experience.

The Group Vice-President, Refining and the Refining Vice-President, U.S. Region make a recommendation to the Chief Executive, Refining and Marketing on who should be appointed a refinery plant manager for a U.S. refinery. The Chief Executive, Refining and Marketing then looks across the entire Refining and Marketing landscape in assessing that recommendation, considers additional candidates, and recommends a candidate to BP's Executive Officer, Strategic Functions, who makes the final decision.

BP provides no specific training for newly appointed refinery plant managers. A new plant manager is provided with an array of documents pertaining to the refinery, and he or she is expected to work side-by-side with the former plant manager during an extensive transition period. BP encourages new plant managers to use a "refinery leadership transition planner," which itself provides no specific training; rather, it is a checklist reminding the incoming plant manager to

- review relevant documents;
- meet with the outgoing plant manager and with direct reports;
- formally communicate the change in position with all site personnel;
- sign off on new accountabilities, objectives, expectations, and risks;
- prepare a self-assessment and development plan for the new position; and
- meet with key internal and external contacts.

The information made available to the Panel indicates that in order to transition a new refinery plant manager into the position, BP relies on a detailed handover process and on-the-job training, coupled with mentoring not only from other refinery plant managers, but also from the Refining Vice-President, U.S. Region and the Group Vice-President, Refining.

In 2006, BP began using a management of change process to assess the impact of appointing a new refinery plant manager. BP has on occasion sent plant managers to refining management training that outside parties provide to address perceived deficiencies.

A U.S. refinery plant manager's performance contract used to be with the Group Vice-President, Refining but now is with the Refining Vice-President, U.S. Region. Historically, about 30 percent of the contract is weighted for HSSE metrics.

As the leader of the refinery with accountability for its performance, the plant manager has a number of individuals who report directly to him. While the numbers and specific titles vary at least to some degree from refinery to refinery, in every case the individuals with functional accountability for operations, maintenance, engineering, commercial, and HSSE report directly to the plant manager. Others who report directly to the plant manager in at least several of the refineries include the individuals in charge of human resources, government affairs, and project management. Many of these individuals who report directly to the plant manager, including the heads of HSSE, operations, and maintenance, have some process safety responsibilities. The operations manager in a refinery has line accountability for process safety. Some of the direct reports also report indirectly to others outside of the refinery. All of the refineries have a head of process safety management who reports to the HSSE Manager.

Individuals who report directly to the refinery plant manager are considered part of the refinery's leadership team. Many of these individuals have performance contracts, and the safety-related metrics in their contracts mirror those in the plant manager's contract. Like all refinery employees, individuals who report directly to the refinery plant manager also participate in the VPP.

Each refinery has an HSSE committee chaired by the site's head of HSSE. This committee sets goals based upon HSSE expectations for the refinery. For example, this committee sets goals for improving personal safety, for implementing Group process safety and integrity management standards, for developing fire safety practices, and for improving organizational capability. HSSE committee members oversee and coordinate these broad initiatives within each refinery. The committee's overall performance is measured on an annual basis against its plan.

Beneath the direct reports to the refinery plant manager are superintendents, then (typically) foremen, then supervisors (known as first level leaders or FLLs). All of these are salaried, non-union BP employees who participate in the VPP. Some superintendents have performance contracts, but foremen, supervisors, and other managers do not. Most first level leaders come from the ranks of the hourly workers.

BP has not yet established formal training programs for these management levels. In 2005, BP's U.S. Refining leadership team determined that attrition and changing demographics were affecting the superintendent ranks within the refineries, and BP initiated a pilot training program at its Whiting refinery to address these problems. To date, BP's pilot superintendent training program has not been expanded to the other U.S. refineries.[26]

BP also uses "step-up" supervisors. During turnarounds or periods of heavy supervisor vacation, BP occasionally needs additional supervisors. At those times, BP hourly employees may be "stepped up" into supervisory positions for a defined period of time. They receive no training for this position, and they report to permanent supervisors while working in that capacity.

Beneath the first level leaders are the BP hourly employees, who are typically operators and maintenance personnel. All BP hourly employees participate in the VPP. At all of the U.S. refineries except Cherry Point, the BP hourly employees are members of the USW and are subject to a collective bargaining agreement.

FUNCTIONS INFLUENCING PROCESS SAFETY

BP states that accountability for process safety, like accountability for virtually all other aspects of the refineries' operations, remains with the line, starting with the Group Chief Executive and running down the line to the refinery plant managers and below. However, a variety of functions outside of the line influence process safety.

> Safety and operations

Prior to the March 2005 Texas City accident, BP had a Group HSSE function that reported to the Executive Officer, Strategic Functions. From 2000 to 2002, John Mogford was the head of HSSE. Before taking that position, Mogford essentially had spent his entire career in BP's Exploration and Production segment.

From 2002 until 2005, Greg Coleman was the Group Vice-President, HSSE. Like Mogford, Coleman's background was in Exploration and Production. During this period, Coleman and the head of Group Technology had an understanding that responsibility for process safety fit within Group Technology, not HSSE. Consequently, prior to 2005, responsibility for supporting health, personal safety, security, and environment at BP fell under the HSSE function, while responsibility for supporting process safety (sometimes referred to within BP as "safety engineering") fell under Group Technology.

As a result of its investigation into the March 2005 Texas City accident, BP concluded that it needed to elevate the profile and importance of safety and operations within the company (with "operations" effectively meaning "management of hydrocarbons"). Mogford, who headed BP's investigation at Texas City, made this recommendation because he believed that BP's issues related more to operations than traditional HSSE and that "safety" had become associated more with personal safety than major risk management.

Following the release of BP's interim investigation report on the Texas City incident, BP announced the creation of a new Group-level function, Safety and Operations, with Mogford, who is based in London, as its head. Mogford's title is Senior Group Vice-President, Safety and Operations. As Senior Group Vice-President, Mogford is positioned one level below an Executive Vice-President, such as Manzoni. In this new position, Mogford reports directly to the Group Chief Executive (Browne) and is a member of the Group Chief Executive team. Mogford also reports indirectly to the Executive Officer, Strategic Resources. Mogford has attended nearly every meeting of the EEAC held since the establishment of the Safety and Operations function.

The new Safety and Operations function is intended to improve risk management, reduce risk levels across the company, and deliver better safety performance and operational capability. The safety aspects of HSSE and process safety are subsumed within the Safety and Operations function, as are the operational sides of health and environment; other aspects of the prior HSSE function (such as security and environmental policy and compliance) have been moved into other functions.

Mogford presently has six people who report directly to him, including vice-presidents for Safety and Operations Audit, Organizational Capability, and Safety and Operations. Three of Mogford's direct reports were hired from other companies, such as DuPont. BP's Director of Process Safety is now part of the Safety and Operations function. BP has allocated a five-year budget to the Safety and Operations function and anticipates adding a number of experts who will be available to provide coaching on specific topics.

Notwithstanding the creation of a Group-level Safety and Operations function, BP states that accountability for safety and sound operations remains completely with the line. The role of the new Safety and Operations function is to develop policies, standards, and practices, as well as an operations management framework to assist the line in delivering safe and efficient operations. To that end, the Safety and Operations function has developed a five-year work program centering on what it refers to as "the 3 Ps":

- **Plant:** (1) improving the design of the facilities and ensuring facilities are safely designed; (2) maintaining plant and operations integrity by ensuring implementation of standards, such as the new Group integrity management standard, and by reporting of process safety-related metrics in addition to personal safety metrics; and (3) reducing risk through BP's major accident risk assessments.
- **Process:** (1) creating an independent auditing function that will review both legal compliance as well as compliance with internal policies and procedures. Audits will be conducted by teams of full-time auditors, and Safety and Operations will track and verify the closure of open action items resulting from the audits; (2) developing Group standards and Safety and Operations practices, which will be given the same weight as engineering technical practices; and (3) preparing and implementing a new integrated management system encompassing operations, HSSE, and compliance.
- **People:** (1) developing minimum standards for control room operators and a training program for senior managers and first level leaders; and (2) providing safety leadership throughout the company, along with organizational culture, assessment, and improvement programs.

While the Safety and Operations function has senior leadership, a budget, and plans in place, BP has not defined all of its responsibilities and accountabilities with respect to other parts of the organization. As Mogford explained to the Panel, much discussion is ongoing within BP on how the Safety and Operations function and Group Technology fit together. Mogford also acknowledged that BP may make further organizational changes after the integrity management standard is implemented. In addition, Mogford stated that as of May 2006, the interaction between Safety and Operations and the post-Texas City position of Group Vice-President, HSSE and Technology was still only "about 80 percent figured out." He also stated that Safety and Operations' relationship with Group Compliance and Ethics was still undefined.

> Group technology

The Group Technology function involves building and assuring BP's long-term technical health, and it encompasses engineering and integrity management. Tony Meggs, Group Vice-President, Technology heads this function. He has a degree in petroleum engineering and worked primarily in upstream roles before his appointment to this position in 2001. He is based in London. From 2001 to the summer of 2006, Meggs reported to the Executive Officer, Strategic Resources. Because BP believes that the Group Technology function is closely linked to corporate strategy, Meggs now reports to BP's Chief of Staff and Head of Strategy.

Meggs has five people who report directly to him, including the Director of Engineering, the Chief Scientist, and the Director of Projects. Others in the Group Technology function include the Head of Integrity Management and the Head of Major Hazards and Fire. Meggs's primary responsibilities include building BP's technology base (essentially research and development efforts), developing BP's "technology leadership areas" (such as alternative fuels), overseeing BP's major projects, and enhancing BP's engineering capabilities.

Meggs told the Panel that prior to the creation of the Safety and Operations function, process safety fell under Group Technology. However, Meggs said that he understands now that both he and Mogford have responsibility for process safety: Meggs, because he heads Group Technology, which is responsible for writing the various standards, and Mogford, because he heads Safety and Operations, which is responsible for ensuring the implementation of those standards.

The Group Technology function was responsible for the promulgation of the integrity management standard, which Browne approved in March 2006 and which BP regards as encompassing process safety. All business units, including the U.S. refineries, must be fully compliant with this standard by the end of 2008. Any site that is not completely compliant at that time must obtain an exemption from the Executive Officer, Strategic Resources (who reports to Browne) or be shut down.

In 2003, BP recognized that while it was making substantial progress on personal safety, it was not experiencing comparable success with losses of containment, and thus, the company's engineering capability needed to be built up. BP then created a new position, Group Engineering Director, and recruited John Baxter from outside BP for this position. Baxter and his 12-member staff are responsible for ensuring consistency in standards across the company and for reviewing major risks to BP.

The Group Technology engineering staff developed hundreds of ETPs, and more than 460 of them apply to BP's refining operations. The process of developing these ETPs took five years, and Group Technology worked with experts from throughout BP to develop consistent, coherent practices based on international standards, best practices from BP's legacy companies, and other sources. While Group Technology continues to promulgate ETPs, some of which are unique to the refining business, BP has identified 62 of them as being "safety critical."

The ETP requirements are divided between "musts, shalls, and shoulds." These three terms relate to the sense of urgency for the ETPs and which level of BP's organization is authorized to issue an exception. For example, an ETP that is considered a "must" is a high-priority issue, and only the most senior engineering leadership can grant a refinery an exception for its failure to implement this practice. An ETP classified as a "shall" is slightly less critical, and a refinery can seek an exception to such a practice from the refining engineering authority. The ETPs of the lowest priority are classified as "shoulds." Although a refinery should implement these practices, it can seek an exception from its refinery engineering authority. Each refinery must comply with the most critical ETPs by 2008 and with all others by 2011.

BP's Head of Major Hazards and Fire reports to the Group Engineering Director and heads BP's Major Accident Risk assessment project. This project is one of BP's techniques to identify major risks in any of its businesses that might not otherwise be revealed. The Major Accident Risk assessment project is designed to assess on a consistent basis and bring to the attention of BP senior management those risks that are so large that they present a risk to BP's corporate existence.

> HSSE and technology

As a result of the Texas City accident, in July 2005 BP created a new HSSE and Technology organization for the Refining and Marketing segment. The head of that organization has been C. J. Warner, who is Group Vice-President, HSSE and Technology, Refining and Marketing. As a Group Vice-President, Warner is on the same level as the Group Vice-President, Refining (Hoffman), and she reports to the Chief Executive, Refining and Marketing (Manzoni). She has a degree in chemical engineering, and her career has largely been in refining. Warner is based in London.

The primary purposes of this new organization are to ensure that the various businesses in the Refining and Marketing segment effectively implement Group standards, to provide a support structure for those businesses' implementation efforts, to deliver safety coaching and leadership to line management in the segment, and to monitor HSSE (including safety) and technology activity within the segment. In Manzoni's words, Warner is to give him "an independent view of the line."

Warner has seven direct reports. One is the Vice-President of HSSE, whose role is to enhance, embed, and sustain the safety capability in the Refining and Marketing segment. Another direct report, the Head of Projects and Engineering, has three roles: overseeing capital projects in the segment, managing the implementation of the integrity management standard in the Refining and Marketing segment, and serving as the designated engineering authority for the segment.

On December 19, 2006, BP announced that Warner will replace Mike Hoffman (who is leaving BP) as the Group Vice-President, Refining effective May 1, 2007. BP has not yet named her replacement.

> Refining technology

The Refining Technology organization provides technical and operational support to the global refining business, particularly with respect to process safety management. Refining Technology personnel have various responsibilities, such as performing a number of monitoring and reporting functions. They track the refineries' performance against a set of process safety-related metrics and milestones and report on these to the Global Refining Leadership team. They review internal and external incidents, particularly those that are process safety related. In addition, they prepare a quarterly safety bulletin that discusses the causes of and lessons learned from incidents at BP and elsewhere. This safety bulletin is widely disseminated throughout BP. Paul Maslin has been the Technology Vice-President, Refining since 2003. Maslin has a chemical engineering degree and a background in refining. He reports to the Group Vice-President, Refining and has a "dotted line" report to the Group Vice-President, HSSE and Technology, Refining and Marketing. Maslin is based in London, with the Refining Technology staff split between London and Chicago.

Following the Amoco merger, BP outsourced much of its refining technology work, and several hundred refining engineers who had been centrally located within both Amoco and BP left. After several years, BP concluded that it had lost too much in-house technical expertise, and it terminated its outside contract for refining technology work, resolving to rebuild its own capabilities. Refining Technology, which had as few as 35 people, now has about 150 people and plans to hire more. Among the current employees are approximately 30 functional experts, referred to as "advisors," including two process safety advisors. The advisors comment on proposed Group standards from a refining perspective, among other things.

Refining Technology also oversees and supports some of the Refining Networks and Communities of Practice. Networks are intended to be a vehicle through which the various refineries will identify and share best practices. Refining has six Networks: HSSE, People, Commercial Managers, Technical Managers, Refinery Operations, and Maintenance. All of these, with the exception of People and Commercial Managers, are run through the Refining Technology organization. Each Network has a performance leader and is composed of the appropriate managers from each of BP's refineries (*e.g.*, the HSSE managers from each of BP's global refineries are in the HSSE Network). Each Network also develops an annual plan and conducts global and regional meetings several times a year. BP regards these Networks as "the glue which holds Refining together."

Each Network has one or more communities of practice, which are "tagged" to it to help deliver the Network's plan. Refining presently has 34 communities of practice, four of which are designated as "supercharged" (Process Safety, Turnarounds, Inspection, and Hydroprocessing) to denote within BP that they are more active and prominent than others. Each community of practice has a performance leader, and like the networks, communities of practice are composed of one or more appropriate persons from each refinery. The relevant functional experts within

Refining Technology also belong to communities of practice. In addition to sharing experiences and best practices, communities of practice define and recommend minimum expectations with respect to their subject matter. Communities of practice have no direct responsibility and serve as support systems for the Networks.

Refining has issued 15 process safety-related minimum expectations. Process safety minimum expectations are just minimum expectations; they are not best practices, and they apply only in the refining business. When a process safety minimum expectation is developed, it is balloted to the refineries for their input on whether it is acceptable, should be revised, or should not be implemented. After Global Refining leadership approves a process safety minimum expectation, each refinery has 90 days to prepare a plan describing how it will be implemented, how long implementation will take, and how much it will cost. Refining Technology tracks a refinery's progress against each of the process safety minimum expectations and reports quarterly on this progress to the Global Refining leadership through what is called a "gap analysis."

OTHER POSITIONS INFLUENCING U.S. REFINERY PROCESS SAFETY

In addition to the various functions discussed above, three other positions also influence process safety in the U.S. refineries.

BP America. Prior to July 2006, the head of BP's operations in the Western Hemisphere had no responsibilities for process safety in the U.S. refineries, even monitoring. BP restructured that position in July 2006, changed its focus, and added to its responsibilities. The new CEO of BP America in the United States, Bob Malone, has the mandate to assure BP on the safety of all of its U.S. operations. BP made the new Safety and Operations Vice-President for Operations Excellence a direct report to Malone while remaining an indirect report to Senior Group Vice-President, Safety and Operations (Mogford). An Operational Advisory Group, a Functional Advisory Board, and an External Advisory Board will also advise Malone. The Panel does not yet have an understanding on how this position will impact process safety in the U.S. refineries because this restructuring and appointment is so recent.

Vice-President of OMS/PSM Program Implementation. In August 2006, BP named Rick Porter, the plant manager at Cherry Point, to the newly created position of Vice-President of Operating Management System/Process Safety Management (OMS/PSM) Program Implementation. In this position, Porter will report to the Group Vice-President, Refining. While Porter's role encompasses all of BP's refining operations, his initial focus will be on the U.S. refineries. Porter's primary responsibilities will include accelerating delivery of improved process safety management and regulatory compliance, implementing a comprehensive system of management that incorporates both Group standards and local influences, and influencing culture in the refineries. As of October 2006, an initial design and implementation team for the OSM/PSM program was composed of five managers within the Refining strategic performance unit. In addition, leads for design and implementation of the OMS/PSM Program had been named for each U.S. refinery.

HRO Manager. BP's Refining strategic performance unit aspires to be a "High Reliability Organization" (HRO). An HRO is one that produces product relatively error-free over a long period of time. This initiative began with a meeting of a handful of refining leaders in the fall of 2000. Their mission was to revitalize refining and to convince BP that refining was a valuable business, as it was their perception that BP regarded refining as merely a "tolerated cousin." The refining leaders articulated the values they believed were necessary to "make BP refining great," which are known as Refining's five "Stands": safety, availability, financial performance, people, and environmental leadership. They adopted the HRO model and subsequently worked with several academics in tailoring the high reliability organization concept to BP's refining operations.

Refining management views HRO as a "way of life" and believes that it is a time-consuming journey to become a high reliability organization. BP Refining assesses its refineries against five HRO principles: preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise. BP's goal is to inculcate HRO throughout the refining business and thereby create and maintain a culture in which reliability and safety are core values. In evaluating management, Refining uses a "Level 5 Leadership" tool based upon Jim Collins' book, Good to Great.

Colin Reid is HRO Manager for the Refining strategic performance unit and reports to Group Vice-President, Refining. Reid is a mechanical engineer by education with more than 25 years in refining. Reid has a very small support staff. He describes his job as being a "cheerleader" for HRO and assisting the refinery plant managers in implementing HRO. Reid works closely with the Senior Group Vice-President, Safety and Operations (Mogford) and the Group Vice-President, HSSE and Technology Refining and Marketing (Warner).

ENGINEERING AUTHORITIES: "STRONG DOTTED LINE"

In addition to refining line managers, the functions, and the various positions outside of either the line or functions that influence process safety, BP recently created a new, "strong dotted line" of engineering authorities. Group Technology perceived the need for more independent engineering authorities at lower levels of the organization. To address that need, BP developed the engineering authority position within the context of the 2006 BP Group standard for integrity management. BP has indicated that the engineering authority position will play a key role in implementing the integrity management standard and will provide a mechanism to evaluate and discuss integrity management issues independent of line management.

The integrity management standard requires that each business line, such as Refining, appoint an engineering authority. The refining engineering authority has multiple responsibilities, including

- identifying the subject matter experts necessary for development and revision of BP's engineering technical practices,
- ensuring that refining operations meet the engineering requirements of the standard or have actions planned to address deficiencies,
- approving the selection and application of site technical practices for each refinery, and
- approving the program of work to ensure that refining technical practices and the approved set of site technical practices for each refinery are consistent with BP engineering technical practices.

BP has created engineering authority positions at both the Refining and Marketing segment level and the Refining business level. Chris London is currently the Refining and Marketing segment engineering authority. London reports to the Group Vice-President, HSSE and Technology, Refining, and Marketing (Warner). Tom Cerwinske is the Refining business engineering authority. Cerwinske is a member of the refining technology organization and reports to the Refining Manufacturing Excellence Manager, Hugh Parsons.

The 2006 integrity management standard further mandates that a separate engineering authority be appointed for each refinery. The role of the site engineering authority includes advising the refinery plant manager on engineering practices and determining how to implement engineering technical practices at that refinery. The responsibilities of each of these refinery-level engineering authorities further include

- ensuring that processes and systems are in place for identifying and managing engineering risk;
- ensuring that the engineering aspects of all significant changes, both temporary and permanent, are risk-assessed and managed;
- overseeing the controlled application of site technical practices appropriate to the particular refinery throughout its lifecycle;
- ensuring that competent discipline experts are available to address technical requirements of the refinery;
- ensuring that changes are adequately documented and that changes to facilities and equipment are accurately recorded and kept up to date on drawings and data retrieval systems; and
- defining the list of equipment to be tested, inspected, and maintained.

While the site engineering authority reports to the plant manager, BP has advised that each site engineering authority will have the authority to raise any issues or concerns about what the refinery or refinery plant manager is doing with the Refining business engineering authority. The Refining business engineering authority, in turn, may elevate any such issues with the Refining and Marketing segment engineering authority, who in turn may go to the BP Group Engineering Director in Group Technology. The Group Engineering Director in Group Technology has the authority to overrule a refinery plant manager. While this "dotted line" reporting relationship cuts across four different functional lines, BP has advised that as a practical matter, the engineering authorities are in frequent contact; BP views this criss-crossing as "engineers talking about engineering." BP has also advised that refinery management is discussing at the refineries this "engineering authority line" and how it acts as a check and balance on the authority of the refinery plant manager as to engineering matters.

D. The Five Refineries

As part of its worldwide network of 23 refineries, BP operates five refineries in the United States: Carson, near Long Beach, California; Cherry Point, in northwest Washington; Texas City, near Galveston, Texas; Toledo, Ohio; and Whiting, in northwest Indiana. Each of these refineries is a separate business unit, and they have a combined daily processing capacity of approximately 1.5 million barrels of crude oil. BP acquired four of these refineries through mergers with Amoco in 1998 and ARCO in 2000.

CARSON

A refinery has operated at the site of the Carson refinery since the late 1930s. Having undergone several major expansions and modernization projects, the Carson refinery sits on more than 586 acres and has more than 28 major process units.

The refinery has the capacity to process 280,000 barrels of crude oil per day. The Carson business unit includes not only the refinery, but also a cogeneration plant and a calciner. BP acquired the refinery in 2000 as part of the ARCO merger.

About 1,100 BP employees and 520 contractors work at the site. Of 719 union-represented BP employees at Carson, the USW represents approximately 688. The International Brotherhood of Electrical Workers represents the remaining 31. Senior leadership turnover at the refinery has been moderate. Since 1997, four refinery plant managers have worked at the site.

CHERRY POINT

ARCO constructed the Cherry Point refinery in 1971. Located near Blaine, Washington, the refinery was designed to process Alaska North Slope crude oil. BP acquired the refinery during the 2000 merger with ARCO.

The refinery occupies 640 acres. A single train refinery, Cherry Point has 12 main processing units. It has a daily processing capacity of 244,000 barrels of crude oil. In addition to refined products, the refinery produces about 2,700 tons per day of anode grade calcined coke. A cogeneration plant is scheduled to begin operation in 2008.

The Cherry Point refinery provides jobs for approximately 650 BP employees and 800 contractors. A labor union does not represent any of the BP employees at the refinery. Senior leadership turnover at the site has been low, and between 1997 and late 2006, Cherry Point had only two refinery plant managers. With Rick Porter's new position of Vice-President of OMS/PSM Program Implementation, Cherry Point is getting a new plant manager.

TEXAS CITY

BP acquired the Texas City refinery when BP merged with Amoco in 1998. Portions of the Texas City refinery were first constructed in 1934. Since then, the refinery has undergone numerous expansions and modernization projects. The Texas City refinery is now the largest of BP's refineries worldwide and has the capacity to process approximately 470,000 barrels of crude oil per day.

The Texas City facility occupies more than 1,200 acres. Considered one of the world's most complex refineries, it includes 29 oil refining units and four chemical units. These refining units produce gasoline, as well as distillate, petrochemical feed, heavy fuel, sulfur, sulfuric acid, petroleum coke, and toluene. The four chemical units produce more metaxylene and paraxylene chemical intermediates than any other facility in the world.

Approximately 1,800 BP employees work at the Texas City refinery. The USW represents approximately 1,020 of them. The refinery also uses numerous contractors. While Texas City generally employs approximately 2,000 contractors during average operating intervals, the number of contractors working at the site may reach as high as 6,000 during peak turnaround periods. Senior leadership turnover at the site has been very high. Since 1997, nine refinery plant managers have worked at Texas City. Between 2001 and 2003 alone, the site had five different refinery plant managers.

The March 23, 2005 accident caused the shutdown of several units at the refinery. In anticipation of Hurricane Rita later that year, BP shut down the entire refinery. Since that time, BP has been repairing the damage caused by the ISOM accident as well as the hurricane. The site has conducted extensive inspections and maintenance work, and it began the restart of the facility's process units in March 2006. Start-up of additional process units will continue into 2007.

TOLEDO

The Toledo refinery is located in the city of Oregon, Ohio. The Standard Oil Company of Ohio (Sohio) constructed this refinery, which began operations in 1919. Numerous expansions and modernization projects have occurred since then. It sits on approximately 650 acres and has a daily processing capacity of 150,000 barrels of crude oil. BP acquired control of the Toledo refinery in 1987 from Sohio.

The site currently employs approximately 460 BP employees and 200 contractors. The USW currently represents approximately 270 BP employees. The Toledo refinery has experienced heavy turnover in senior leadership. Since 1997, five different refinery plant managers have directed operations at the site.

WHITING

The Whiting refinery is BP's oldest and second largest refinery. The Standard Oil Company of Indiana began operating the refinery in 1890. Numerous expansions and modernization projects have occurred since the refinery was constructed. BP acquired the refinery in 1998 when it merged with Amoco. The refinery occupies 950 acres. It has a daily processing capacity of 400,000 barrels of crude oil.

The Whiting refinery has approximately 1,400 BP employees. The USW represents 1,025 of them, and the Office and Professional Employees International Union represents 41. The site also utilizes an average of 1,250 contractors, depending on the level of maintenance and construction activity at the refinery. Senior leadership turnover has been heavy. Since 1997, the site has had five different refinery plant managers.

ENDNOTES FOR SECTION IV

[1] Forbes.com, *accessed at* http://www.forbes.com/finance/mktguideapps/compinfo/ForeignCompanyTearsheet.jhtml?cusip=0798059 on January 7, 2007; *see also* Forbes.com, Scott DeCarlo, editor, "Special Report: The World's 2000 Largest Public Companies," March 30, 2006, *accessed at* www.forbes.com/2006/03/29/06f2k_worlds-largest-public-companies_land.html on December 1, 2006 (also ranking BP the eighth largest public company in the world based on a composite score for sales, profits, assets and market value).

[2] BP p.l.c., "Making Energy More: Annual Report and Accounts 2005," (2006), pp. 8, 100.

[3] *See* Joel Podolny and John Roberts, *British Petroleum (A2): Organizing for Performance at BPX*, case study S-IB-16A2 (Graduate School of Business Stanford University, revised April 2, 2002).

[4] *Ibid,* pp. 1-2.

[5] *Ibid,* p. 2.

[6] BP p.l.c., "Making Energy More: Annual Report and Accounts 2005," (2006), p. 162.

[7] Joel Podolny and John Roberts, *British Petroleum (A2): Organizing for Performance at BPX*, case study S-IB-16A2 (Graduate School of Business Stanford University, revised April 2, 2002), pp. 7-9, 17-18.

[8] *Ibid,* pp. 7-9.

[9] *Ibid,* p. 7.

[10] *Ibid,* pp. 4-7.

[11] *Ibid,* p. 7.

[12] *Ibid.*

[13] BP p.l.c., Press Release, "Robert A. Malone to Lead BP America, Inc.," June 19, 2006.

[14] The Group Chief Executive Meeting (GCEM) represents the principal executive leadership of the Group and is instrumental in developing and implementing the Group Strategy.

[15] BP p.l.c., "Making Energy More: Annual Report and Accounts 2005," (2006), p. 8.

[16] *Ibid.*

[17] *Ibid,* p. 14.

[18] Joel Podolny and John Roberts, *British Petroleum (A2): Organizing for Performance at BPX*, case study S-IB-16A2 (Graduate School of Business Stanford University, revised April 2, 2002), pp. 7-8.

[19] *See generally ibid.*

[20] BP p.l.c., "Making Energy More: Annual Report and Accounts 2005," (2006), p. 174.

[21] *Ibid.*

[22] *Ibid.*

[23] BP p.l.c., Statement of The Lord Browne of Madingley, Group Chief Executive, during the BP Second Quarter 2006 Results and Strategy Update Press Conference, July 25, 2006.

[24] Texas City has a complex management history. Unlike the other U.S. refineries, Texas City had both refinery and chemical operations until 2004. Facilities with both refining and chemical operations were called Star Sites, and BP struggled with how to manage them. From 2000 to 2004, BP had a Complex Director for Texas City with responsibility for the overall refining and chemical operations. During that period, the refinery plant manager for the Texas City refinery had limited responsibilities and was not even required to be based in Texas City (*e.g.*, for a period, the nominal Texas City refinery plant manager was the Group-Vice President for Refining based in London). During this interval, the Texas City Operations Manager effectively ran the refinery. Eventually BP determined that it needed a more senior manager present at the site and responsible for its performance. In 2004, BP sold its chemical operations, and the Texas City refinery plant manager began reporting directly to Gower in late 2004.

[25] BP evaluates (1) "Level 5 Leadership Competences" such as "Operates from intrinsic motivation and inner will," "Thinks strategically," "Catalyses change," "Thinks and acts systematically," "Creates space and empowers others," and "Embodies self-management and humility"; (2) Group Behavioral Expectations, including "Setting context," "Establishing priorities," "Providing support," "Assessing external environment," "Developing relationships," "Integrating values," and "Role modeling code of conduct"; and (3) Experience, including Technical, Commercial, Manufacturing Operations, Leading Big Teams and Delivering Business Results.

[26] BP's U.S. Refining leadership team reviewed the pilot program in July 2006 and transferred responsibility for implementing a superintendent training program to the individual refineries. The Panel understands that BP expects full implementation by late 2007.

V. BP'S HSSE MANAGEMENT FRAMEWORK AND PROCESS SAFETY-RELATED STANDARDS

To a large degree, three basic sources shape process safety-related practices at BP's U.S. refineries: (1) U.S. federal regulatory process safety requirements that OSHA and the EPA administer; (2) BP Group standards, practices, and expectations; and (3) BP Refining-specific process safety minimum expectations. Additionally, each U.S. refinery has implemented site-specific safety programs.

BP's Group requirements are intended to ensure a consistent Group-wide effort to achieve BP's stated commitment toward "no accidents, no harm to people, and no damage to the environment." Recognizing that different businesses within the company face unique risks, BP also enables its business segments (*e.g.*, Refining and Marketing) and performance units (*e.g.*, Refining) to establish "minimum expectations" related to their operations.[1]

Compliance requirements from the three sources listed above are not entirely independent. In some instances, compliance requirements overlap, and refinery-specific directives often serve to guide the refinery in implementing or complying with more general BP Group-wide requirements or federal regulatory requirements. However, refinery-specific materials do not ensure compliance with more general federal or BP Group-wide requirements in every instance, and some of the broadest federal or BP Group-wide requirements have a direct impact on the process safety practices at each of BP's U.S. Refineries. For that reason, the most significant process safety-related compliance requirements affecting BP's U.S. refineries are discussed here, from the general to the more specific.

A. Regulation of Process Safety in the United States

A number of catastrophic incidents at refineries and chemical manufacturing facilities in the 1980s led the U.S. government to increase its regulation of process safety. A dual regulatory scheme emerged because different federal agencies have responsibilities for protection of worker health and safety versus protection of public health and the environment. OSHA administers its process safety management standard for worker health and safety, and the EPA administers its risk management program for public health and the environment. This OSHA standard and the EPA program contain many overlapping requirements.

OVERVIEW OF OSHA'S PROCESS SAFETY MANAGEMENT STANDARD

OSHA is the federal agency charged with ensuring worker health and safety. For this reason, OSHA's process safety management (PSM) standard principally governs process safety as it relates to the workplace.[2] The purpose of this standard is to eliminate or mitigate the consequences of releases of highly hazardous chemicals.[3] The standard emphasizes the application of management controls when addressing the risks associated with handling or working near hazardous chemicals.

The OSHA PSM standard covers any process that involves a highly hazardous chemical.[4] It defines a process as "any activity involving a highly hazardous chemical including any use, storage, manufacturing, handling, or on-site movement of such chemicals, or combination of these activities."[5] The standard contains 14 elements:

(1) employee participation,

(2) process safety information,

(3) process hazard analysis,

(4) operating procedures,

(5) training,

(6) contractors,

(7) pre-start-up safety review,

(8) mechanical integrity,

(9) hot work permits,

(10) management of change,

(11) incident investigation,

(12) emergency planning and response,

(13) compliance audits, and

(14) trade secrets.

OSHA considers its PSM standard to be a performance-oriented requirement. In other words, the PSM standard establishes specific performance objectives. The standard largely leaves the employer to decide the means by which it will achieve compliance with these objectives. In this regard, many employers choose to rely on generally accepted industry practices. OSHA specifically acknowledges the existence of certain industry standards or recommended practices. For example, the PSM standard's Appendix D—Sources of Further Information (Nonmandatory)—lists process safety information that the CCPS,[6] the API, and the American Chemistry Council have developed.

OVERVIEW OF THE CLEAN AIR ACT'S GENERAL DUTY CLAUSE AND EPA'S RISK MANAGEMENT PROGRAM

In 1990, Congress amended the Clean Air Act to include what is known as a general duty clause.[7] The Act's general duty clause requires owners and operators of facilities producing, processing, handling, or storing a regulated substance[8] to identify hazards that may result from accidental releases using appropriate hazard assessment techniques; to design and maintain a safe facility, taking such steps as are necessary to prevent releases; and to minimize the consequences of accidental releases that do occur.[9]

The EPA subsequently promulgated its risk management program in 1996.[10] In establishing this compliance framework, the EPA borrowed heavily from the requirements of the OSHA PSM standard.

B. BP Group-Level Standards, Practices, and Expectations for Process Safety

BP's 2004 Sustainability Review provides that the company seeks "to display some unchanging fundamental qualities—integrity, honest dealing, treating everyone with respect and dignity, striving for mutual advantage and contributing to human progress."[11] To elaborate on these principles, BP has developed "Group values" that express the company's aspirations and are intended to guide its strategy, activities, and operations.

Some of the Group values are related to health, safety, and the environment. Specifically, BP states its aim as "no accidents, no harm to people, and no damage to the environment." John Browne, as Group Chief Executive, first articulated this commitment in a Health, Safety, and Environment policy document in January 1999.

To achieve the Group values, BP has established Group-level requirements. Included among these are the BP Code of Conduct, getting HSE right, the BP Golden Rules of Safety, and several Group standards.

BP CODE OF CONDUCT

The Code of Conduct provides a starting point for the conduct expected of BP employees.[12] All employees must follow the Code of Conduct, and supervisors must also promote, monitor, and enforce compliance with it.[13] The Code of Conduct contains a two-page section addressing the health- and safety-related conduct of all BP employees and anyone else working at BP facilities.[14] It provides that "[n]o activity is so important that it cannot be done safely"[15] and emphasizes that "[s]imply obeying safety rules is not enough. BP's commitment to safety means each of us needs to be alert to safety risks as we go about our jobs."[16] The Code of Conduct does not make reference to specific BP standards, practices, or expectations; instead, it contains a list of basic rules that all employees must follow.[17] These basic rules include practices that might be described as axiomatic, such as "stop any work that becomes unsafe" and "make sure you know what to do if an emergency occurs at your place of work."[18]

GETTING HSE RIGHT

Getting HSE right (gHSEr) describes the BP HSE Management System Framework and represents how BP intends to meet its HSE performance commitment. It sets forth the Group's expectations for the health, safety, and environmental practices of its business units.[19] These HSE expectations "encompass the complete spectrum of health, safety[,] and environmental risk management including personal security, technical/operational integrity of facilities and equipment, and product stewardship."[20] gHSEr represents "the boundaries within which all BP managers must operate" and is mandatory for every business unit.[21]

According to BP, an HSE management system containing the gHSEr elements should ensure continuous improvement of the business unit's HSE practices through a "Plan-Perform-Measure-and-Improve Cycle."[22] Each business unit is then responsible for designing an HSE management system that meets all of the relevant BP Group-wide expectations set out in gHSEr.[23]

BP's HSE expectations are presented in gHSEr's 13 Elements of Accountability, which provide expectations in the following areas:

- **Leadership and accountability.** Managers must develop, document, and implement HSE management systems in accordance with HSE expectations.
- **Risk assessment and management.** Managers must assess, document, and reference risks in their decisions.
- **People, training, and behaviors.** HSE responsibilities should be assigned by managers to individuals, and managers must document those responsibilities and create performance targets.
- **Working with contractors and others.** Contractors must be supervised, and this includes reviewing their HSE policies.
- **Facilities design and construction.** There must be documentation of project management systems and formal approval for design, procurement, and construction standards. Also, pre-start-up reviews must be carried out for all new or modified equipment.
- **Operations and maintenance.** Post-start-up reviews must be completed and procedures must be developed and followed for equipment operations, maintenance, and retirement.
- **Management of change.** Changes must be formally assessed and approved, and they must not exceed their original scope or duration.
- **Information and documentation.** Information must be made available but also secure.
- **Customers and products.** BP must maintain information about product hazards and adverse product effects and have a recall system in place.
- **Community and stakeholder awareness.** BP must communicate HSE information to the community.
- **Crisis and emergency management.** Plans must be developed, continuously updated, and tested through drills.
- **Incident analysis and prevention.** All incidents must be fully reported, investigated, and findings must be shared as appropriate. BP should have teams with some members from outside the business unit for major incidents.

- **Assessment, assurance, and improvement.** HSE targets, and audit programs to track progress towards them, must be established.[24]

In addition to these elements of accountability, gHSEr contains key HSE processes that BP business units should employ as part of their HSE management systems. The HSSE processes listed in gHSEr are directed toward delivering HSSE assurance, behaviors, HSSE risk management, crisis and emergency management, major incident and high potential incident reporting, incident investigation guidelines, HSSE performance targets, HSSE reporting requirements, joint ventures and other operational experiences, HSSE reporting definitions, and health management.[25]

gHSEr contains an expectation that BP business units conduct gHSEr self-assessments annually and sponsor external gHSEr audits at least once every three years.[26] The Panel has reviewed a number of reports describing recent gHSEr self-assessments and audits of individual U.S. refineries.[27] The Panel has also reviewed reports that BP's Internal Audit function prepared describing trends and common issues identified in gHSEr audits across BP as a whole. The Panel's review of these reports contributed to findings discussed in Sections VI.B and Section VI.C.

BP GOLDEN RULES

The Golden Rules are intended to provide easy-to-remember, basic guidance to the BP workforce in eight areas: (1) permit to work, (2) ground disturbance, (3) working at heights, (4) driving safety, (5) energy isolation, (6) confined space entry, (7) lifting operations, and (8) management of change. Several of the Golden Rules, including permit to work and management of change, are relevant to the management of process safety.

In addition to the Golden Rules, BP expects that the following basic principles will be incorporated into each rule:

> [W]ork will not be conducted without a pre-job risk assessment and a safety discussion. . . . [A]ll persons will be trained and competent in the work they conduct. [P]ersonal protection equipment will be worn. . . . [E]mergency response plans. . . will be in place before the commencement of work. . . . [And] everyone has an obligation to stop work that is unsafe.[28]

The Golden Rules do not provide specific procedures aimed at refining operations or any other individual BP operation. Standards and policies addressing specific aspects of BP operations are contained in, among other sources, Group standards and engineering technical practices, which are discussed below. Because they apply broadly to the daily activities of BP's workforce, the Golden Rules frequently overlap with more specific sources of authority such as Group standards or engineering technical practices. The Golden Rules are relatively simple, and they do not appear to conflict with more specific authorities. BP's control of work Group standard, which touches on many of the same work practices contained in the Golden Rules, states that guidelines in the control of work standard should be used in conjunction with the Golden Rules.[29]

BP GROUP STANDARDS

BP has issued a limited number of Group standards to address certain risks relating to all of BP's business segments, such as Refining and Marketing. Group standards establish expectations and processes for reducing the risk of failure to deliver Board goals or the risk of non-compliance with the Code of Conduct in the areas that are subject to Group standards. As of December 1, 2006, BP had issued Group standards related to safety in the areas of driving safety, control of work, and integrity management. In addition, a draft Group marine operations standard is currently under review. Three of BP's Group standards have direct bearing on process safety practices in refining: the 2001 process safety/integrity management standard; the new 2006 integrity management standard, which replaces the process safety/integrity management standard; and the control of work standard.

> BP process safety/integrity management standard

In May 2001, BP issued a process safety/integrity management (PS/IM) standard directed toward process safety/integrity management at BP facilities. Intended to support the delivery of the HSE expectations in gHSEr, BP promulgated this standard partly in response to three major process incidents that occurred at the BP Grangemouth Petrochemical Complex in Scotland during May through June 2000.

The PS/IM standard sought to "help prevent the occurrence of, or minimize the consequences of, catastrophic releases of hazardous materials and to assure facilities are designed, constructed, operated[,] and maintained in a safe fashion using appropriate codes and standards." It established requirements in the following areas related to process safety and integrity management: hazard evaluation, management of change, mechanical integrity, protective systems, competent personnel, incident investigation, emergency response, and performance management and assurance. BP viewed the eight requirements comprising the PS/IM standard as having their basis in the gHSEr expectations, and applicable gHSEr expectations were linked to each of the eight requirements. A key aspect of the PS/IM standard is the requirement that "[a]ll facilities must systematically identify hazards within its boundary arising from normal and abnormal operations and shall eliminate/control/mitigate the hazards such that residual risks are as low as is reasonably practicable."[30] The new integrity management standard, described below, has superseded the PS/IM standard.

> BP integrity management standard

BP designed the integrity management standard to ensure that equipment used in BP operations is fit for service, thereby avoiding loss of containment incidents. In promulgating this standard, BP observed that it was derived from, and intended to improve upon, the 2001 PS/IM standard. The integrity management standard defines a formal approach to management of integrity at BP operations during all phases of equipment life: from design and construction, through operation and maintenance, to decommissioning. BP's U.S. refineries have begun to implement the integrity management standard, with full implementation required by December 31, 2008.[31] BP has recently developed an audit protocol for assessing compliance with the integrity management standard.

The integrity management standard has ten elements: (1) accountabilities, (2) competence, (3) hazard evaluation and risk management, (4) facilities and process integrity, (5) protective systems, (6) practices and procedures, (7) management of change, (8) emergency response, (9) incident investigation and learning, and (10) performance management and learning. According to BP, the integrity management standard has incorporated all elements of the superseded PS/IM standard. However, the Panel notes that the integrity management standard's hazard evaluation and risk management element does not contain the PS/IM standard's requirement that identified risks be mitigated "as low as reasonably practicable." Instead, the new integrity management standard contains a more general requirement that BP operations "identify and mitigate" integrity management hazards and risks, including development of a hazard and risk register for each BP operation with links to the measures, systems, processes, and procedures in place to manage or mitigate the risks.

The integrity management standard requires all BP operations to conduct an assessment for quantifying and ranking major accident risks. This major accident risk methodology is described in BP Group Engineering Technical Practice GP 48-50, *Guidance on Practice for Major Accident Risk Process*, discussed below. To ensure that the assessments are done consistently from one refinery to the next, BP's Head of Major Hazards and Fire established dedicated teams to conduct major accident risk assessments of BP refineries. In addition to major accident risk assessments, the integrity management standard also requires each site to develop formal procedures for identifying and managing integrity management hazards associated with both normal and abnormal operations.

> BP control of work standard

BP issued the control of work standard to ensure a "formal approach to managing work risk for BP employees and for BP companies and their contractors."[32] Although the BP Golden Rules existed prior to the control of work standard and provided some basic guidance relating to control of work, BP concluded that the standard was necessary based upon its review of fatal accidents to the BP workforce from 2000 to 2004. From this review, BP discovered that job factors related to control of work were frequently identified during its incident root cause analyses.[33]

BP intends for the control of work standard to provide a means for safely controlling construction, maintenance, demolition, remediation, operating tasks, and similar work activities. Among other things, the control of work standard requires a written policy for describing the control of work process, defined accountabilities for all identified roles within the control of work policy and associated procedures, and training for persons involved in the control of work process.[34] The standard also prohibits tasks unless they are assessed for risk. Additionally, it imposes a permit requirement for work involving confined space entry, work on energy systems, ground disturbance, hot work, or other hazardous activities.[35] Control of work policy and associated procedures must also make clear to everyone that they have the obligation and authority to stop unsafe work.[36] Refineries must implement the standard by the end of 2009.[37]

BP refining subsequently published minimum expectations for control of work to implement the control of work standard. This publication contains element-by-element direction, specific to BP refining operations, to ensure that BP refineries comply with the requirements contained in each element of the standard.

ENGINEERING TECHNICAL PRACTICES

BP uses Group engineering technical practices (ETPs) as a way to share the engineering design and operating knowledge that it has acquired. These ETPs are intended "to provide general technical and operational guidance for the activities associated with the EPIC project process (engineering design, procurement, installation, and construction) . . ." and to transfer good practices across all of BP. BP's policy on the development of ETPs provides that applicable industry standards are to be used when possible as the basis for new ETPs.

When developing an ETP, BP might supplement the applicable industry standard with internally developed guidance. These supplements are to be read in conjunction with the basic industry standard; they do not limit or supplant it. When no suitable industry standard exists for a given subject matter, the ETP and corresponding guidance are developed internally.

ETPs are written as guidance documents and suggest taking a risk-based approach to engineering design. The site engineering authority is responsible for determining what practices are appropriate for a given site and for ensuring that the site is in compliance with applicable ETPs. If the site engineering authority determines that an ETP is applicable and the site will "use" the ETP, then the site must either fully meet the requirements contained in the ETP or document deviations from those requirements. In this sense, the requirements in the ETPs are mandatory. The site engineering authority has the sole authority to authorize and document site-specific deviations from ETP requirements. In situations in which an ETP is not appropriate for a site's use, BP's policies still allow for the site to benefit from guidance contained in the ETP without formally using the ETP and becoming subject to its requirements.

A dedicated maintenance team consisting of BP Group Technology personnel and practice-specific subject matter experts periodically updates BP's ETPs. To assist both ETP users and maintenance teams, BP has developed an ETP shared learning system to collect feedback and capture practical experiences from users. Shared learning system feedback provides input to those who update ETPs to identify areas for development of new ETPs.

Approximately 50 major categories of and more than 400 individual ETPs exist. The Panel has not reviewed all of the ETPs because most of them are not relevant to the Panel's charter. Two that are particularly significant, however, are discussed below.

> Guidance on practice for major accident risk process (GP 48-50)

BP issued this ETP, which is a guidance on practice commonly referred to as "the MAR," in August 2004. The Major Accident Risk (MAR) guidance, which the new integrity management standard requires, establishes a specific process designed to ensure a continuous reduction in the risk of potential major accidents at BP's facilities. The MAR assessment process is intended as a high-level, quantified risk assessment across all of BP's operations. The MAR guidance was specifically designed for the Group-level to understand major risks that could threaten the corporate existence of BP. For this purpose, BP considers a major accident as one that results in multiple fatalities and/or severe damage to the environment. The MAR assessment methodology requires the identification of a representative range of hypothetical events that could lead to a major accident, quantification of the hypothetical likelihood of these events, quantification of the possible physical effects resulting from these events and an assessment of their consequences, and an evaluation of options to mitigate the likelihood and/or consequences of the considered events. Although the MAR assessment for a given site is prepared with site input, personnel in the Group Technology function area perform each assessment.

MAR assessments are not intended to provide a comprehensive evaluation of hazards at a site, and the use of these assessments has various limitations. For example, MAR assessments use event frequencies that are based on industry experience and that reflect average design and operation. For this reason, the MAR assessment process does not reflect instances in which unit conditions are better or worse than the industry average. In addition, the MAR assessment process does not account for operation of a facility outside reasonably anticipated parameters. BP does not intend for the MAR assessment process to be the sole hazard evaluation and risk management tool that the sites use. According to BP, individual sites use a range of risk assessment tools, including hazard identification, layers of protection analysis, hazard and operability studies, and quantified risk assessment. Although the MAR guidance is applied Groupwide, it is an ETP, not a Group standard. While the MAR guidance provides a key tool in assessing certain major risks, BP intends that all risks, not just major accident risks, will be continuously reduced.

> Guidance on practice for design and location of occupied portable buildings within refineries and chemical plants (RM-GP 04-30)

BP issued this ETP in December 2005 in response to the Texas City accident. It establishes requirements for the design and location of new and existing occupied portable buildings (*e.g.*, trailers)[38] that apply without regard to the length of time that the portable building will be positioned at the site or the number of occupants in the building.[39] This ETP contains a method for defining three concentric zones (red, yellow, and orange) surrounding process units based on the estimated potential for hazards associated with vapor cloud explosion overpressures, thermal radiation, exposure to toxic materials, or flammable gas or liquids releases.[40] Depending upon the classification of a particular zone, occupied portable buildings within that zone are either prohibited or subject to specific restrictions. This ETP also requires a site to develop and maintain procedures for the control of occupied portable buildings.[41] Occupied portable buildings, for example, are subject to a management of change approval process,[42] which must include a risk assessment that takes into account specified factors.[43] This ETP also requires a site to develop procedures for the evacuation of occupants from portable buildings when facilities that can affect the safety of the occupants start up, shut down or are in upset condition.[44] BP required full compliance with the ETP by December 31, 2006.

BP PROCESS AND PERSONAL SAFETY BOOKLETS

BP has developed and issued a series of booklets designed to identify potential hazards in refineries and petrochemical plants.[45] These booklets supplement operator training courses, operating manuals, and operating procedures.[46] BP intends for these booklets to assist its employees and contractors to better understand the "why" of safe operating practices and procedures.[47] Topics within the series include the safe operation and control of process heaters, the safe shutdown and start-up of process units, the hazards associated with steam and process systems, and the safe handling and storage of the hydrocarbons. These booklets cover approximately 14 topics and are publicly available.

C. Refining-Specific Process Safety Minimum Expectations

As discussed above, BP business segments and strategic performance units may establish minimum expectations related to their health and safety performance operations in recognition of the unique risks in these operations. Process safety minimum expectations define the minimum expectations for operation of process units and major equipment at all BP refineries worldwide. They provide minimum requirements for significant aspects of process operation, such as start-up, shutdown, normal operation, and maintenance. In many instances, these minimum expectations do not require specific actions or practices, but instead require the refinery to develop its own procedures or define an operating window to address a safety risk identified in the minimum expectations. The minimum expectations also contain pertinent references along with sections listing process hazards and safe operating conditions for the process or equipment that is subject to the minimum expectation. Framed as *minimum* expectations, BP encourages the refineries to regularly exceed these requirements.

Development of these minimum expectations, which began in 2000, was intended to standardize process safety requirements across BP's global portfolio of refineries. BP subsequently rebranded the process safety standards as minimum expectations in 2004, and new minimum expectations have continued to be developed since the rebranding. BP originally identified 15 subjects for process safety standard development, and these 15 subjects have provided the basic framework for the development of process safety minimum expectations to the present day.

As of June 2006, BP refining had issued 13 process safety minimum expectations in addition to minimum expectations relating to inspections and control of work:

- PSME No. 3: Hydrogen Sulfide Processing and Handling (First issued March 26, 2001, Rebranded April 28, 2004);
- PSME No. 4: Sulfuric Acid Alkylation Process Operations (First issued October 29, 2001, Rebranded April 28, 2004);
- PSME No. 5: Fluid Catalytic Cracking (First issued October 1, 2001, Rebranded April 28, 2004);
- PSME No. 6: Hydrofluoric Acid Alkylation Process Operations (First issued February 19, 2002, Rebranded April 28, 2004);
- PSME No. 7: Crude and Vacuum Distillation (First issued October 23, 2002, Rebranded April 28, 2004);
- PSME No. 8: Delayed Coking (First issued December 26, 2002, Rebranded April 28, 2004);
- PSME No. 10: Hydrotreating/Hydrocracking (First issued June 2, 2003, Rebranded April 28, 2004);
- PSME No. 11: Sulphur Recovery Process Operations (First issued December 15, 2005);
- PSME No. 12: Cyclic Reforming (Ultraforming) Process (First issued August 11, 2003, Rebranded April 28, 2004);
- PSME No. 13: Semi-Regen Reforming Process (First issued November 23, 2004);
- PSME No. 14: Continuous (CCR) Reforming Process (First issued November 23, 2004);
- PSME No. 16: LPG (Light Ends) Handling (First issued May 6, 2005); and
- PSME No. 18: Safe Use of Nitrogen (First issued February 25, 2004, Rebranded April 28, 2004).

BP has advised the Panel that additional process safety minimum expectations are in development or are under consideration for development.

Once the Group Refining Leadership team approves and formally issues a process safety minimum expectation, each refinery has 90 days to complete a gap analysis and develop an implementation plan to close the gaps between the new minimum expectation and the refinery's existing practices. The process safety community of practice tracks each refinery's progress toward resolving action items stemming from the implementation plan and reports to Global refining leadership on a quarterly basis. Ultimately, however, the rate at which the refinery implements a process safety minimum expectation is at the discretion of that refinery's plant manager, subject to Global refining leadership approval.

ENDNOTES FOR SECTION V

[1] BP addresses risks that are unique to specific sites by developing site-specific policies, processes, and procedures.

[2] *See* 29 C.F.R. § 1910.119 (2006).

[3] *Ibid*.

[4] A *highly hazardous chemical* is a substance possessing toxic, reactive, flammable or explosive properties and is (1) a chemical listed on Appendix A of the PSM standard at or above the specified threshold quantity; or (2) a flammable liquid or gas in a quantity of 10,000 pounds or more. 29 C.F.R. § 1910.119(a)(1), (b) (2006).

[5] 29 C.F.R. § 1910.119(b) (2006).

[6] Developed in response to the tragic release of methyl isocyanate in Bhopal, India, CCPS is a non-profit educational organization comprising more than 70 corporate and governmental sponsors. In addition to developing guidelines, publications, and other resources, CCPS has issued a 19-element plan for process safety.

[7] 42 U.S.C. § 7412(r) (2006).

[8] A *regulated substance* is any substance listed in 40 C.F.R. § 68.130 pursuant to section 112(r)(3) of the Clean Air Act.

[9] 42 U.S.C. § 7412 (r)(1) (2006).

[10] Accidental Release Prevention Requirements: Risk Management Programs Under Clean Air Act Section 112(r)(7), 61 Fed. Reg. 31,668 (June 20, 1996). *See also* 40 C.F.R. § 68, Subpart G (2006).

[11] BP p.l.c., "Making the Right Choices: Sustainability Report 2004," (2005), p. 10.

[12] BP p.l.c., "Our Commitment to Integrity: BP Code of Conduct," (2005), pp. 4-5.

[13] *Ibid*, p. 6.

[14] *Ibid*, pp. 14-15.

[15] *Ibid*, p. 14.

[16] *Ibid*, p. 15.

[17] *Ibid*.

[18] *Ibid*.

[19] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 3.

[20] *Ibid*.

[21] *Ibid*.

[22] *Ibid*, p. 4.

[23] *Ibid*.

[24] *Ibid*.

[25] *Ibid*, p. 2.

[26] *See ibid*, p. 22.

[27] BP p.l.c., "getting HSE right Audit Report, BP South Houston, Audit No. 2003-41," September 22, 2003, p. 2.

[28] BP p.l.c., "The BP Golden Rules of Safety," (2001).

[29] BP p.l.c., "BP Group Standard, Control of Work," (2005).

[30] The standard's "as low as reasonably practicable" tracks similar language found in the United Kingdom's Health and Safety at Work Act of 1974 and subsequent enabling regulations. *See* Health & Safety Executive, "Guidance on 'as low as reasonably practicable' (ALARP) decisions in control of major accident hazards (COMAH)" *accessed at* http://hse.gov.uk/comah/circular/perm12.htm on November 17, 2006.

[31] BP p.l.c., "Making Energy More: Sustainability Report 2005," (2006), p. 20.

[32] BP p.l.c., "BP Group Standard, Control of Work," (2005), p. 2.

[33] *Ibid*.

[34] *Ibid*, pp. 5-6.

[35] *Ibid*, pp. 6-8.

[36] *Ibid*, p. 11.

[37] *Ibid*, p. 3.

[38] BP p.l.c., Engineering Technical Practice, "Design and Location of Occupied Portable Buildings within Refineries and Chemical Plants ETP RM-GP 04-30," (2005), pp. 4, 6.

[39] *Ibid*, p. 4.

[40] *Ibid*, pp. 8-11.

[41] *Ibid*, p. 11.

[42] *Ibid*.

[43] *Ibid*.

[44] *Ibid*, p. 12.

[45] *See, e.g.*, BP p.l.c., "Confined Space Entry," (2005), p. 2.

[46] *Ibid*.

[47] *Ibid*.

VI. FINDINGS

A. Corporate Safety Culture

A positive safety culture is important for good process safety performance. Absent a healthy safety culture, even the best safety management systems will be largely ineffective in ensuring and sustaining excellent process safety performance. In 2003, the Conference Board studied best practices in corporate safety and health among major corporations, analyzing how leading companies develop safety cultures. While this study focused on management and management practices, the Conference Board's 2003 report indicates that one of the key themes emerging from the study

> was that management practices alone are not sufficient to achieve outstanding safety performance; *all* of a company's workers must be engaged and involved. Ultimately, achieving excellence is about empowering all workers—management, supervisors, employees, and even contractors—to make safety and health practices truly work.[1]

The report also provides that "[c]ompanies have found that if safety and health values are not consistently (and constantly) shared at all levels of management and among *all* employees, any gains that result from declaring safety and health excellence a 'priority' are likely to be short-lived."[2]

Through BP's investigation of the March 2005 Texas City accident, it appears to the Panel that BP has come to appreciate the importance of cultural factors in promoting good process safety performance.[3] It also appears that BP now understands that a positive safety culture is a critical driver of process safety performance.

The Panel makes five fundamental observations about BP's corporate safety culture with respect to BP's U.S. refineries. First, BP has not provided effective process safety leadership. BP has not adequately established process safety as a core value across all its five U.S. refineries. While BP has an aspirational goal of "no accidents, no harm to people," BP has not provided effective leadership in making certain its management and U.S. refining workforce understand what is expected of them regarding process safety performance. BP has emphasized personal safety in recent years and has achieved significant improvement in personal safety performance, but BP did not emphasize process safety. BP mistakenly interpreted improving personal injury rates as an indication of acceptable process safety performance at its U.S. refineries. BP's reliance on this data, combined with an inadequate process safety understanding, created a false sense of confidence that BP was properly addressing process safety risks. The Panel further found that process safety leadership appeared to have suffered as a result of high turnover of refinery plant managers.

Second, at some of its U.S. refineries BP has not established a positive, trusting, and open environment with effective lines of communication between management and the workforce, including employee representatives. Creating trust within the organization at all levels is key to establishing an environment in which safety critical information can be shared among the workforce and with management with confidence that the information will be used primarily for one purpose—to improve safety conditions and performance.

Third, BP has not always ensured that it identified and provided the resources required for strong process safety performance at its U.S. refineries, including both financial and human resources. Despite having numerous staff at different levels of the organization that support process safety, BP does not have a designated, high-ranking leader for process safety dedicated to its refining business. While the Panel did not develop or identify sufficient information to conclude whether BP ever intentionally withheld resources on any safety-related assets or projects for budgetary or cost reasons, the Panel believes that the company did not always ensure that adequate resources were effectively allocated to support or sustain a high level of process safety performance. In addition, BP's corporate management mandated numerous company-wide initiatives that apply to the U.S. refineries and that, while well intentioned, have overloaded personnel at BP's U.S. refineries. This "initiative overload" may have undermined process safety performance. In addition, operations and maintenance personnel in BP's five U.S. refineries sometimes work high rates of overtime, and this could impact their ability to perform their jobs safely and increase process safety risk.

Fourth, BP did not effectively incorporate process safety considerations into management decision-making that affects the U.S. refineries. BP tended to have a short-term focus, and its decentralized management system and entrepreneurial culture have delegated substantial discretion to U.S. refinery plant managers without clearly defining process safety expectations, responsibilities, or accountabilities. In addition, while accountability is a core concept in BP's Management Framework for driving desired conduct, BP has not demonstrated that it has effectively held executive management and refining line managers and supervisors, both at the corporate level and at the refinery level, accountable for process safety performance at its U.S. refineries.

Finally, BP has not instilled a common, unifying process safety culture among its U.S. refineries. Rather, the Panel found that each refinery has its own separate and distinct process safety culture. While some refineries are far more effective than others in promoting process safety, significant process safety culture issues exist at all five U.S. refineries, not just Texas City. Indeed, the refineries show some similar process safety cultural weaknesses, even though they do not share a unified process safety culture. The Panel found instances of a lack of operating discipline, tolerance of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks at each refinery.

PROCESS SAFETY LEADERSHIP

In a positive process safety culture, all constituencies of the refinery's workforce—from the plant managers to superintendents to HSSE professionals to hourly employees and contractors—regard process safety as a core value, and all levels of the workforce appreciate that process safety expectations are not considered secondary to production goals, budgetary objectives, or other competing considerations. While site leadership is certainly important in establishing a positive process safety culture, the Panel believes that leadership from the top of the company, starting with the Board and going down, is essential. In the Panel's opinion, it is imperative that BP's leadership set the process safety "tone at the top" of the organization and establish appropriate expectations regarding process safety performance. Those expectations must reflect an unwavering commitment to process safety and infuse into BP's workforce the mindset that process accidents are not acceptable. Those expectations must also be translated into measurable goals designed to move BP toward the achievement of excellence in process safety performance.

Through interviews of the refinery workforce, a review of BP documents, and the process safety culture survey, the Panel determined that BP has not adequately established process safety as a core value across its U.S. refineries. The Panel believes that a primary reason that process safety is not more widely shared as a core value in the U.S. refinery workforce is that BP executive and corporate refining management have not provided effective process safety leadership. Instead, they provided the refining workforce with a plethora of messages concerning many values, and these tended to dilute the importance of any corporate vision on safety generally, much less process safety in particular. As discussed below, the Panel believes that BP has not provided effective leadership on or established appropriate operational expectations regarding process safety performance at its U.S. refineries. The Panel also believes that the lack of effective leadership was systemic, touching all levels of BP's corporate management having responsibilities relating to BP's U.S. refineries.

BP has emphasized personal safety but not process safety. BP has relied largely upon injury statistics, rather than process safety metrics, in performance contracts and variable pay programs that it uses to drive conduct within its organization. BP interpreted improving injury rates, which are widely tracked in the industry, as an indication of acceptable process safety performance at its U.S. refineries, BP's reliance on this data and its inadequate process safety understanding created a false sense of confidence that BP was properly addressing process safety risks at these refineries.

> Process safety as a core value in BP's U.S. refineries

The Panel's review indicates that BP has not adequately established process safety as a core value across its U.S. refineries.

Many competing values. The Panel's refinery level interviews, the process safety culture survey, and some BP documents suggest that significant portions of the U.S. refinery workforce do not believe that process safety is a core value at BP. As many of the refinery interviewees pointed out, and as some BP documents and the process safety culture survey seem to confirm, one of the reasons for this belief is that BP's executive and corporate refining management have not communicated a consistent and meaningful message about the importance of process safety and a firm conviction that process accidents are not acceptable. The inability of many in the workforce to perceive a consistent and meaningful corporate message about process safety is easy to understand given the number of "values" that BP articulates:

- BP's 18 "Group values," only one of which encompasses health and safety—the company's broad, aspirational goal of "no accidents, no harm to people, and no harm to the environment."
- Four "Brand values," which BP claims "underpin everything we do": being performance driven, innovative, progressive, and green. None of these relates to safety.
- BP's code of conduct, which covers health, safety, security, the environment, diversity, ethics, and compliance.

These messages to the BP workforce on so many values and priorities contribute to a dilution of the effectiveness of any management message on process safety. This is consistent with a recent observation from the organizational expert that BP retained under the 2005 OSHA settlement relating to Texas City:

> There appears to be no one, over-arching, clearly-stated worksite policy at Texas City, regardless of respondents' answers. The BP stated policy on health and safety, "no accidents, no harm to people and no damage to the environment" is not widely known at Texas City and points to a weak connection between BP Texas City and BP as a corporation. Safety communication is viewed more as a function of particular individuals in Texas City versus a BP wide commitment.

Until BP's management, from the Group Chief Executive down through the refinery superintendents, consistently articulates a clear message on process safety, it will be difficult to persuade the refining workforce that BP is truly committed on a long-term basis to process safety excellence.

Of course, it is not just what management says that matters, and management's process safety message will ring hollow unless management's actions support it. The U.S. refinery workers recognize that "talk is cheap," and even the most sincerely delivered message on process safety will backfire if it is not supported by action. As an outside consulting firm noted in its June 2004 report about Toledo, telling the workforce that "safety is number one" when it really was not only served to increase cynicism within that refinery.

Refinery interviews. The Panel's interviews of hourly workers and refinery management establish that a significant portion of the U.S. refining workforce believed that production goals, operational pressures, or budgetary constraints sometimes overrode process safety concerns. This perception was most widely held at Toledo, Texas City, and Whiting, although interviews suggest that Texas City and Whiting are making progress on convincing the workforce that process safety comes first. At Carson, interviewees suggested that the perception that production goals, operational pressures, or budgetary constraints overrode process safety concerns appeared to vary by unit in the refinery. The Panel's review indicates that the perception did not appear to be widespread at Cherry Point.

At Toledo, higher levels of management typically stated that decisions regarding production and cost savings did not override process safety concerns, but that belief tended to change in the middle and lower ranks of the Toledo organization. Many lower and middle managers interviewed expressed skepticism about whether process safety concerns came first. Toledo hourly workers interviewed widely believed that production was a higher priority than process safety.

At Texas City, many hourly workers who were interviewed in early February 2006 stated their perception that profit came before safety. Many of the Texas City management interviewees (interviewed in June 2006) acknowledged that in the past production had effectively been a priority over process safety concerns, but these management interviewees were broadly of the view that the culture was changing rapidly.

At Whiting, many interviewees discussed the "can do" culture in which the workforce took great pride in getting the job done—doing whatever was necessary to keep the refinery running. Whiting management acknowledged a culture of heroism and discussed how they were trying to change the culture to one of planning and compliance—scheduling work and getting it done in an orderly manner. The Whiting hourly workforce interviewees generally believed that progress was being made in establishing process safety as a core value.

At Carson, workers in some units claimed that production and cost goals sometimes overrode process safety, but workers in other units disagreed.

Few interviewees at Cherry Point believed that production goals, operational pressures, or budgetary concerns overrode process safety issues.

BP reports and analyses. Various BP reports and analyses reflect some of these same concerns. For example, the Mogford Report relating to the Texas City ISOM accident provides that "[a] number of interviewees noted that safety did not seem to be a priority, particularly as compared to cost management, for example."[4] Similarly, a June 2004 outside consulting firm report on Toledo concluded that

> [t]he predominant view of safety at the Toledo Refinery is that it is inadequate and stagnant due to a disjointed culture that is primarily focused on production and bottom-line results. Although almost every person at the refinery is to some degree aware of how important it is to work safely, the culture actually promotes a production focus over "safety first" and getting the job done takes precedence.

Process safety culture survey. Please read Section I for a discussion of considerations and limitations relating to survey data and the Panel's method of analyzing that data. The analysis of survey data contained in this section is qualified by, and should be read in conjunction with, the discussion of those considerations and limitations in Section I.

As stated in Section I, for analytical purposes the Panel often presents data for respondents—both contractors and one or more of nine employee groups—whose job functions likely involve some degree of on-site exposure to process safety hazards and process safety practices. Throughout the report, the Panel refers to the employee groups as the "process safety functional groups," which include operators, operations management, maintenance/craft technicians, maintenance/turnaround planners, maintenance management, full-time HSSE employees, learning and development/training employees, engineering professionals, and project management.[5]

The Panel's process safety culture survey generally indicates that significant portions of the Toledo and Texas City workforce do not believe that process safety is a core value, that pockets of the Whiting and Carson workforce believe likewise, and that the Cherry Point workforce tends to believe otherwise. Four survey items are particularly relevant.

One of the four relevant survey items addressed whether respondents believed that refinery management placed a high priority on process safety through actions rather than just empty slogans. As shown in Table 1 below, Toledo operators and maintenance/craft technicians provided the highest negative response rates of 54 percent and 44 percent, respectively. At Texas City, operators, maintenance/craft technicians, and HSSE employees also generated relatively high negative response rates, ranging between 29 percent and 31 percent. At Whiting and Carson, contractors and employees in the process safety functional groups responded more positively than their counterparts at Toledo and Texas City. Moreover, as reflected in Table 1, their negative response rates did not exceed 20 percent. Cherry Point respondents were even more positive and, as indicated below, five employee groups (maintenance/craft technicians, full-time HSSE employees, engineering professionals, operations management, and maintenance management) provided negative response rates below ten percent.

Table 1

**Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"Refinery management puts a high priority on process safety through actions and not just empty slogans."**

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	17	12	29	54	16
Maintenance/Craft Technicians	19	5	31	44‡	18
Full-Time HSSE Employees	0	8	30	26‡	18
Engineering Professionals	11	5	17	19	8
Operations Management	0	5	6	12	4
Maintenance Management	0‡	6‡	13	*	3
Contractors	17	17	19	26	18

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Another relevant survey item inquired whether operational pressures led to cutting corners where process safety was concerned. As seen in Table 2 below, relatively high percentages of contractors and employees in a few process safety functional groups at certain refineries indicated their impression that operational pressures had that result. Operators (except at Cherry Point), maintenance/craft technicians, and contractors were particularly likely to respond negatively, but there were also relatively high percentages of negative responses from some other groups. Of the engineering professionals, for example, more than 20 percent responded negatively at Toledo (27 percent) and Texas City (22 percent). The same was true for Carson maintenance management (29 percent) and Whiting HSSE employees (23 percent). Additionally, 32 percent of Texas City HSSE employees indicated that operational pressures led to cutting corners, but an equal percentage of that group responded that they did not know or did not have an opinion on the issue.

Employees in several process safety functional groups responded quite favorably to this item. This is reflected in part by their low negative response rates, which are contained in Table 2. Only three percent of the HSSE employees at Carson and four percent of the HSSE employees at Cherry Point expressed an opinion that operational pressures led to cutting corners where process safety was concerned. In addition, operation management's negative response rate ranged from a low of five percent at Cherry Point to a high of only 16 percent at Texas City. Finally, maintenance management at all refineries except Carson provided low negative response rates.

Table 2

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"Operational pressures do not lead to cutting corners where process safety is concerned."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	19	11	35	49	28
Maintenance/Craft Technicians	29	21	36	44‡	24
Full-Time HSSE Employees	3	4	32	16‡	23
Engineering Professionals	15	5	22	27	17
Operations Management	15	5	16	14	7
Maintenance Management	29‡	0‡	11	*	6
Contractors	22	30	22	36	25

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

A third survey item solicited impressions about whether process safety improvement was a long-term commitment that was not compromised by short-term financial goals. Responses again were mixed. As indicated in Table 3 below, relatively high percentages of operators, maintenance/craft technicians, and HSSE employees at Toledo, Texas City, and Whiting responded negatively. Most notably, 56 percent of maintenance/craft technicians and 45 percent of operators at Toledo responded negatively. Responses from each of those groups at Carson and Cherry Point, however, were more positive. Moreover, contractors and management generally responded positively across all five refineries and as indicated below, they typically provided low negative response rates. Contractors' negative response rates ranged from just nine percent at Carson to 16 percent at Texas City, and in most cases, operations and maintenance management's negative response rates were less than ten percent.

Table 3

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"[P]rocess safety improvement is a long-term commitment that is not compromised by short-term financial goals."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	15	15	30	45	24
Maintenance/Craft Technicians	18	7	39	56‡	21
Full-Time HSSE Employees	3	8	29	21‡	28
Engineering Professionals	10	7	29	19	16
Operations Management	0	3	6	19	9
Maintenance Management	0‡	0‡	13	*	9
Contractors	9	11	16	13	12

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

A fourth and similar survey item addressed whether process safety concerns were secondary to achieving production goals. The majority of HSSE employees, engineering professionals, operations management, and maintenance management (at all refineries except Carson) responded positively, expressing a belief that process safety concerns were not secondary. In contrast, as shown in Table 4 negative response rates were somewhat high for operators (at or above 20 percent for all refineries except Cherry Point), maintenance/craft technicians (ranging from 23 percent to 56 percent), and contractors (ranging from 39 percent to 60 percent), especially at Texas City and Toledo.

Table 4

Percentages of Agree/Tend to Agree Responses to Survey Item:
"In my work group, process safety concerns are secondary to achieving production goals."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	21	13	33	42	20
Maintenance/Craft Technicians	49	41	37	56‡	23
Full-Time HSSE Employees	3	12	15	11‡	8
Engineering Professionals	11	9	11	19	13
Operations Management	15	17	7	12	15
Maintenance Management	25‡	6‡	11	*	0
Contractors	41	41	46	60	39

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Finding:

BP has not adequately established process safety as a core value across its five U.S. refineries.

> Process safety leadership

The Panel believes that BP has not provided effective leadership on or established appropriate operational expectations regarding process safety performance at its U.S. refineries. As discussed below, the Panel believes that the lack of effective leadership is systemic, touching all levels of BP's corporate management having responsibility for BP's U.S. refineries.

Establishing appropriate process safety goals and performance expectations. The information available to the Panel indicates that BP emphasized personal safety but not process safety and did not set an appropriate process safety "tone at the top" or establish appropriate operational goals and expectations regarding process safety performance for BP's U.S. refineries. The Panel believes that establishing the right "tone at the top" of an organization is particularly within the domain of executive management.

As discussed later in this section, BP uses a system of cascading performance contracts and variable pay programs to drive desired performance within the organization on a variety of matters, including operations, financial performance, environmental performance, and personal safety. Given the importance of performance contracts and variable pay programs to achieving BP's goals, the metrics and milestones included in them are critical. Prior to 2006, however, performance contracts and variable pay programs in BP's U.S. refineries did not contain metrics that would act as a significant and positive incentive for ensuring process safety performance.

While BP has the aspirational goal that there be "no accidents, no harm to people," it appears that refinery managers have not received effective operational guidance from corporate-level refining management about how to achieve this goal. It also appears that executive management has neither technical refining experience nor substantial input from a designated full-time process safety staff position to provide process safety input into decisions that affect the U.S. refining operations. The Panel would not necessarily expect the chief executive officer or head of all of refining and marketing of a global integrated energy company to be a process safety expert. BP has long had a number of corporate-level managers—in refining, Group Technology, Refining Technology, the HSSE organization, and elsewhere—who either had, or should have had, a much deeper understanding of refining process safety than BP executive management. As discussed elsewhere in this section, that so many different staff members in the BP organization provide some support for process safety performance may dilute the effectiveness of input from staff to line management. The information available to the Panel also indicates, as would be expected, that corporate-level refining line management below the executive level has greater process safety knowledge and operating and technical refining expertise than executive management. For whatever reasons, BP corporate managers with line responsibility for the U.S. refineries have not, as a group, demonstrated effective leadership in and commitment to process safety. BP appears to have had a corporate blind spot relating to process safety. BP executive management apparently believed that they were appropriately addressing process safety issues and risks, and it took the tragedy of the Texas City accident to wake BP up to the fact that it was not adequately measuring, tracking, and managing process safety performance.

During the course of its review, however, the Panel observed a shift in BP's understanding of process safety. As discussed in Appendix F, BP has undertaken a number of measures designed to improve process safety performance. In addition, BP executive management and corporate-level management have more visibly demonstrated their commitment to process safety in recent months.

Demonstrating commitment to process safety through communications and visibility. In order to ensure that corporate-level managers and the U.S. refining workforce develop a shared value on the importance of process safety, BP's corporate management must clearly, frequently, and consistently communicate that value. During its review, the Panel found little to indicate that before March 2005, BP corporate management had effectively demonstrated its commitment to process safety either through its communications or through a regular presence at the U.S. refineries.

The Panel recognizes that Browne is a very visible chief executive officer. Browne is generally noted for his leadership in various areas, including reducing carbon dioxide emissions[6] and developing the use of alternative fuels.[7] During the last eight years, Browne has spoken frequently on these issues across the globe.[8] In 2005, *The Financial Times* named him the fifth most respected business leader in the world. Browne's passion and commitment for climate change is particularly apparent. In hindsight, the Panel believes that if Browne had demonstrated comparable leadership on and commitment to process safety, that leadership and commitment would likely have resulted in a higher level of process safety performance in BP's U.S. refineries. As observed in the 2003 Conference Board report on best practices in corporate safety and health, "[i]f the top executive believes in the worth of the strategies, sets expectations for other managers, follows through on those expectations, and commits appropriate resources, shared beliefs, norms, and practices will evolve."[9]

The Panel's review indicates that prior to the Texas City accident, executive management, like BP generally, had been more focused on personal safety than process safety. For example, the Panel found only a limited number of internal or public statements on process safety that Browne made, including letters published in the October 2000 and June 2006 editions of *Horizon*, BP's in-house magazine.[10] The October 2000 letter, which was written shortly after the Grangemouth incidents, is a general plea for all BP employees to take safety seriously.[11] The June 2006 letter discusses the Safety and Operations function and other corporate responses to the lessons learned from the Texas City ISOM accident.[12]

The Panel recognizes, however, that in his September 2006 interview with the Panel, Browne appeared to demonstrate a markedly different attitude toward process safety. Browne acknowledged that BP has not been sufficiently clear on process safety, that BP must make process safety a "key imperative," and that getting personal and process safety right must be the foundation of the company's operations. Browne further explained the need to reset process safety expectations, establish appropriate process safety metrics and milestones, and strengthen the process safety capabilities of line management. The Panel notes the evolution of Browne's articulation of the importance of process safety between his first and second interviews with the Panel,[13] as well as his expressed commitment to what he called the "insistent, unfailing priority of process safety."

The Panel is also aware of several presentations that Browne made in October 2006 to BP employees in town hall meetings in Chicago and Southern California. The Panel understands that in these meetings Browne conveyed the following messages about process safety:

- BP, and he, had not been sufficiently passionate about plant safety.
- BP needed to listen to people better.
- BP must have a verified system to put in place repeatable operations.
- BP will add people to operations, supervision, and HSSE.
- BP personnel must take personal responsibility for safety, "stop and escalate" if in doubt, and not tolerate noncompliance.

The Panel believes that if Browne continues to champion these messages, and that if he and other members of BP management reinforce them with consistent and sustained actions, process safety culture and performance within BP will improve.

Demonstrating commitment to process safety through other actions. The Panel believes that in addition to communicating its commitment to process safety excellence to stakeholders, BP management must demonstrate that commitment through its actions and decisions. The Panel agrees with an observation that Browne made during an interview with the Panel—"90 percent will be what we do, not what we say"—and believes that Browne and the rest of BP management must reinforce the message about the importance of process safety with clear and consistent actions.

The Panel understands that neither the Group Chief Executive nor the Chief Executive, Refining and Marketing has any operating management responsibilities with respect to BP's U.S. refineries. The Panel is not suggesting that either of them should be involved in the day-to-day management of the U.S. refining operations, particularly given the scope and complexity of BP's global businesses. However, executive management and refining line management above the refinery level have other significant opportunities to affect process safety performance in the U.S. refineries. These opportunities include influencing the corporate safety culture to establish process safety as a core value (as discussed above), establishing and monitoring of process safety management systems, and ensuring that adequate resources are made available to sustain a high level of process safety performance.

Finding:

> ***BP has not provided effective leadership on or established appropriate operational expectations regarding process safety performance at its five U.S. refineries.***

> BP management's focus on personal safety

Until very recently, BP's executive and corporate refining management emphasized personal safety but not process safety. BP's attention to personal safety performance appears to have stemmed from two sources. First, personal safety statistics, unlike process safety statistics, are widely tracked, benchmarked, and reported. In fact, OSHA requires that companies report safety-output metrics, such as fatalities, days away from work case frequencies, and recordable injury rates—all of which are much more closely linked to personal safety than process safety. For many years, BP and a number of its peers benchmarked their performance on these measures against each other. In effect, BP focused on the metrics that received regulatory and industry attention, but those metrics were safety output-oriented and bore little relation to the state of process safety. For a discussion on BP's measurement of process safety performance and its use of process safety metrics, see Section VI.C.

Second, BP recognized that driving-related incidents have historically been by far the most frequent cause of workforce fatalities in BP's operations. For example, in 2003, 70 percent of BP employee and contractor fatalities were driving-related, as were 90 percent of the fatalities involving third parties. As a result, BP's executive management initiated a Group-wide effort to reduce vehicular accidents. To that end, BP promulgated, and Browne approved, the Group driving standard in 2004. Pursuant to that initiative, BP tracked, benchmarked, and set targets for vehicular accident performance, such as severe vehicular accident rate, across all of BP's businesses.

The Panel is by no means critical of BP for focusing on personal safety. Given the nature of BP's global businesses, the majority of BP's injuries historically have been personal safety-related. The Panel's concern is that BP's safety focus has been almost exclusively on personal safety to the exclusion of process safety. BP's focus on personal safety is evident in BP's performance contracts, reports prepared at various levels of the company to track refinery performance, and the absence of clear process safety metrics and performance expectations for the individual refineries.

BP uses a system of cascading performance contracts and variable pay programs to drive desired conduct.[14] Given the importance of performance contracts and variable pay programs to achieving BP's goals, the metrics and milestones included in them are critical. As an aphorism recognizes, "what gets measured gets managed." Prior to 2006, performance contracts and variable pay programs in BP's U.S. refineries contained primarily personal safety metrics and milestones but did not contain metrics that would act as a significant positive incentive for ensuring process safety performance. In fact, some of BP's historical metrics and milestones in performance contracts and variable pay programs may have had a negative influence on refinery process safety performance.

The Chief Executive, Refining and Marketing determines which HSSE metrics must be considered for inclusion in performance contracts of group leaders in the business units within the Refining and Marketing segment, including Refining. Prior to 2006, the only safety-related metric in his own personal performance contract was days away from work case frequency. Through 2005, the only safety metrics in performance contracts for refining corporate management were recordable injury frequency and severe vehicle accident rate. Recordable injury frequency, like days away from work case frequency, is a commonly reported output measure associated with personal safety. Including severe vehicle accident rate as a safety metric furthered the goals of the Group driving standard, but had little to do with refining safety. These performance contracts did not act as a direct incentive for refining corporate management to ensure strong process safety performance in the U.S. refineries.

The performance contracts for U.S. refinery plant managers generally tracked the same metrics as the performance contracts for refining corporate line management. For example, the 2005 performance contract for the Texas City plant manager contained HSSE targets for recordable injury frequency, severe vehicle accident rate, oil spills greater than one barrel, and greenhouse gas emissions. With the arguable exception of oil spills, none of these metrics is process safety-related.

The metrics and milestones in a refinery plant manager's performance contract cascade down to the other performance contracts within that refinery. The Panel has not been provided information concerning any performance contracts through 2005 that contain process safety-related metrics.

BP's corporate program for rewarding performance generally, including safety performance, is the variable pay program (VPP). While performance contracts typically cascade only one or two levels beneath the refinery plant manager, all refinery workers participate in the VPP. Each refinery has an annual VPP containing a suite of metrics, milestones, and targets relating to financial, availability, and safety objectives for that refinery for that year. Although VPPs contain some milestones unique to each refinery, all VPPs mirror a broad framework set by leadership of the Refining and Marketing segment.

Historically, the safety-related metrics in VPPs in U.S. refineries tended to be OSHA recordables, such as recordable injury frequency and days away from work case frequency. While these are widely tracked safety-output metrics, they provide little if any underlying information on the state of process safety or process safety performance in a refinery. Moreover, linking compensation to safety output metrics such as these can create a disincentive for the workforce to report injuries or other "negative outputs" that the VPP covers.[15] As the Mogford Report notes, this could have negative implications for ongoing process safety at the refineries:

> While the Investigation Team did not find any direct evidence of deliberate under-reporting of incidents, the reward system employed within this site appears misaligned. The system rewarded employees for having fewer incidents, and it is possible that this incentive could drive reporting tendency downwards.[16]

Other targets and milestones in the U.S. refining VPP, while not specifically safety-related, may also have negative consequences for process safety. For example, some refineries have included a VPP milestone for meeting a turnaround schedule. Providing refinery workers with a financial incentive to keep pace on a turnaround schedule may well encourage them to take process safety risks.

In 2005, Texas City changed the safety-related metrics in its VPP to "Great Days" and process safety management action item completion. As of 2006, all of BP's U.S. refineries used Great Days as an HSSE metric in their VPPs. While the definition of a "Great Day" is not completely consistent across the refineries, most of them define it as a day in which no safety incident, environmental incident, or community impact incident occurs. A "safety incident" in this context means any injury that is recordable under OSHA. Accordingly, while Great Days is a blend of environmental, regulatory, community, and safety metrics, it is still far more aligned with personal safety than process safety because it relies upon the personal safety metric of OSHA recordables. The Panel therefore does not regard Great Days as an effective process safety indicator or metric. The Panel believes that process safety management audit action item completion included by Texas City and Cherry Point as a VPP metric in 2005 and later adopted as a VPP metric by the remaining U.S. refineries in 2006, and percentage action item closure, which Texas City included as a VPP metric in 2006, are both leading indicators that are better aligned with process safety.

This same focus on personal safety performance is reflected in each U.S. refinery's site-specific business plan. Each refinery prepares and reviews with corporate refining management a business plan outlining a site's strategic and financial aspirations. Each plan contains historical and targeted key performance indicators for the refinery. Through 2005, the only safety-related key performance indicators in U.S. site-specific business plans were days away from work case frequency and recordable injury frequency. The reports that BP used routinely to monitor the performance of the U.S. refineries likewise focused on personal safety, not process safety. See Section VI.C for a more detailed discussion of reporting and monitoring of personal safety and process safety performance information.

Consistent with the lack of an effective focus on process safety performance, BP management did not establish appropriate operational expectations regarding process safety performance at its U.S. refineries. Through its performance contracts, site-specific business plans, and VPPs, BP in many ways established specific operational expectations regarding financial performance, environmental performance, and personal safety performance. With respect to all three of these areas of performance, BP management specified key performance indicators, targets, and milestones to guide the efforts of the refinery workforce. BP management did not, however, provide comparable operational expectations for process safety performance. Refinery performance contracts, VPPs, and site-specific business plans through 2005 did not have any operational targets, milestones, or key performance indicators for process safety performance. While refinery management certainly understood gHSEr's aspiration of "no accidents," BP management provided no metrics or targets to translate that aspiration into meaningful refinery-level guidance.

Finding:

BP has emphasized personal safety but not process safety.

> Reliance on injury rates

BP's executive management tracked the trends in BP's personal safety metrics, and they understood that BP's performance in this regard was both better than industry averages and consistently improving. Based upon these trends, BP's executive management believed that the focus on metrics such as OSHA recordables and the implementation of the Group-wide driving standard were largely successful. With respect to personal safety, that focus evidently was effective. BP's executive management, however, mistakenly believed that injury rates, such as days away from work case frequency and recordable injury frequency, were indicators of acceptable process safety performance. While executive management understood that the outputs BP tracked to monitor safety were the same as those that the industry generally monitored, it was not until after the Texas City accident that management understood that those metrics do not correlate with the state of process safety. Prior to the Texas City accident, BP's executive management authorized a number of initiatives designed to improve process safety, including the 2001 process safety/integrity management standard, the lengthy development of engineering technical practices, the hiring of a Group Engineering Director, and the development of the Group integrity management standard. BP's executive management apparently believed that these measures were sufficient. BP's reliance on improving injury rates as an indication of acceptable process safety performance, coupled with an apparent inadequate understanding of process safety, created a false sense of confidence within BP's executive management that BP was properly addressing process safety risks at its U.S. refineries.

Finding:

BP mistakenly used improving personal safety performance (i.e., personal injury rates) as an indication of acceptable process safety performance at its five U.S. refineries; BP's reliance on this data and inadequate process safety understanding created a false sense of confidence that it was properly addressing process safety risks at those refineries.

> Refinery plant manager turnover

Under BP's Management Framework, refinery plant managers, like other BP business unit leaders, have a great deal of latitude to run the business. The refinery plant manager has direct responsibility for virtually all aspects of the refinery's performance, including process safety performance. With respect to process safety at the refinery, the Panel believes that refinery plant managers play a vital role. The refinery plant manager is the top leader at the site, and the message the refinery plant manager communicates about process safety throughout the refinery is critical to process safety performance. The refinery plant manager has substantial leeway to manage the refinery's operations, including where process safety objectives compete with other objectives such as meeting budget targets, production targets, and schedules. Further, in order to be effective, the refinery plant manager must have a positive relationship with refinery stakeholders, and it necessarily takes some time for a new plant manager and the workforce to get to know one another and to gain trust.

Stability in the refinery plant manager position can be important to process safety performance in a number of ways. If an effective process safety management system and a strong process safety culture both exist at a site, having some amount of turnover at the refinery plant manager position conceivably might not materially affect process safety performance. If either a strong management system or a strong safety culture is not present, however, the stability of the refinery plant manager appears to be much more important, if not critical, to promoting a high level of process safety performance. In such an environment where strong management systems or culture are lacking, establishing and maintaining controls around process risks may depend disproportionately on the capabilities, efforts, and even personalities of individuals. If one or both of effective management systems or strong safety culture do not exist, frequent turnover of the local refinery plant manager may detract from maintaining shared values on process safety among the refinery workforce. Each new refinery plant manager may be viewed as having different priorities, and leadership continuity around process safety can be jeopardized.

BP's Texas City, Toledo, and Whiting refineries have experienced relatively frequent turnover at the plant manager position. In the last six years, Toledo has had five plant managers, Whiting has had four, and Texas City has had eight. Yet another refinery plant manager is scheduled to start at Texas City in January 2007.

The Panel believes that the high turnover at the plant manager position has contributed to the process safety culture weaknesses at those refineries. Numerous interviewees at Toledo, both hourly workers and managers, commented that the frequent plant manager turnover fostered the belief at the refinery that Toledo was merely a training ground that did not fit into BP's long-term plans, and this damaged the general morale of the Toledo workforce. Many interviewees at Toledo also noted that each of the refinery plant managers at that site appears to have had a different focus and set of priorities, and as a result Toledo has had no clear and consistent message about process safety. Some interviewees at Whiting expressed similar concerns. The turnover at Texas City appears to have had more to do with BP's struggles with how to manage the refinery and several chemical operations in the Texas City area than it did with the performance of the refinery plant managers themselves. Nonetheless, Texas City interviewees also noted the differing personalities and priorities of the plant managers.

BP does not have a list of specific qualifications it expects a new refinery plant manager to possess. BP has, however, recently adopted a formal management of change process for considering a change in certain positions, including refinery plant managers. Previously, BP used a formal management of change analysis primarily for proposed engineering, technical, and procedural changes, and not for personnel changes.

By using a formal management of change process in considering changing a refinery plant manager, BP presumably will introduce a more rigorous consideration of a host of factors, including the impact of such a change on the local process safety culture. The Panel commends BP for adopting the management of change analysis when considering the refinery plant manager position. Further, the Panel notes that BP acknowledges the need for stability in the refining plant manager position, and BP has emphasized that the new managers of Texas City and Toledo will be in those positions for at least five years.

Finding:

> ***Most of BP's five U.S. refineries have had high turnover of refinery plant managers, and process safety leadership appears to have suffered as a result.***

EMPLOYEE EMPOWERMENT

The Panel believes that a good safety culture requires a positive, trusting, and open environment with effective lines of communication between management and the workforce, including employee representatives. The single most important factor in creating a good process safety culture is trust. Employees and contractors must trust that they can report incidents, near misses, and other concerns—even when it reflects poorly on their own knowledge, skills, or conduct—without fear of punishment or repercussion.[17] The workforce must trust that when provided with such information, management will investigate and use it to improve safety and not to assign blame. Management must trust that the workforce is accurately and thoroughly reporting such matters in order to improve safety and learn from mistakes, not simply to obtain some financial or other benefit. Management and labor must trust each other so that safety issues do not become bargaining chips in the pursuit of other goals, and management and employee representatives must communicate well. In addition, management and labor must trust contractors, and vice versa, so that information and lessons learned are properly shared among all workers in their refinery. Finally, effective means of communicating across units in the refinery and among the refineries must be in place so that all share process safety knowledge.

The interviews of refinery workers and management, the results of the process safety culture survey, and the review of documents show that Cherry Point has a very positive, open, and trusting environment. Carson appears to have a generally positive, open, and trusting environment with open lines of communication between management and the workforce, including employee representatives. The Panel understands that the effective safety cultures at both of these refineries largely pre-date BP's acquisition of ARCO. BP has not established a positive, open, and trusting environment at Texas City, Toledo, and Whiting, although the safety culture appears to be improving at Texas City and Whiting.

> Reporting of process safety-related concerns

A positive safety culture requires that employees and contractors feel comfortable reporting safety-related concerns. If incidents and near misses do not get reported, management will miss opportunities to learn of and address process hazards that pose risks to refinery workers and neighbors. As one commentator observed, engineering an effective reporting culture is difficult:

> In the absence of sufficient accidents to steer by, the only way to sustain a state of intelligent and respectful wariness is by creating a safety information system that collects, analyzes and disseminates the knowledge gained from incidents, near misses and other 'free lessons'. To achieve this, it is first necessary to engineer a *reporting culture*—not an easy thing, especially when it requires people to confess their own slips, lapses and mistakes.[18]

In Texas City, Toledo, and to a lesser extent Whiting, a significant number of hourly workers stated during interviews that incidents, near misses, and safety-related concerns sometimes did not get reported because of fear of repercussion, and in some cases out of a belief that the refinery would not act on the report. These interviewees commented that people who raise these issues were sometimes branded as troublemakers and given less attractive work. Workers' willingness to report appears to depend in some measure upon their relationship with their supervisors. A number of Texas City managers acknowledged that workers stopped raising safety concerns because workers believed that nothing they said mattered. Many workers at Whiting commented, however, that they felt much more comfortable reporting safety issues today than they did before Amoco's merger with BP.

Some, but not all, of the results from the process safety culture survey support the reporting-related theme raised during the refinery interviews. For example, as Table 5 demonstrates, relatively high percentages of employees in certain non-management process safety functional groups at Texas City (operators, maintenance/craft technicians, and HSSE employees) and at Toledo (operators and maintenance/craft technicians) indicated their impression that the refinery's culture did not encourage raising process safety concerns. The far lower percentages of employees at Carson, Cherry Point, and Whiting expressing that belief, however, suggests that these refineries have been much more successful in fostering a favorable reporting climate. Moreover, the low negative response rates from contractors at all U.S. refineries suggest that contractors generally feel encouraged to report process safety concerns.

Table 5

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"I believe a culture exists at this refinery that encourages raising process safety concerns."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	8	1	23	30	9
Maintenance/Craft Technicians	15	2	23	38‡	9
Full-Time HSSE Employees	3	4	29	16‡	13
Engineering Professionals	5	4	17	15	8
Operations Management	0	5	7	7	5
Maintenance Management	0‡	0‡	16	*	0
Contractors	8	7	12	8	10

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Surveyed employees and contractors tended to be even more positive overall in response to an item addressing whether their supervisors encouraged them to "identify and report unsafe conditions." Generally, less than 15 percent of the contractors and employees in the process safety functional groups at the five U.S. refineries expressed a belief that their supervisors did not encourage such reporting. There were, however, exceptions: 44 percent of Toledo maintenance/craft technicians,[19] and 21 percent of Texas City maintenance/craft technicians indicated a lack of supervisory encouragement to raise process safety concerns.

> Workforce perception about management responses to incident reports

A positive safety culture requires a reporting culture, one in which workers feel comfortable to report incidents, near misses, and other concerns, even when reporting may reflect poorly on their own conduct.[20] When workers believe that this information will be used unfairly to blame or punish them, and not to improve safety, reporting will decrease.

Virtually all of the workers interviewed at Cherry Point, as well as the vast majority of those interviewed at Carson, said that they believed management used reports of incidents, near misses, and safety concerns primarily to improve safety and not to assign blame or to administer discipline unfairly. A significant number of hourly workers interviewed at Toledo and Texas City reported that they had concerns about whether refinery management used incident reports primarily to assign blame, and that as a result, many incidents and near misses do not get reported. A smaller number of hourly workers interviewed at Whiting expressed similar concerns.

This skepticism about investigations appears to have existed for some time at the Texas City, Toledo, and Whiting refineries. The June 2005 behavioral safety culture assessment report for Whiting notes that a number of the interviewees perceived that the trend in Whiting's incident investigation was to focus on "finding fault and blaming someone so that discipline can be metered [sic] out." Similarly, a 2004 third-party consultant report relating to Toledo notes that "when asked about the incident investigation process, many [interviewees] view it to be more punitive in nature, a process that does not look to the root cause of an incident." The 2003 gHSEr audit of Texas City cites the refinery's "blame" culture as one of the most important gaps that limits HSSE and general performance.[21]

Survey responses substantiate that a somewhat heightened degree of skepticism exists among certain employee groups at Texas City, Toledo, and Whiting, but not at Carson and Cherry Point. One relevant survey item stated: "After a process-related incident, accident, or near miss, management is more concerned with correcting the hazard than assigning blame or issuing discipline." As shown in the table below, the negative response rates for operators and maintenance/craft technicians ranged from 44 percent to 60 percent at Texas City and Toledo and from 21 percent to 25 percent at Whiting. Several other employee groups and contractors at these refineries, however, responded more positively. Moreover, all Carson and Cherry Point respondents tended to provide positive responses, as reflected by the low negative response rates below.

Table 6

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "After a process-related incident, accident, or near miss, management is more concerned with correcting hazards than assigning blame or issuing discipline."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	16	7	46	50	25
Maintenance/Craft Technicians	18	5	44	60‡	21
Full-Time HSSE Employees	3	0	27	5‡	10
Engineering Professionals	5	0	15	15	0
Operations Management	5	0	17	5	7
Maintenance Management	4‡	0‡	24	*	9
Contractors	12	8	15	6	14

* Survey data are not available because of the small number (fewer than 15) of potential respondents.

‡ Fewer than 25 respondents were in this group.

Two additional survey items addressed whether workers could challenge decisions that their supervisor or refinery management made without fear of negative consequences when a process safety issue was involved. Consistent with the survey data, Toledo and Texas City employees and contractors were more likely than their counterparts at other refineries to respond negatively to the two items. Nonetheless, as indicated by the low negative response rates in Table 7 below, at all U.S. refineries several groups tended to respond positively to the item addressing ability to challenge supervisors' decisions without fear of negative consequences.

In general, percentages of respondents who indicated they could not challenge refinery management's decisions were higher than the percentages of respondents indicating they could not challenge a superior's decisions. For example, at Toledo, more than half (52 percent) of operators and half of maintenance/craft technicians conveyed that they did not believe they could challenge refinery management's decisions without fear of negative consequences. In contrast, only a quarter of those groups indicated they could not challenge their supervisors' decisions without fear of negative consequences. Similarly, while 38 percent of contractors across all U.S. refineries conveyed that they did not believe they could challenge refinery management's decisions, only 11 percent indicated they could not challenge their supervisors' decisions. Tables 7 and 8 below contain negative response rates for contractors and for employees in six process safety functional groups.

Table 7

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "When a process safety issue is involved, I can challenge decisions made by [my supervisor] without fear of negative consequence."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	12	9	28	25	17
Maintenance/Craft Technicians	16	12	30	25‡	23
Full-Time HSSE Employees	0	4	17	16‡	10
Engineering Professionals	8	4	10	19	5
Operations Management	2	7	9	9	5
Maintenance Management	0‡	6‡	16	*	3
Contractors	7	8	14	3	11

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Table 8

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "When a process safety issue is involved, I can challenge decisions made by [refinery management] without fear of negative consequence."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	21	14	43	52	16
Maintenance/Craft Technicians	45	33	41	50‡	32
Full-Time HSSE Employees	5	0	24	28‡	15
Engineering Professionals	15	11	24	30	6
Operations Management	8	10	22	24	5
Maintenance Management	46‡	13‡	20	*	6
Contractors	35	45	32	49	46

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

> Information systems and communication

In an effective safety culture, information systems should promote the free flow of information in at least three ways: (1) from the workforce up to management, including reporting of incidents, near misses, and safety concerns; (2) from management down to the workforce, including reporting the results of investigations; and (3) horizontally across units and refineries, including sharing concerns, lessons learned, and best practices. BP's information systems do not appear to be wholly effective in promoting these types of communications.

As discussed later in this section, refinery interviews and the process safety culture survey indicated that many workers, particularly at Texas City, Toledo, and Whiting, believe that some incidents, near misses, or other safety concerns do not get reported for a variety of reasons, including fear of being blamed or retaliated against—or that no corrective action would be taken so reporting would not be of any value. The interviews and survey data also reveal that at all five refineries, significant doubt existed about whether minor process-related incidents, accidents, and near misses were reported.

BP has two other systems—"Tr@ction" and "Open Talk"—for reporting safety concerns, but neither appears to be particularly effective. Tr@ction is a computer-based system through which incidents, near misses, or other safety concerns can be reported, tracked, and closed out. The Panel's review indicates that Tr@ction has several problems. First, it is not used consistently. Some sites use it to report only major incidents, other sites include near misses in Tr@ction, and still other sites include any type of safety concern including those unrelated to process safety. Second, each refinery still maintains its own tracking system, and some sites, like Whiting, still rely heavily on these systems. Third, many interviewees reported that they do not use Tr@ction because they find it to be user-unfriendly, while others do not use it because they do not have routine access to a computer. Fourth, many find Tr@ction unwieldy and unhelpful because of the lack of consistency of the data that goes into it and because it contains substantial amounts of unfiltered information pertaining to other types of concerns.

Open Talk is a confidential hot line that an independent third party administers through which employees can anonymously raise any type of complaint or concern. While in theory this hot line should promote the reporting of safety matters, in practice it apparently has not. Most of the hourly workers interviewed said they had never heard of Open Talk. Others who knew of Open Talk stated that they would never use it because they are skeptical that it is truly anonymous. BP data reflect only two U.S. refinery process safety-related concerns reported through Open Talk in 2005, and only four more in the first nine months of 2006. Given the number of workers at Texas City, Toledo, and to a lesser extent Whiting, who reported in interviews that they did not believe they could report incidents without fear of repercussion, a well-publicized and trusted anonymous hot line would be expected to receive a far greater number of reports of incidents. By and large, however, the workers interviewed who expressed mistrust of BP's investigative process likewise expressed a belief that BP could ascertain the identities of people who reported through Open Talk. The Panel understands that BP is redoubling its efforts to publicize and foster trust in Open Talk.

Additionally, process safety information is not freely exchanged at the refineries in that investigation results are not communicated routinely to BP's workforce. BP recognizes that the results of investigations should be reported to the workforce, particularly those associated with the incident or near miss being investigated, and BP refinery procedures reflect this. In practice, however, whether this happens appears to be left to the discretion of the investigators or supervisors, and the refineries are not consistent in their follow-through. While workers at Cherry Point, Carson, and to a somewhat lesser extent Whiting, report positive results on feedback from investigations, workers at Toledo and Texas City reported far less favorable results.

Finally, BP's systems are not effective at promoting the free flow of information across units and refineries. Workers interviewed at all the refineries except Cherry Point reported that they frequently do not learn of incidents or lessons learned occurring at other units within their own refineries, much less other BP refineries. The "silo mentality" that the Mogford Report found[22] appears to exist in varying degrees at all of the refineries except Cherry Point, with information often being confined to particular units in a refinery.

Finding:

> ***BP has not established a positive, trusting, and open environment at some of its U.S. refineries with effective lines of communication between management and the workforce, including employee representatives.***

RESOURCES AND POSITIONING

The Panel believes that BP has not always provided the resources and the positional support necessary to promote strong process safety performance in its U.S. refineries. BP does not have a designated, high-ranking leader for process safety dedicated to its refining business who can help ensure that major decisions impacting BP's refining operations are based upon a proper consideration of process safety. BP has not always ensured that its U.S. refineries had adequate expertise and capabilities in place, or that the refineries received sufficient funding for strong process safety performance. Moreover, BP overloaded the U.S. refineries with a host of corporate initiatives. While these initiatives were well intentioned, they diverted attention from a greater focus on process safety issues because BP did not provide adequate resources or guidance for prioritization to the refineries. Finally, operations and maintenance personnel in BP's U.S. refineries sometimes work high rates of overtime, and the Panel believes that this overtime rate impacts their ability to perform their jobs safely and increases process safety risks.

> Positions influencing U.S. refinery process safety

Accountability for process safety performance at BP's U.S. refineries is with the line that runs from (a) the Group Chief Executive to (b) the Chief Executive, Refining and Marketing to (c) the Group Vice-President, Refining, whom BP considers the most senior manager of the refining business, to (d) the Refining Vice President—North America to (e) the individual refinery plant managers to (f) operating personnel at the refineries. Outside of line management, BP has a number of functions and positions with some connection to process safety in the refining business. Currently, process safety functions and experts reside within a number of different parts of the BP corporate organization, including

- the BP Group Technology function,
- the newly formed Safety and Operations function,
- the Refining Technology Group,
- the Group Vice-President—HSSE and Technology for Refining and Marketing,
- the HRO manager in the Refining organization,
- the new position of Vice President of OMS/PSM Program Implementation, and
- the Chief Executive Officer of BP America.

The Panel believes that this organizational framework produces a number of weak process safety voices—weak in the sense of apparently lacking the ability to influence in a meaningful way strategic decision-making with respect to U.S. refining operations. Although many of the individuals holding these positions appear very capable, they do not appear to participate substantially in the critical decision-making process with respect to BP's U.S. refineries. Rather, three people appear to make some of the most important and strategic decisions regarding BP's U.S. refineries: the Chief Executive, Refining and Marketing; the Group Vice-President for Refining; and the Refining Vice President—North America. These individuals collectively, however, have line responsibility for monitoring all aspects of performance in the refineries, including financial, budgetary, environmental, and otherwise. Because process safety objectives may potentially conflict, particularly in the short-term, with other objectives such as production, meeting budgets, cost cutting, and scheduling, those making decisions relating to the refining business must necessarily weigh all of these considerations to the possible detriment of process safety. The Panel believes that process safety in BP's refining operations would benefit from BP's designation of a high-ranking process safety leader who will participate consistently in important refining decision-making that affects process safety performance.

Finding:

BP does not have a designated, high-ranking leader for process safety dedicated to its refining business.

> U.S. refinery staff and capability

BP has not always ensured that its U.S. refineries had sufficient staff and capability to promote strong process safety performance. Since the Amoco merger, BP has lost many people and capabilities in its refining operations for a variety of reasons:

- In connection with the merger, BP eliminated several thousand jobs in the United States, many in refining.
- BP decided to outsource much of the refining technology function, leading to the loss of several hundred engineers.
- As BP announced further restructurings and job reductions in refining, additional expertise left and was not replaced.
- BP's U.S. refineries all had aging workforces. As employees retired, they typically were replaced by substantially younger and less experienced people.

Over time, the cumulative effect of these decisions and events was a collective loss of human expertise in the refining business, both in the line and in supporting functions.

The Panel is not suggesting that BP intended to remove needed capability from its refinery operations. Rather, the Panel understands that BP typically did not receive short-term negative feedback on its reorganizations or job reductions, and as a result, BP apparently believed that the refinery operations continued to have the necessary capabilities in place. Not until after a substantially longer period, however, did BP come to appreciate that it had lost, and had not replaced, valuable refining operating and technical expertise.

Interviews of hourly workers and refinery management reveal that understaffing is a serious concern at all of the U.S. refineries except Cherry Point. In Toledo, the vast majority of hourly, management, and contractor interviewees said they believed that the refinery was understaffed in various positions. Many of the Toledo interviewees reported the feeling that understaffing was among the most serious process safety issues at that site. They also reported their belief that understaffing had precipitated low morale, poor communication, delayed responses between departments and units, an inability to properly supervise contractors working on projects, and slow turnaround on hazard assessments and investigations. Similarly, survey data reveal that many employees believed there was insufficient staff in their work groups to perform their jobs safely. Contractors, however, generally expressed satisfaction with staffing levels in their work groups.

Table 9

	Toledo Group	Percentages of Disagree/Tend to Disagree Responses
"There is usually sufficient staff in my work group to perform my job safely."	Maintenance/Craft Technicians‡	50
	Engineering Professionals	44
	Operators	32
	Operations Management	29
	Full-Time HSSE Employees‡	21
	Contractors	4

‡ Fewer than 25 respondents were in this group.

At Whiting, both hourly workers and management interviewed generally said they believed that operators and supervisors were stretched too thin to perform their functions safely. The interviewees reported that Whiting needed more operators, chief operators, and supervisors. Many Whiting employees acknowledged that low supervisor pay and union negotiations under the collective bargaining agreement affected staffing.

The Panel's review indicates that experienced refinery workers are often reluctant to take supervisory positions, resulting in inexperienced supervisors. Consistent with the sentiment expressed during interviews, more than 20 percent of Whiting's maintenance/craft technicians, HSSE employees, and operators indicated their impression that sometimes there was insufficient staff in their work groups to perform their jobs safely. On the other hand, contractors' responses suggested that they were generally satisfied with the amount of staff in their work groups.

Many hourly workers interviewed at Texas City reported that understaffing had historically been a significant issue at that refinery, and many BP documents reflect this concern. Survey results demonstrate this perception, as reflected by 26 percent of employees in the nine process safety functional groups, as a whole, indicating that sometimes there was insufficient staff in their work groups to perform their jobs safely. For the six process safety functional groups highlighted throughout this report (*i.e.*, operators, maintenance/craft technicians, HSSE employees, engineering professionals, operations management, and maintenance management), negative response rates ranged between 20 percent and 32 percent. On the other hand, contractors provided a low negative response rate of nine percent and a high positive response rate of 78 percent.

Many workers interviewed at Carson expressed concern about staffing at all levels of that refinery. Many management employees stated that their departments were understaffed, leaving them unable to keep up with the recent increase in paperwork, audits, and initiatives. Additionally, hourly employees interviewed said that their units were staffed adequately for normal operations but not for emergency procedures or upset conditions. Survey results provided a mixed message. Sixteen percent of employees in Carson's nine process safety functional groups indicated their belief that there was sometimes insufficient staff in their work groups to perform their jobs safely. Carson operators and maintenance/craft technicians provided the highest negative response rates of 21 percent and 20 percent, respectively. In contrast, contractors and employees in the other process safety functional groups tended to respond more positively.

Cherry Point's interviewees and survey respondents generally did not express concern about staffing problems at the refinery.

BP now appreciates the loss of its refining expertise and is taking meaningful steps to address it. The Refining Technology function, which once had as few as 35 people, currently has more than 150 and is still growing. BP is examining line management for its U.S. refineries to see where it needs strengthening, and many of the refineries are hiring at various levels, particularly operators and engineers.

> U.S. refinery funding

Good process safety performance requires adequate resources, including funding for inspecting, testing, maintaining, and repairing or replacing equipment; resources for training and educating personnel; resources for keeping operating procedures up-to-date; and resources for implementing best or good industry practices. If a refinery is underresourced, maintenance may be deferred, inspections and testing may fall behind, old and obsolete equipment may not be replaced, and process risks will inevitably increase. The Panel does not believe that BP has always ensured that the resources required for strong process safety performance at its U.S. refineries were identified and provided.

The Texas City refinery illustrates this point. From 1992 to the 1998 merger with BP, Amoco consistently and significantly cut costs in the Texas City refinery.[23] Between 1992 and 1999, total maintenance spending fell 41 percent; from 1992 to 2000, total capital spending fell 84 percent.[24] Notwithstanding this sustained period of budget cutting, after the merger BP issued a company-wide challenge to each of the refineries to cut their budgets an additional 25 percent without jeopardizing the integrity of the facility. According to at least one senior manager, progress toward meeting that challenge to cut costs 25 percent became a milestone in each refinery plant manager's performance contract. Pursuant to that corporate challenge, Texas City continued to cut costs,[25] and some data indicate the refinery came close to meeting the 25 percent target.

In 2002, BP commissioned a report by A.T. Kearney to understand, among other things, "the historical facts which have led to the deterioration of the Texas City refinery performance."[26] The report noted the funding trends discussed above and connected the significant reductions in refinery spending with the corresponding deterioration in the refinery's integrity and reliability:[27]

- In the last ten years, maintenance budget allocation has been controlled essentially by a "top down" allocation of funds.[28]
- Budget cuts were imposed based on the previous year's spend, and did not take into account the specific needs of the refinery.[29]
- Prior to 2002, the refinery did not carry out a thorough, "bottom up" analysis of maintenance needs or challenge the budget allocation process.[30]
- Evidence from annual performance reports suggested that cost cutting was not carried out as a structured, managed, and measured process.[31]
- There was no application of best practice in order to reach the budget reductions without reducing the level of maintenance work.[32]

In October 2002, refining corporate management requested that from a budgetary perspective, Texas City "enter 'crisis mode.' . . . [while] not compromis[ing] the safety and environmental performance of our units."

Although BP began to increase funding for the U.S. refineries in 2002, and between 2002 and 2006 the budgets for the U.S. refineries increased every year, BP nonetheless continued to issue budgetary challenges. For example, in late 2004 BP issued a 25 percent regional capital budget challenge for the five U.S. refineries for 2005 seeking to reduce capital spending. Numerous interviews and documents reflect that Texas City continued to feel considerable budget pressure, and some at the refinery were critical of the refinery's senior leadership for not pushing harder for larger budgets.

Despite BP's increased funding for its U.S. refineries from 2002 onward, the Panel's impression is that BP did not act with sufficient urgency to make up for what had been many years of insufficient funding, and as a result, at least some of the refineries continued to be underinvested. The Panel does not mean to suggest that BP deliberately underinvested in the refineries and notes that it does not have sufficient data to quantify such an assessment. Moreover, during the course of the review, the Panel did not develop or identify sufficient information to conclude whether BP ever intentionally withheld resources on any safety-related assets or projects for budgetary or cost reasons. The Panel believes, however, that the company did not always ensure that adequate resources were effectively allocated to support or sustain a high level of process safety performance.

It is not clear to the Panel why the U.S. refineries did not receive greater funding. The Panel did not have access to specific refinery budget requests and allocations or other detailed documentation. As a result, the Panel could not attempt to ascertain whether and the extent to which refinery requests for funding that arguably impact process safety were reduced or rejected. As part of its business plan, each refinery requests capital for three different purposes: (1) license-to-operate (funding needed to be in legal compliance and otherwise remain open to operate); (2) sustainability (capital needed to maintain long-term operations); and (3) commercial (money for new opportunities, expansions, and so forth).

The Panel understands that BP examines each "bucket" differently: license-to-operate requests receive little push back; sustainability requests get reviewed by technical experts; and commercial requests are considered last and receive the heaviest scrutiny. According to various BP personnel, license-to-operate and sustainability requests typically receive full allocations, with the vast majority of the annual fluctuations in refinery spending falling on commercial requests. While BP does not have a "safety" component *per se* in its refinery budgets, the Group Vice President—Refining informed the Panel that he had not encountered a situation in which BP failed to provide a refinery with the necessary resources to address a known safety problem. Because that same executive also acknowledged to the Panel—as did some other members of BP management—that some of the U.S. refineries were underinvested in prior years, the question of "why" is raised. Did the refinery plant managers and their staff fail to see the need to spend more? Were they paring back on the amounts requested because they believed this was what their superiors wanted to see? Did they believe that they were more likely to be rewarded for meeting aggressive cost-cutting goals? The Panel is unable to answer these questions because of the BP "three bucket" budgeting approach, which makes it difficult to identify safety-related requests, the lack of historical budget documentation, and the turnover of most of the refinery plant managers from the 2000-2004 period.

Browne's recent presentations within BP appear to acknowledge the previous underinvestment and to suggest that it was largely the result of an inability on the part of refining line management to see the need to spend more money. In his October 2006 BP town hall meetings, Browne commented that for a number of years, BP had a "make do" mentality when times in the refinery business were tough and there was not much money to go around. Browne also commented that the other side of "making do" is the fact that if a business gets used to not having something, it does not notice its absence. If the business makes do for a long time, it begins to become blind to some of the risks that the business faced because the business just got used to them. The Panel generally agrees with Browne's comments, and the Panel commends BP for its July 2006 announcement that it would increase its spending in the U.S. refineries on maintenance, turnarounds, inspections, and training to $1.2 billion in 2005, to $1.5 billion in 2006, and to an average of $1.7 billion each year from 2007 to 2010.

Regardless of the reason at least some of the refineries were underinvested, it is apparent that refinery-level management has been concerned about the sufficiency of BP's funding. For example, the Whiting 2005 site specific business plan lists the refinery's first "key risk" as

> Availability and Infrastructure Renewal—Whiting is a very old facility with aging infrastructure. Reduced spending in past years has resulted in degradation of a lot of this infrastructure and coupled with poor work processes has resulted in significant availability, safety and environmental issues and high reactive maintenance costs.

Similarly, the Texas City plans for 2003 and 2004 list "Infrastructure Reliability and Mechanical Integrity" as short/near term risks, and the 2003 gHSEr audit of Texas City noted that the "condition of the infrastructure and assets is poor." And again, corporate-level refining managers acknowledged to the Panel that some of the refineries historically were underfunded.

Interviews with refinery personnel reflect concerns about process safety funding at three of the refineries. While employees at Cherry Point and Carson generally did not complain about the funding of their refineries, many workers at Texas City, Toledo, and Whiting did. Many employees interviewed at Texas City expressed the belief that BP was generally unwilling to spend the money to maintain the integrity of equipment, although they uniformly believed that BP had demonstrated a substantial monetary commitment to the refinery since March 2005. The January 2005 Telos survey report relating to Texas City noted the "strong sense that the [site's safety] commitment . . . is contradicted by the lack of resources . . . ."[33] Many hourly workers interviewed in Toledo said they believed that the maintenance budget had been slashed, with significant negative process safety implications for the refinery. However, Toledo management disputed any budget cutting, and documents indicate that the maintenance budget in Toledo has, in fact, increased since 2002. Many hourly workers interviewed at Whiting reported believing that the refinery was significantly underfunded and that as a result, preventive maintenance was seldom practiced, the refinery had a "run until it breaks" mentality, and the workforce had a great deal of experience running equipment with "Band-Aids."

The process safety culture survey revealed a fairly prevalent perception among certain employee groups at Texas City, Toledo, and Whiting that BP provided inadequate funding for process safety programs. The highest percentages of negative responses came from HSSE employees at Toledo (63 percent), Texas City (49 percent), and Whiting (44 percent), and maintenance/craft technicians at Toledo (44 percent). As detailed in Table 10 below, however, there were relatively high negative response rates for some other employee groups at those refineries. Carson and Cherry Point employees responded more positively overall, but nonetheless provided a few negative response rates near or in excess of 20 percent. Contractors, on the other hand, provided low negative response rates across the board.

Table 10

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "[P]rocess safety programs . . . have [a]dequate funding."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	16	24	25	30	26
Maintenance/Craft Technicians	13	6	27	44‡	20
Full-Time HSSE Employees	19	12	49	63‡	44
Engineering Professionals	18	9	26	22	31
Operations Management	13	15	24	33	19
Maintenance Management	4‡	13‡	24	*	12
Contractors	7	5	9	5	5

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

The Panel makes an additional observation regarding the funding of the U.S. refineries. The Panel does not believe that the absolute level of funding is a deciding factor with respect to the state of process safety performance in a refinery. Many of the Solomon Associates Pacesetters with respect to reliability-centered maintenance—the industry leaders—frequently are not the biggest spenders on maintenance. Spending more money does not necessarily improve process safety if the money is not spent effectively, and the Panel acknowledges that many different variables affect a refinery's need for capital investment.

Finding:

BP has not always ensured that the resources required for strong process safety performance at its five U.S. refineries were identified and provided.

> Initiative overload

BP's corporate organization has mandated numerous initiatives to its businesses, including its U.S. refineries, during the last several years. Some of these have been directly related to process safety, such as the integrity management standard, process safety minimum expectations, and engineering technical practices. Some have been more focused on personal safety, such as the control of work standard and the driving standard, while others relate to non-safety aspects of HSSE, including environmental and other compliance initiatives. Still other initiatives were driven primarily by commercial considerations, such as the separation for sale to a third party of business assets embedded in sites where BP also conducted refining operations. Each successive initiative has required the refineries to develop plans, conduct analyses, commit resources, and report on progress.

While each initiative has been well intentioned, collectively they have overloaded refinery management and staff. BP's corporate organization has provided the refineries with little guidance on how to prioritize these many initiatives, and the refineries do not receive additional funding to implement each initiative. As a result, senior refinery managers used phrases such as "initiative overload," "incoming," and "unfunded mandates" to describe what they perceived as an avalanche of programs and endeavors that compete for funding and attention. The ripple effects are then felt throughout the refinery. Many of the hourly workers interviewed at all of the refineries complained that the large number of initiatives and related paperwork contributed to a heavy workload and prevented the workforce from being as focused on safety and operations as they would like. They also reported that the repeated launch of each successive initiative made it increasingly difficult for the workforce to take any of these initiatives seriously; many interviewees described this as the "flavor of the month" phenomenon. This situation has existed for a number of years. As a 2004 third-party consultant report on Toledo observed:

> Safety policies, programs and procedures, according to many have value, but are reaching a saturation point. Some add that there are too many safety programs that "miss the mark" and those that are effective are only occasionally seen through to completion.

Further, many refinery workers expressed their belief that focusing time, attention, and resources on initiatives such as the driving standard made little sense for BP's refining operations. They also indicated that they thought these initiatives ultimately distracted management and HSSE personnel, and possibly took resources, from more important refining concerns such as process safety.

Individuals within BP corporate management indicated to the Panel that they appreciated and agreed with the refineries' concerns about initiative overload. Refining corporate management explained to the Panel that refineries had been burdened with initiative overload and that the organization needed to assist the refineries in prioritizing these initiatives. The head of the Safety and Operations function also recognized that the refineries had been overrun with initiatives and given little guidance in determining priorities. He explained to the Panel that the Safety and Operations function would "be on the side of the refineries" in the planning process.

Finding:

> ***BP's corporate initiatives have overloaded personnel at its five U.S. refineries, to the possible detriment of process safety.***

> Worker fatigue and overtime

The Panel believes that worker fatigue has a negative impact on process safety performance. Academic studies establish that workers are far less capable of performing their jobs safely and risks increase when workers are fatigued. Staffing at a refinery and the workload of the refinery workforce can affect process safety performance. When not enough personnel are available to do the job, when personnel are trying to do too much, or when personnel are working too many hours, it is more difficult to ensure that the workforce will follow processes and procedures, will inspect and test equipment, and will maintain integrity management.

The Mogford Report cites fatigue as one of the root causes of the Texas City accident:

> Some employees had worked up to 30 days of consecutive 12-hour shifts. The reward system (staff remuneration and union contract) within the site encouraged this extended working period without consideration of fatigue. There were no clear limitations on the maximum allowable work periods without time off.
>
> It has not been possible for the Investigation Team to directly attribute actions or inactions of the operators and supervisors to fatigue. However, this extended working period clearly has the potential to contribute to a lack of attentiveness, and slowness to identify and respond to process upsets.[34]

While the Panel heard very little to attribute any process safety incident to excessive overtime or fatigue, the information available to the Panel leads the Panel to believe that many BP refinery personnel work excessive hours, thereby increasing process safety risks.

Data that BP maintained show, in the Panel's opinion, that hourly BP operations and maintenance personnel at all five U.S. refineries sometimes work significant overtime. The following table depicts the average percentage of overtime worked by operators and maintenance personnel in each of BP's U.S. refineries as represented by the total number of overtime hours worked by operations and maintenance personnel divided by the total number of standard (non-overtime) hours worked by hourly workers:

Table 11

Percentage of Overtime by Operators and Maintenance Personnel

Site	2002	2003	2004	2005	1/1/06-6/30/06	Site average (2002-6/30/06)
Carson Operations	21	25	23	31	21	24
Carson Maintenance	15	21	24	24	25	22
Cherry Point Operations	14	14	20	19	20	17
Cherry Point Maintenance	10	10	19	20	15	15
Texas City Operations	24	31	28	23	28	27
Texas City Maintenance	24	27	31	25	29	27
Toledo Operations	18	23	18	22	18	20
Toledo Maintenance	13	19	17	20	14	17
Whiting Operations	24	29	28	28	31	28
Whiting Maintenance	16	26	23	26	23	23

Perhaps more significantly, BP's data indicate that some hourly workers work overtime hours that the Panel believes is clearly excessive. The following table shows the percentage of overtime (expressed as a range) worked by the ten hourly workers with the highest amount of overtime at each site:

Table 12

Percentage of Overtime by Ten Hourly Workers at Site with Highest Amount of Overtime

Site	2002	2003	2004	2005	1/1/06-6/30/06
Carson	55-75	58-74	59-84	60-86	70-114
Cherry Point	27-36	29-36	39-48	38-59	41-54
Texas City	68-79	69-93	80-94	86-96	87-121
Toledo	N/A	39-93	33-48	42-56	N/A
Whiting	64-96	72-116	74-89	73-99	83-127

The average overtime data at each refinery suggest that the refineries have been understaffed at the operations and maintenance functions for years. In addition, the overtime percentages shown in Table 12 above suggest that the refineries' management of overtime has not been effective to avoid excessive overtime. Some hourly workers worked more overtime than non-overtime in 2006, and the trend does not appear to be improving.

The Panel's concern about excessive work hours is not limited to hourly employees and contractors. Although BP apparently does not closely track the hours that salaried refinery personnel work, the Panel's review suggests that some managers and other non-hourly personnel work excessive hours. In addition to the Mogford Report, which notes that many supervisors had been working for extended periods leading up to the Texas City ISOM accident, a variety of other BP documents reflect concerns about certain personnel working excessive hours. For example, the June 19, 2003 meeting minutes from the HSSE-PSM Committee for the Toledo refinery reflect these concerns:

> Twice recently, lab employees were forced to work 24 hours straight. They were offered accommodations such as a cab ride home and back to retrieve their vehicles. However, fatigue is a common cause of accidents in the workplace. A Circadian Technologies survey was cited which stated that the lack of sleep for 20—22 hours has the same effect as a blood alcohol level of .08.

The Panel does not believe that any bright lines delineate excessive overtime from non-excessive overtime. While the Panel is not aware of any refining industry norms or benchmarks for overtime, the Panel is aware that guidelines, standards, and restrictions on working excessive hours exist in other industries (such as nuclear generation and airlines) that involve hazardous operations. The Panel believes it is appropriate to consider a particular worker's position and working conditions in assessing whether overtime or other extended hours can be worked without compromising process safety and increasing risks. Nonetheless, the Panel believes that BP's average rates of overtime for operations and maintenance personnel, and in particular the overtime rates for certain workers, are excessive and may compromise process safety.

As demonstrated below, process safety culture survey data indicate that hourly workers at all refineries feel pressured to work considerable overtime. Based upon survey responses, the greatest source of pressure stems from the workers' own sense of loyalty to their operating units.

Table 13

<table>
<tr><td rowspan="7">"Workers at this refinery feel pressured to work considerable overtime from:

[A]. Co-workers
[B]. Supervisors
[C]. Refinery management
[D]. Their own sense of loyalty to their operating units."</td><td rowspan="2">Refinery</td><td colspan="4">Percentages of Agree/Tend to Agree Responses (among hourly workers)</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>Cherry Point</td><td>37</td><td>38</td><td>35</td><td>72</td></tr>
<tr><td>Carson</td><td>37</td><td>31</td><td>29</td><td>53</td></tr>
<tr><td>Whiting</td><td>17</td><td>23</td><td>21</td><td>48</td></tr>
<tr><td>Toledo</td><td>31</td><td>39</td><td>39</td><td>61</td></tr>
<tr><td>Texas City</td><td>20</td><td>32</td><td>29</td><td>56</td></tr>
</table>

The Panel recognizes that many hourly workers like to work a significant amount of overtime and are reluctant to restrict potential overtime. The Panel believes, however, that BP should adopt and implement policies to prevent operators, maintenance personnel, other hourly workers, and other refinery personnel from working excessive hours. The Panel suggests that BP use a process similar to what it did in developing limits on driving time in its Group driving standard to enact a sensible overtime or extended hours policy.

Finding:

Operations and maintenance personnel at BP's five U.S. refineries sometimes work high rates of overtime, which the Panel believes impacts their ability to perform their jobs safely and increases process safety risk.

INCORPORATION OF PROCESS SAFETY INTO MANAGEMENT DECISION-MAKING

In addition to a lack of a high-ranking process safety leader who can ensure that process safety is sufficiently considered in management decision-making, the Panel detected several issues with BP's approach to incorporating process safety into management decision-making. In the implementation of its business plans, BP establishes various goals and metrics for performance, including financial performance, operating performance, environmental performance, and personal safety performance. In this process, as discussed in Section IV and elsewhere in this report, BP relies to a large degree on its performance contract system to drive conduct in a manner consistent with its corporate goals. To a large degree, the BP system focuses on measurement and monitoring of performance results against these corporate objectives, established at the corporate level and cascaded through the BP organization using performance contracts. These performance contracts establish goals and metrics, and management at different levels of the organization monitors performance against the metrics to provide assurance that corporate objectives are being accomplished. The system also uses many goals and metrics, including financial results and production, that are capable of measurement and feedback in the short-term. For Refining, other metrics used include availability of refineries for operation and personal injury rates. The performance system has a decidedly short-term emphasis, with performance contracts typically focused on annual metrics and goals.

Without commenting specifically on the use of performance contracts, the Panel believes that this general approach of establishing performance metrics and targets to accomplish corporate objectives, including the use of annual metrics, is not unusual. The Panel believes, however, that process safety considerations, many of which have implications that extend well beyond one year, have not been considered adequately in BP's management decision-making process and the implementation system used to drive conduct, at least in the U.S. refining operations. Many decisions relating to process safety involve costs and benefits that are both long-term in nature and sometimes difficult to measure. In making these decisions, how should management measure the benefits of expenditures intended to improve process safety performance, such as expenditures for training or additional testing of equipment? The costs, in terms of present dollars to be spent, can be determined or estimated with relative certainty; the benefits, in terms of an incremental reduction of process risk (*i.e.*, incremental reduction of likelihood of occurrence of a process incident), perhaps occurring over an indeterminate period, can often be very difficult to estimate. The benefit of some of these types of expenditures may not be known or realized for many years.

In addition, while BP promulgates broad, aspirational goals, it delegates substantial discretion to refinery plant managers without clearly defining process safety expectations or responsibilities. BP's framework lacks meaningful checks and balances, and while accountability is a core concept in BP's Management Framework for driving desired behavior, BP has not demonstrated that it has effectively held those with refinery line accountability responsible for process safety performance at its U.S. refineries.

> Short-term focus

The Panel observes that BP directs a great deal of attention to short-term performance that is capable of quick measurement, analysis, and feedback (*e.g.*, profitability, production, environmental performance, and injury rates). BP provides clear expectations for performance in these areas, and can promptly ascertain how various decisions and events impact BP's performance. This focus is reflected in BP's reliance on performance contracts, which are the primary consideration in determining annual bonuses. The metrics and milestones contained in performance contracts have historically focused on short-term performance in areas such as profitability, production, environmental, and injury rates, all of which are measured in a relatively short (one year) period.

Assessments of process safety performance and capabilities, however, require metrics that differ from those used to assess performance in other areas and a management system that can measure performance against those metrics. The fact that a facility has not had a significant process safety incident for some time may say little about the true state of process safety at that site or the potential for a major process incident. Decisions and events impacting process safety or human capability may not have a discernible impact for many years. For example, a decision to reduce spending on inspections, testing, or maintenance may have no apparent negative impact on process safety performance for a lengthy period. By the same token, increasing spending on inspections, testing, or maintenance may not lead to an ascertainable improvement in process safety performance in the short-term, as the lead times between the decision and the noticeable effect can be substantial. These long-term concepts such as process safety performance and human capabilities appear to be less well tracked, understood, and managed by BP's systems. BP management historically has neither particularly emphasized these items nor driven their results.

This observation finds a parallel in BP's own lessons from the Grangemouth incidents in 2000. Following the Grangemouth incidents, BP mobilized a task force to undertake a review of all operating units and functions at that refinery. One of the task force's findings was that BP was too focused on short-term cost reduction, and not focused enough on longer-term investment for the future. The task force also found that BP reinforced the short-term cost reduction focus through performance contract metrics, and the task force concluded that "HSSE was unofficially sacrificed to cost reductions, and cost pressures inhibited staff from asking the right questions; eventually staff stopped asking." It appears to the Panel that this problem also applied to the U.S. refineries.

> Process safety expectations, responsibilities, and accountabilities

BP's Management Framework is based upon delegation and accountability through a chain of command that has numerous links. Through delegation, BP attempts to ensure that the most appropriate person is responsible for meeting expectations; through accountability, it attempts to ensure that each person in the chain of command has an interest in making certain that the responsible delegate performs the task.

In the broadest sense, BP's Board of Directors is accountable for ensuring process safety because it is ultimately accountable to BP's owners, the shareholders. BP's Board of Directors itself does not manage; instead, it delegates responsibility for all of BP's operations, including process safety in the U.S. refineries, to the Group Chief Executive. The Group Chief Executive himself does not manage BP's operations. While remaining accountable to the Board, he delegates responsibility to the Chief Executive, Refining and Marketing for all aspects of the refining business's performance. This series of delegations and commensurate accountability continues through two more levels until responsibility rests with the refinery plant managers. At each refinery, the plant manager is directly responsible for ensuring process safety in the refinery and all management in the refining line above the plant manager remain accountable. The refinery plant manager then cascades responsibility down throughout the refinery while remaining accountable. The overarching principle is that responsibility is delegated downward until it reaches the most appropriate person. Each person in the chain of command continues to be accountable, but the person closest to the task is responsible for ensuring that expectations are met.

In theory, this framework appears to be logical and coherent. In practice, however, the Panel perceives four problems. First, BP has often been unclear about specific accountabilities and responsibilities, creating confusion and situations in which no one appears to have responsibility for decisions impacting process safety. Second, the BP framework relies on a chain of individual-to-individual interfaces with few independent checks or reviews so that any single dysfunctional relationship can create a break in the process safety system management chain. Third, BP has not provided clear process safety performance expectations to refinery line management, including refinery plant managers. Fourth, the Panel has seen little information suggesting that BP has held people accountable for process safety performance.

Unclear responsibilities. While BP appears to have been clear about the general concept of line accountability, it is apparent that responsibilities with respect to BP's refining organization have often been muddled. BP has a complex structure, and BP has frequently reorganized, created new positions, and shifted responsibilities between organizations. As a result, it has not always been clear with respect to process safety just who was responsible for what. Referring to Texas City, the Mogford Report observes:

> This large complex organization has many interfaces requiring clear accountabilities and good communication both horizontally and vertically throughout the organization. In reality, the Investigation Team found examples of a lack of

> accountability, unclear roles and responsibilities, and poor communication with employees tending to work within silos. This, in turn, creates a confusion around some of the many interfaces.[35]

The Panel observed many instances of this lack of clarity. In the view of the Panel and within BP, the respective responsibilities and accountabilities of, and the inter-relationships among, the Safety and Operations function, the Group Technology function, and the Refining and Marketing HSSE and Technology organization (all of which are outside the refinery line organization) are not clear. At the refinery level, it is apparent that situations existed in which no one was clearly responsible for work that clearly impacts process safety (for example, the preparation of management of change analyses), and some refinery workers were uncertain how and where process safety management fit within the refinery's organization. While the BP Management Framework recognizes that accountabilities for process safety performance run with the line, BP must clarify the responsibilities of those in the line and of staff that supports the line to be successful in fostering good process safety performance.

Absence of checks and reviews. At each link in the management chain, a BP manager or supervisor delegates responsibility to a person below, and the delegator satisfies his or her ongoing accountability by monitoring the delegatee's performance. BP's structure provides very few independent checks and reviews with respect to the functionality of this chain. As a practical matter, this framework depends heavily upon having healthy, productive relationships between the individuals at each and every link in this chain of command.

A problem can occur in this management framework if a breakdown in communication or understanding exists at any one of these interfaces. With respect to process safety, there are many potential reasons for such a breakdown, including

- the delegatee may not perceive a process hazard, the need to correct a process safety problem, or a process safety cultural weakness, and as a result, the delegator does not learn of the issue;
- the delegatee may believe that other goals, such as financial, production, or cost-cutting objectives, are more important to the delegator than process safety goals; and
- the delegator may not have sufficient understanding of the issues facing the delegatee, whether because of poor communication, lack of substantive knowledge, or otherwise.

Even a single dysfunctional relationship in the chain—whether between a supervisor and a superintendent, a refinery plant manager and the regional vice president, or the head of global refining and the Chief Executive, Refining and Marketing—can create a significant break in the management system for ensuring process safety performance.

Lack of process safety expectations. Under BP's Management Framework, the refinery plant manager is accountable for all aspects of the refinery's operations with the exception of those encompassed by the centralized group functions, such as Tax and Accounting. While the refinery plant manager has many direct reports to whom accountabilities may be further delegated, BP regards the refinery plant manager as the person responsible for the refinery's financial, operational, environmental, and safety performance. While those in the line above the refinery remain accountable for all aspects of the refinery's performance, including safety, BP's management framework is clear that refinery corporate management satisfies its responsibility by monitoring performance, not by supervising the operations of the refineries.

BP recognizes that in this organizational framework, the refinery plant manager has a tremendous amount of discretion in running the business. Some people at BP refer to this as an "empowerment ethos."[36] As Browne has described, "we want them to be entrepreneurs, not bureaucrats doing exactly what they are told from above."[37]

On a day-to-day level, the refinery plant manager makes countless decisions relating to or affecting process safety. Particularly in the short-term, many of these decisions often involve balancing of various other refinery objectives and goals, such as production, profitability, cost reduction, and scheduling. While BP provides plant managers with reasonably clear guidance and direction with respect to financial, environmental, and operational goals and targets, it does not provide comparable guidance as to process safety.[38] Refinery plant managers well understand BP's aspirational goal (and Group Value) that there be "no accidents, no harm to people," but BP does not provide the plant managers with specific directions on how to achieve that goal. Historically, BP has not included any targets or milestones for process safety objectives in refining performance contracts or variable pay programs, nor has BP provided any meaningful guidance to refinery personnel on how process safety objectives should be considered when they may compete with other refinery objectives.

Specific business plans reflect the same absence of focus on process safety. Each refinery's specific business plan contains detailed financial metrics and targets, along with key performance indicators based on delivery of strategic objectives. Through 2005, however, the only safety-related key performance indicators were days away from work case frequency and recordable injury frequency, neither of which is an appropriate indicator of process safety performance. The absence of any process safety-related metrics in Refining performance contracts, variable pay programs, and site-specific business plans left local refinery management largely on its own in making decisions that could affect process safety.

It appears to the Panel that BP recognizes the need to provide more clarity on process safety expectations. In the Group HSSE Report issued in mid-2005 to the EEAC, BP proposed several "safety interventions" to improve safety performance, including a reworking of gHSEr to "become more prescriptive for those units who [sic] can benefit from more guidance and implementation assistance." In his second interview with the Panel, Browne acknowledged the need to reset process safety expectations, and BP has begun tracking, from the Board down to the refineries, what BP calls the eight "enduring milestones" that include some leading and lagging indicators of process safety. Finally, BP is now including better metrics for process safety in Refining performance contracts and variable pay programs.

Lack of holding people accountable. In order for BP's framework to be meaningful, BP must truly hold people accountable for process safety performance against meaningful performance metrics—with rewards for good performance and repercussions for poor performance. If BP does not actually hold people accountable for process safety performance against such metrics, then BP will have an organization in which no one is responsible for process safety performance. When refinery personnel perceive that neither they nor others are actually held accountable for process safety, it is difficult to see how a positive safety culture can be sustained, or how process safety risks will not increase. Both the Mogford Report and the Stanley Report noted the lack of accountability (referred to as the perception of "[n]o consequences of good or bad performance" in the Mogford Report) as significant drivers of poor process safety performance at Texas City.[39]

BP provided the Panel with few examples of actually holding people at all levels accountable for process safety performance.[40] The Texas City accident provides a good illustration. Under BP's Management Framework, those accountable for that accident, and Texas City's process safety performance generally, include the Group Chief Executive, the head of the Refining and Marketing segment, and on down the chain to the Texas City plant manager, the refinery operations manager, and various supervisors and superintendents in the ISOM unit. While recognizing that the process safety culture problems at Texas City developed during the course of many years and that some people in the line of accountability had been in those positions for only a short time, the Panel considered the extent to which BP held all levels of the line in some way accountable. In making this assessment, the Panel understands that accountability within BP is not tantamount to fault.

The Group Chief Executive's 2005 bonus was 40 percent less than his 2004 bonus, notwithstanding the fact that BP had its best financial performance ever in 2005. While BP did not expressly inform the Panel that the Board reduced the Group Chief Executive's bonus because of the Texas City incident, the Panel believes that it may reasonably infer that the Board did exact a significant financial penalty on the Group Chief Executive at least in part for that accident.

The Panel has little specific information about the financial or other repercussions of the Texas City ISOM accident on other members of corporate management. The only information BP provided the Panel in this regard was the representation that for 2005, the Refining and Marketing senior executive team received bonuses that were, on average, 13 percent lower than those of their peers in BP's other two segments. BP did not provide the Panel with any information indicating what the bonuses would have been absent the accident, or even which members of the Refining and Marketing senior executive team had bonuses reduced more than others. Based upon this scant information, the Panel cannot conclude that BP truly held Refining and Marketing segment management or Refining management accountable for the Texas City accident.

As a result of the Texas City accident, BP terminated three hourly workers and three low-level supervisors (two shift supervisors and a unit training coordinator). The Panel understands that BP did not terminate or discipline anyone else in refinery line management (although BP placed the plant manager on paid administrative leave, and he remained in that status through at least December 31, 2006). The Panel understands that BP is still investigating the accountability of others in refinery line management for the Texas City accident.

The Panel also perceives a lack of accountability for process safety performance at lower ranks of refinery management. Interviews of hourly workers and refinery management, along with third-party assessments of some at the refineries, reflect that a good portion of the workforce believes that the lack of line accountability is a significant deterrent to good process safety performance. Many refinery-level workers interviewed, particularly in Toledo, Texas City, and Whiting, share the perception that process safety complaints and concerns often are ignored or downplayed by lower levels of refinery management. According to those interviewees, while process safety complaints and concerns are directed to first level leaders and superintendents, BP does not ensure that individuals at those levels are held accountable for process safety performance, and financial and production goals appear to motivate those individuals more than process safety or even personal safety objectives. This perception reinforces the lack of trust between hourly workers and management at some sites and inhibits the establishment of a culture in which incidents and near misses are reported, investigated, and learned from. The Panel believes that BP must demonstrate to its U.S. refining workforce that it is holding all levels of line management accountable for process safety performance.

Finally, many hourly workers interviewed reported their belief that refinery management had not done enough to discipline hourly workers who deviated from policies and procedures. Other hourly workers interviewed said they believed that inconsistent standards on discipline applied within their refinery, depending upon whether the person being disciplined was an employee or contractor, or upon whether the person was perceived to be a favorite of the supervisor. The Panel believes that BP must apply accountability consistently throughout the refinery workforce.

Findings:

BP's decentralized management system and entrepreneurial culture have delegated substantial discretion to U.S. refinery managers without clearly defining process safety expectations, responsibilities, or accountabilities.

BP has not demonstrated that it has effectively held executive management and refining line managers and supervisors, both at the corporate level and at the refinery level, accountable for process safety performance at its five U.S. refineries.

THE PROCESS SAFETY CULTURE AT EACH OF BP'S FIVE U.S. REFINERIES

Through interviews of refinery personnel and management, interviews of corporate level management above the refinery level, the process safety culture survey, and a review of BP documents, the Panel analyzed the safety culture within each refinery. In assessing the local safety culture at each refinery, the Panel focused on a number of attributes, including

- the degree to which the workforce feels "empowered" as to process safety and "ownership" of process safety;
- the extent to which the workforce feels free to report safety-related incidents, near misses, and concerns without fear of retaliation;
- the process safety awareness, knowledge, and competency of the workforce;
- relationships and trust between different constituencies, including management and the workforce, management and contractors, and contractors and the workforce;
- whether deviations from policies and procedures are tolerated;
- the extent to which safety-related information flows freely among all levels of the refinery;
- whether the workforce has a shared belief that safety comes first, regardless of financial, scheduling, or cost objectives; and
- the extent to which the workforce is vigilant about process safety risks, continuously tries to reduce them, and seeks to learn from incidents and near misses.

> The wide variability in process safety cultures

The Panel struggled to detect any common safety culture among BP's U.S. refineries. Because of legacy, historical, geographic, and other site-specific influences, each of BP's U.S. refineries appears to have a unique local safety culture, and significant differences exist among them. Other than corporate signage and the prevalence of the BP logo, little indicates that these refineries have common ownership. The process safety culture survey of BP's refinery workforce demonstrates this wide variability.

Survey data demonstrate a consistent and wide divergence among, for example, the responses of Cherry Point employees and contractors, who tended to have the most positive perspectives of process safety culture, and those of Texas City and Toledo employees and contractors, who tended to have the most negative perspectives. Data from three representative survey items that yielded large percentage gaps in positive responses highlight this inter-refinery divergence.

One survey item addressed whether respondents believed a culture existed at their refineries that encouraged raising process safety concerns. At Cherry Point, 95 percent of employees in the nine process safety functional groups, taken as a whole, agreed or tended to agree that such a culture existed, thereby revealing an overall positive opinion of this aspect of the refinery's process safety culture. Responses were increasingly less positive at the Whiting, Carson, Texas City, and Toledo refineries. In fact, the positive response rate at Toledo was 28 percentage points lower than the positive response rate at Cherry Point. The following table, like the other tables below, highlights the wide range in response rates obtained from employees in the nine process safety functional groups at BP's U.S. refineries.

Table 14

Percentages of Agree/Tend to Agree Responses to Survey Item:
"I believe a culture exists at this refinery that encourages raising process safety concerns."

Toledo	Texas City	Refinery Average	Carson	Whiting	Cherry Point
67	72	81	86	87	95

Positive response rates were much lower for a survey item addressing whether workers bothered to report minor process-related incidents, accidents, or near misses; however, the overall response percentage gap was similar to the one depicted above. The percentage of employees indicating an impression that workers reported minor process-related events peaked at 77 percent at Cherry Point, and dipped 30 percentage points to a low of 47 percent at Texas City.

Table 15

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"In general, workers don't bother to report minor process-related incidents, accidents, or near misses."

Texas City	Carson	Toledo	Refinery Average	Whiting	Cherry Point
47	54	56	57	62	77

Finally, a third survey item addressed whether respondents believed process safety improvement was a long-term commitment that was not compromised by short-term financial goals. Of employees in the nine process safety functional groups, 83 percent at Cherry Point and 80 percent at Carson responded positively. Positive response rates were much lower, however, at Texas City (56 percent) and Toledo (54 percent).

Table 16

Percentages of Agree/Tend to Agree Responses to Survey Item:
"At this refinery, process safety improvement is a long-term commitment that is not compromised by short-term financial goals."

Toledo	Texas City	Refinery Average	Whiting	Carson	Cherry Point
54	56	68	69	80	83

The Panel's interviews of refinery employees and contractors likewise revealed substantial differences in local safety culture among the five refineries. The interviews of refinery management and hourly workers suggested a very strong safety culture at Cherry Point, a generally positive safety culture at Carson, a mixed but improving safety culture at Whiting, a weak safety culture at Toledo, and a safety culture at Texas City that was very poor for a substantial period, but that appears to be changing for the better because of recent activities and initiatives in the refinery.

BP's management acknowledged this wide variability in safety cultures at the U.S. refineries. The Panel interviewed more than 30 BP managers outside of the refineries, including corporate refining line management, people in the various functional groups that impact process safety, and others with at least some knowledge of the state of safety culture within BP's U.S. refineries. Almost all agreed that each U.S. refinery had its own safety culture and that those cultures were substantially different.

Finally, the Panel's own observations from the time it spent at each refinery are consistent with conclusions drawn from the interviews. To at least a certain extent, safety culture can be "felt"—from talking with hourly workers and managers, observing practices, and simply being around the refinery. Based upon its experience at the refineries, the Panel observed markedly different process safety cultures at the five refineries. Each refinery's process safety culture is discussed below.

> Process safety culture in each refinery

Cherry Point process safety culture. Cherry Point is an ARCO-heritage refinery. Cherry Point provides jobs for more than 1,400 BP employees and contractors. Unlike BP's other U.S. refineries, a labor union does not represent any of the BP employees at Cherry Point. The dominant feature of Cherry Point's safety culture is the overwhelming sense that everyone who works there, from the refinery plant manager to the hourly employees and the contractors, believes that the Cherry Point refinery workforce is one "family." The refinery's pervasive feeling of trust and inclusiveness appears to be founded on a number of sources.

First, the Cherry Point refinery is smaller and less complex than some of BP's other U.S. facilities, such as Whiting or Texas City. The smaller size of the refinery contributes to the family-like atmosphere. Fewer process units translates into fewer people and more opportunity for interaction. The smaller size of the facility also permits the refinery leadership team to interact frequently with the workforce. Most interviewees claimed to have met frequently with senior members of Cherry Point management.

Second, the Cherry Point refinery is isolated in a fairly remote community in northern Washington state. The vast majority of the workforce interviewed remarked that geographic location contributed to the sense of inclusiveness. The bulk of the refinery leadership team, supervisors, hourly workforce, and contractors live in the same community and socialize together. Many of the Cherry Point interviewees remarked that interacting routinely in the general community with other members of the refinery workforce contributed to the family-like feeling in the facility.

Third, the Cherry Point refinery workforce is highly educated and close-knit. Cherry Point draws largely upon former military personnel from a local post, as well as recent graduates from the local university, to staff the refinery. Many of the operators interviewed were military veterans, college educated, or both. This shared background contributes to the sense that each member of the Cherry Point workforce trusts the other members of the workforce to do a good job. Additionally, many of the employees at Cherry Point helped construct the plant, furthering the sense of trust and worker ownership of the refinery. Many interviewees reported their perception that the Cherry Point refinery was by far the best job available in the area. As such, the Cherry Point workforce tends to be very stable, well educated, and loyal, and the positive safety culture there appears to have existed for many years.

Fourth, the Cherry Point refinery leadership team has worked actively to create an egalitarian, non-hierarchical culture in which all employees and contractors feel vital to the success of the plant. BP hourly employees and contractors discussed the various refinery safety committees as an example of how they felt they could contribute to the safety culture. For example, Cherry Point has established a Refinery Safety Committee to address workforce safety concerns. The committee is composed of 60 hourly, contractor, and management volunteers who meet for one full day each month to address safety issues. Initially, the committee had a $500,000 budget, but the refinery recently increased the budget to $750,000 because the committee was so well received by the workforce. Both contractors and BP employees stated in interviews that they believed their joint participation on the committee contributed to a feeling of equality between the two groups. These interviewees also stated that they believed management took their opinions seriously.

While it is true that Cherry Point is the only non-unionized BP refinery in the United States, the Panel does not believe that this is a factor in establishing a positive safety culture. If the relationship between management and the unionized workforce is open and trusting, there will be a positive impact on the safety culture. Conversely, if the relationship between management and the unionized workforce is characterized by distrust or hostility, this relationship will negatively affect safety culture. In any case, it is the quality of the relationship between management and the rest of the workforce that is the key factor, not whether the workforce is organized.

Another dominant theme from Cherry Point interviews was that "safety comes first." Few of the workers interviewed at Cherry Point disagreed with the refinery's HSE Handbook, which declares that "BP Cherry Point Refinery's number one goal is to be the safest operating refinery in the world." The prevailing attitude at Cherry Point appeared to be that "everyone works to get safety right." Most of the workforce interviewed said they believed that Cherry Point truly wanted to learn from incidents and near misses: reporting was encouraged, incidents were investigated with a view toward making things better, and safety incidents from outside the refinery were reviewed for any potential application to Cherry Point policies and procedures.

Process safety culture survey data substantiate many of these conclusions. For example, many Cherry Point employees and contractors expressed a belief that they could influence process safety policies implemented at their refinery. Table 17 below contains percentages of positive responses (in descending order) from contractors and employees at the Cherry Point refinery.

Table 17

	Cherry Point Group	Percentages of Agree/Tend to Agree Responses
"I feel that I can influence the process safety policies implemented at this refinery."	Maintenance Management‡	100
	Operations Management	98
	Engineering Professionals	95
	Full-Time HSSE Employees	88
	Operators	80
	Maintenance/Craft Technicians	74
	Contractors	66

‡ Fewer than 25 respondents were in this group.

While the positive response rate from contractors was lower than the positive response rates from other groups, only 13 percent of contractors indicated a belief that they could not influence policies; the remaining 22 percent either did not know or did not have an opinion on the matter.

Survey responses from Cherry Point employees and contractors also tend to reinforce the notion expressed during interviews that process safety was a high priority at the refinery. As indicated below, however, only 49 percent of maintenance/craft technicians and 39 percent of contractors disagreed or tended to disagree with a survey item stating that in their work groups, process safety concerns were secondary to achieving production goals.

Table 18

	Cherry Point Group	Percentages of Disagree/Tend to Disagree Responses
"In my work group, process safety concerns are secondary to achieving production goals."	Maintenance Management[‡]	94
	Engineering Professionals	91
	Full-Time HSSE Employees	88
	Operations Management	83
	Operators	82
	Maintenance/Craft Technicians	49
	Contractors	39

[‡] Fewer than 25 respondents were in this group.

Finally, like interviewees, many survey respondents indicated their impression that the Cherry Point refinery's culture encouraged raising process safety concerns.

Table 19

	Cherry Point Group	Percentages of Agree/Tend to Agree Responses
"I believe a culture exists at this refinery that encourages raising process safety concerns."	Maintenance Management[‡]	100
	Operators	97
	Engineering Professionals	96
	Full-Time HSSE Employees	96
	Operations Management	93
	Maintenance/Craft Technicians	88
	Contractors	84

[‡] Fewer than 25 respondents were in this group.

Despite data demonstrating a number of positive aspects of Cherry Point's safety culture, the Panel's review revealed at least two elements that merit attention. First, both interviews and survey data suggest that the workforce is expected to work significant hours. Experienced operators noted in their interviews that expectations about hours of work were particularly high during turnarounds. Four survey items addressed perceived pressure to work considerable overtime. Table 20 below contains those items and percentages of Cherry Point contractors and employees who responded negatively to the items.

Table 20

<table>
<tr><td rowspan="10">"Workers at this refinery feel pressured to work considerable overtime from:

[A]. Co-workers
[B]. Supervisors
[C]. Refinery Management
[D]. Their own sense of loyalty to their operating units."</td><td rowspan="2">Cherry Point Group</td><td colspan="4">Percentages of Agree/Tend to Agree Responses</td></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>Maintenance/Craft Technicians</td><td>49</td><td>52</td><td>46</td><td>76</td></tr>
<tr><td>Maintenance/Turnaround Planners‡</td><td>45</td><td>30</td><td>30</td><td>80</td></tr>
<tr><td>Contractors</td><td>43</td><td>53</td><td>46</td><td>58</td></tr>
<tr><td>Operations Management</td><td>37</td><td>37</td><td>33</td><td>76</td></tr>
<tr><td>Full-Time HSSE Employees</td><td>36</td><td>40</td><td>20</td><td>65</td></tr>
<tr><td>Engineering Professionals</td><td>33</td><td>25</td><td>19</td><td>72</td></tr>
<tr><td>Operators</td><td>31</td><td>28</td><td>27</td><td>70</td></tr>
<tr><td>Maintenance Management‡</td><td>27</td><td>25</td><td>25</td><td>81</td></tr>
</table>

‡ Fewer than 25 respondents were in this group.

The high negative response rates for these specific survey items are even more significant when compared to positive response rates for the remainder of the survey items. For three of the four survey items quoted above, employees in the nine process safety functional groups, as a whole, provided positive response rates that were lower at Cherry Point than they were on average across the five U.S. refineries. That response spread was not common; it did not occur for any of the remaining 62 survey items. Cherry Point management acknowledges the overtime issue as significant and recognizes that it could impact safety performance at the site.

Second, Cherry Point also appears to have an overconfidence that may reduce its sense of vulnerability to process safety risks. Many of the individuals interviewed at Cherry Point indicated they believed that the refinery's safety culture was premised upon site management's knowledge of the refinery, its sense of personal responsibility for the refinery's safety performance, and its belief that it had the authority to manage as it sees fit. This sense that "Cherry Point knows what's best for Cherry Point" appears to make the refinery less receptive—and even on occasion hostile—to corporate initiatives, programs, and oversight, including those intended to identify and reduce process safety risks. Not surprisingly, the Cherry Point workforce did not attribute its positive safety culture to BP Group initiatives, programs, or policies; on the contrary, widespread concern exists at Cherry Point that such company-wide directives will impair process safety and damage the refinery's safety culture.

Carson process safety culture. Like Cherry Point, Carson is an ARCO-heritage refinery. Many interviewees reported that throughout most of the 1990s, while still under ARCO ownership, Carson had a poor safety culture and a deteriorating safety record. Following three significant process safety incidents in 1998, Mike Hoffman, the Carson refinery plant manager at the time, made it clear that no process safety incident would be tolerated, reinforced the belief that anyone could and should report a process safety concern without fear of reprisal, and secured from ARCO sufficient funding to address process safety issues. Many Carson interviewees credited Hoffman's actions with turning around the process safety culture at the refinery. Similarly, many interviewees stated that the refinery's generally positive safety culture existed at the time of the BP acquisition, and few attributed the positive culture to BP.

While the Panel did not detect in Carson the same "family-like" sense of environment as in Cherry Point, the interviews of refinery workers and management at Carson, as well as the process safety culture survey, indicate a safety culture that is generally positive. Several aspects of Carson's process safety culture stand out.

First, the different groups within Carson—management, the unionized workforce, and contractors—appear to share a commitment to safety. The hourly workers and managers interviewed almost uniformly indicated they believed that Carson has a strong safety culture and commitment to safety. Workers at all levels interviewed at Carson, including contractors, generally possess a strong feeling of individual commitment to and responsibility for safety. Some referred to the union and management as having a partnership as to safety.

Second, Carson workers feel comfortable reporting safety-related issues and stopping unsafe work. Almost all levels of personnel and contractors interviewed said that they generally felt comfortable reporting incidents, near misses, and other concerns; most interviewees reported believing that they could shut down a job for safety reasons without fear of repercussion. The interviewees described a variety of situations in which a worker shut down an operation because of a safety concern and received the complete support of refinery management. In general, the interviews pointed to a reasonably open environment in which the vast majority of the workforce takes safety very seriously, and safety-related concerns are freely raised and discussed.

Third, Carson appears to enjoy relatively good relationships between management and the union, the union and contractors, and management and contractors. Both hourly workers and management interviewed generally reported good relations between the union and management. Little tension appears to exist between Carson management and the union, and the two groups appear to communicate well with respect to safety. Many hourly workers and managers at Carson credited this lack of tension to having both union and management representatives on the refinery's Policy and Procedures, Joint Health and Safety, and Process Safety Management Committees. In fact, a hourly worker-led safety program called "STOMP" is the primary local safety initiative. Relations between refinery management and the union appear to be far better at Carson than they are at Whiting, Toledo, or Texas City. Similarly, interviews of contractors, hourly workers, and management indicate that generally good relations exist with contractors, and contractors typically feel that they are not treated as second-class citizens at the refinery.

Fourth, Carson managers and hourly workers noted that Carson is the most heavily scrutinized BP refinery in the United States because it operates in the highly regulated Southern California area. They explained that on an almost daily basis, inspectors from any of a number of state or other regulatory agencies might be in the refinery, including the California Division of Occupational Safety and Health, the Los Angeles County Fire Department, Hazardous Materials Division (the Certified Unified Planning Agency for the Carson area), the California Environmental Protection Agency, the California Air Resources Board, and the South Coast Air Quality Management District. Many Carson employees believe, and the Panel does not disagree, that being so closely watched by so many regulators compels Carson to conduct safer operations.

Results from the process safety culture survey reflect many of the same positive attitudes expressed during interviews. Like the interviewed workers, for example, survey respondents, particularly operations management and operators, generally indicated that they felt responsible for process safety at the Carson refinery. Table 21 below contains representative responses.

Table 21

	Carson Group	Percentages of Agree/Tend to Agree Responses
"I am responsible for identifying process safety concerns at my refinery."	Operations Management	98
	Operators	93
	Engineering Professionals	85
	Full-Time HSSE Employees	84
	Contractors	84
	Maintenance Management‡	83
	Maintenance/Craft Technicians	79

‡ Fewer than 25 respondents were in this group.

High percentages of respondents in the groups listed above also expressed their belief that they could report hazardous conditions without fear of negative consequences and, similarly, that operators were empowered to take corrective action as soon as possible if process safety-related devices failed or became unavailable during operation. Notably, 85 percent of operators expressed their belief that they were empowered to take corrective action as soon as possible if process safety-related devices failed or became unavailable during operations. Management groups, however, had the highest positive response rates.

Table 22

	Carson Group	Percentages of Agree/Tend to Agree Responses
"I can report hazardous conditions without fear of negative consequences."	Maintenance Management‡	100
	Operations Management	98
	Full-Time HSSE Employees	97
	Engineering Professionals	95
	Operators	91
	Contractors	85
	Maintenance/Craft Technicians	80

"Operators are empowered to take corrective action as soon as possible (including shutting down when appropriate) if . . . process safety-related devices fail or become unavailable during operation."	Maintenance Management‡	96
	Operations Management	88
	Operators	85
	Engineering Professionals	84
	Full-Time HSSE Employees	81
	Contractors	77
	Maintenance/Craft Technicians	74

‡ Fewer than 25 respondents were in this group.

Finally, many employees and contractors conveyed positive perspectives about the level of communication regarding process-related events at the refinery. Specifically, most of the respondents in the groups listed below expressed their impression that Carson workers were informed about the results of process-related incident, accident, and near-miss investigations.

Table 23

	Carson Group	Percentages of Agree/Tend to Agree Responses
"Workers are informed about the results of process related incident, accident, and near miss investigations."	Operations Management	98
	Maintenance Management‡	96
	Full-Time HSSE Employees	95
	Operators	92
	Engineering Professionals	87
	Maintenance/Craft Technicians	77
	Contractors	75

‡ Fewer than 25 respondents were in this group

Despite the many positive aspects of Carson's safety culture, refinery interviews and process safety culture survey results revealed some concerns regarding safety culture. Many operators interviewed indicated they believed that refinery management was not as visible as it should be, and some of the management leadership interviewed acknowledged this deficiency. Many hourly workers interviewed also expressed their belief that little preventive maintenance took place, and some felt that training generally was inadequate. Some hourly workers doubted whether all incidents got reported, particularly by contractors, and others indicated that near misses did not get investigated regularly. Some hourly workers expressed concern that knowledge was not shared within and between units at the refinery. Many hourly workers interviewed reported that they lacked complete and updated procedures. Some hourly workers complained that BP was more "bottom line focused" and less "people focused" than ARCO was. Others expressed concern about having too much work to ensure that it was all completed properly and safely.

Some of the survey results support these observations from interviews. For example, 42 percent of maintenance/craft technicians, 37 percent of maintenance management,[41] and 22 percent of operators agreed or tended to agree that "[p]rocess equipment [was] not regularly . . . [m]aintained." More than one-third (35 percent) of maintenance/craft technicians expressed a belief that the training they had received "[did] not provide [them] with a clear understanding of the process safety risks at [their] refinery." One-third (33 percent) of the operators and 23 percent of operations management indicated an impression that written operating procedures were not kept up to date. Finally, 49 percent of maintenance/craft technicians, 25 percent of maintenance management,[42] and 21 percent of operators indicated their belief that in their work groups, "process safety concerns [were] secondary to achieving production goals."

While some areas of genuine concern were noted, Carson appears to have a generally positive process safety culture. Relatively good relations among management, the unionized workforce, and contractors facilitate a reasonably open and trusting environment. Many hourly workers and contractors interviewed stated that they had worked at other refineries in the area, and they uniformly reported that in their opinion, Carson had by far the best process safety culture.

Whiting process safety culture. The refinery-level interviews and the process safety culture survey provided mixed signals about the strength of the safety culture at Whiting, an Amoco-heritage refinery. Many interviewees indicated that under Amoco leadership, the safety culture was poor and management was focused more on production than safety. Similarly, many interviewees, both hourly and management, discussed Whiting's longstanding pride in its ability to keep the refinery running despite an aging infrastructure and budgetary constraints (sometimes called the "can do" culture). Some interviewees indicated their belief that BP had reduced funding for Whiting after the Amoco merger, but most of the workforce believed that BP was making a significant effort to improve the facility. Most Whiting workers believed that BP has improved safety relative to Amoco and that the safety culture at Whiting was continuing to improve. Nevertheless, the Panel observed both positive and negative characteristics of the Whiting safety culture during its review.

For example, interviews revealed the following positive process safety culture aspects:

- the workforce broadly perceived the refinery to be safer today than it used to be;
- many hourly workers felt more empowered to report safety concerns today than they did under Amoco;
- almost all of the hourly workers believed they have the authority to shut down an unsafe job; and
- most interviewees believed that the relationship between the union and management is good.

Although most interviewees reported that they believed the relationship between the union and management was generally good, instances of strained relations between them occurred from time to time. For example, in the fall of 2003, the hourly workers stopped participation on a joint company/union committee and initiatives, except where required by contract.

The Panel found other issues that can or do have a negative effect on Whiting's safety culture:

- Many hourly workers interviewed perceived the culture as more reactive than proactive and believed that the refinery would make repairs and spend money only after an accident.
- Numerous operators interviewed believed that budget constraints have affected preventive maintenance, and they pointed to various examples of major safety hazards remaining unaddressed despite repeated work order requests.
- Many hourly workers interviewed believed that senior refinery management was not sufficiently visible and that some managers had so lost touch with the daily operations that they no longer understood the units they manage.
- Many hourly workers interviewed believed that supervisory oversight of safety varies considerably from unit to unit.
- Consistent with Whiting's "can do" legacy, some hourly workers acknowledged that it was still common to deviate from procedures in order to finish a job more quickly.
- Many interviewees were critical of the quality of training, expressed concerns about the qualifications of chief operators and first level leaders, and some stated that hourly workers and supervisors were stretched too thinly to perform their safety functions adequately.

Moreover, interviewees almost uniformly reported that significant animosity and tension exists at Whiting between the unionized maintenance employees and contractors. This condition, which appears to be based upon the union's perception that contractors are taking jobs away from the union, inhibits the sharing of information between contractors and employees. BP maintenance workers interviewed were critical of contractors, claiming that they were inexperienced, performed substandard work, and lacked sufficient knowledge about the refinery's safety processes and standards. Relations between unionized BP personnel and non-unionized contractors were so strained that the unionized BP personnel refused to work any jobs manned by "split crews" composed of both BP unionized employees and non-unionized contractors.

The process safety culture survey data reflect some of the same mixed signals conveyed during interviews. For example, as represented in Table 24, many survey respondents expressed a belief that the refinery's culture encouraged raising process safety concerns. Contractors and HSSE employees were less likely to respond positively; however, because 13 percent of both groups indicated that they did not know or have an opinion on the issue, their negative response rates were relatively low.

Table 24

	Whiting Group	Percentages of Agree/Tend to Agree Responses
"I believe a culture exists at this refinery that encourages raising process safety concerns."	Maintenance Management	100
	Operations Management	89
	Engineering Professionals	89
	Maintenance/Craft Technicians	86
	Operators	84
	Contractors	77
	Full-Time HSSE Employees	74

High percentages of the identified employee groups indicated that they did not hesitate to report actions or conditions that raised a process safety concern, even when co-workers were involved. Contractors were, however, less likely to respond in that manner and, in fact, 20 percent of that group disagreed or tended to disagree that they did not hesitate to report.

Table 25

“I do not hesitate to report actions or conditions that raise a process safety concern, even when a co-worker is involved.”	Whiting Group	Percentages of Agree/Tend to Agree Response
	Operations Management	99
	Maintenance Management	97
	Full-Time HSSE Employees	97
	Engineering Professionals	97
	Operators	90
	Maintenance/Craft Technicians	82
	Contractors	69

Finally, consistent with the sentiment that hourly workers expressed during interviews, high percentages of contractors and employees in most of the process safety functional groups indicated their impression that operators were empowered to shut down potentially unsafe operations. Although only 58 percent of surveyed maintenance/craft technicians agreed or tended to agree, 29 percent responded that they did not know or have an opinion, and thus, only 13 percent actually responded negatively.

Table 26

“Operators are empowered to take corrective action as soon as possible (including shutting down when appropriate) if . . . process safety-related devices fail or become unavailable during operation.”	Whiting Group	Percentages of Agree/ Tend to Agree Responses
	Operations Management	92
	Maintenance Management	88
	Full-Time HSSE Employees	84
	Engineering Professionals	81
	Operators	79
	Contractors	77
	Maintenance/Craft Technicians	58

Data from Whiting on other survey items reveal some potential safety culture weaknesses. For example, many employees in certain process safety functional groups indicated that there were inadequate resources for process safety programs. As seen in the table below, more than 40 percent of HSSE employees expressed a belief that the refinery’s process safety programs had an inadequate number of people responsible for process safety and inadequate funding. More than 20 percent of engineering professionals and operators shared this belief, as did between 19 and 20 percent of maintenance/craft technicians and operations-management. Maintenance management and contractors, however, responded positively overall.

Table 27

"In my opinion, process safety programs at my refinery have: [A]. An adequate number of people responsible for process safety [B]. Adequate funding."	Whiting Group	Percentages of Disagree/Tend to Disagree Responses A	B
	Full-Time HSSE Employees	41	44
	Engineering Professionals	24	31
	Operators	22	26
	Maintenance/Craft Technicians	19	20
	Operations Management	19	19
	Maintenance Management	9	12
	Contractors	9	5

Finally, relatively high percentages of certain employee groups indicated a belief that they could not influence process safety policies at the Whiting refinery. Negative response rates exceeded 25 percent for maintenance/craft technicians and operators, and they were just under 20 percent for contractors and HSSE employees. In contrast, maintenance management, engineering professionals, and particularly operations management responded more positively, as reflected by the low percentages of negative responses in Table 28.

Table 28

"I feel that I can influence the process safety policies implemented at this refinery."	Whiting Group	Percentages of Disagree/Tend to Disagree Responses
	Maintenance/Craft Technicians	38
	Operators	26
	Contractors	18
	Full-Time HSSE Employees	18
	Maintenance Management	12
	Engineering Professionals	10
	Operations Management	3

While the data indicate a mixed process safety culture at Whiting, all interviewed constituencies at that refinery—site management, the unionized employees, and contractors—believe that the refinery's process safety culture is improving.

Texas City process safety culture. BP's Texas City refinery has had a troubled process safety culture history. While the Panel did not conduct a detailed historical analysis, the Panel observed that Texas City's safety culture problems were very serious and appear to have gone back many years, pre-dating BP's merger with Amoco. The Panel also noted that following the March 2005 accident, BP initiated many changes at Texas City, and these appear to be making the safety culture at the refinery better. Perhaps even more importantly, BP shut down the entire refinery in September 2005 in anticipation of Hurricane Rita. The refinery remained completely out of operation for six months while BP conducted a comprehensive inspection and review of the facility. BP did not begin to start the refinery process units back up until March 2006, and given the size and complexity of Texas City, units will continue to be started back up into 2007. It appears to the Panel that BP's conduct in connection with the restart of Texas City is having a significant impact on the process safety culture in that refinery. Many of the managers interviewed after the commencement of the start-up credit the following directives as having a positive influence on the process safety culture:

- no unit in Texas City would be started back up until every vessel, tank, and piece of equipment in that unit has been inspected, and the inspection approved;
- no unit will be started back up until everyone working on it is confident that it is safe;
- anyone has the right and obligation to shut down a unit or delay the start-up of a unit if there is any concern that it is unsafe; and
- if there are any more significant process safety incidents, the refinery might get shut down permanently.

Perhaps more important than what BP has said is what it has done. Interviews indicate that BP only brought units in the refinery back up following engineering authorities' careful inspection of every piece of equipment. In addition, BP announced in late 2005 that it would spend $1 billion in Texas City during the next five years.[43] The independent cultural expert whom BP retained pursuant to BP's OSHA settlement recently made the following conclusion based upon its preliminary assessment of Texas City:

> The manner in which management has dealt with the shutdown post-Hurricane Rita and the subsequent restart of the refinery has had an enormous positive impact on people's trust of management's message. The combination of action and communication has penetrated the resignation and cynicism of the workforce and begun to build a momentum toward a positive future where workplace safety is paramount.

Because of the apparent shift in safety culture that is occurring in 2006, the Panel believes it important to note when various information relating to Texas City was collected. BP's documentation, including past surveys, gHSEr audits, HRO assessments, and third-party analyses, reflect the state of safety culture at Texas City at the time those documents were prepared. The Panel's staff interviewed hourly workers and contractors in late January and early February 2006, before the start-up began, and interviewed refinery management in May 2006, when the start-up was underway. The process safety culture survey was administered in May 2006.

BP's own assessments, audits, and studies pointed out serious weaknesses in Texas City's safety culture. For example,

- BP's South Houston business unit, which at the time included the Texas City refinery, was the subject of a "Good Practice Sharing Assessment" conducted in 2002.[44] The assessment report contains several observations related to leadership and tolerance of non-compliance at Texas City, noting that "it is observed that the site often thrives on 'train wrecks' as opposed to focusing on meticulous planning and being boringly efficient."[45]
- South Houston's 2003 gHSEr Audit Report also highlights safety culture as one of the report's four "most important gaps."[46] The audit team, composed of BP employees from outside Texas City, concluded that a " 'checkbook mentality,' blame, and status culture exists throughout most of the Texas City Site; and this limits HSE and general performance."[47]
- The Stanley Report described a "silo culture" at Texas City in which work groups functioned independently rather than collaboratively. It also found a "[c]omplacency towards serious process safety risk, driven by a lack of awareness of potential consequences,"[48] along with a failure to "hold people at all levels at the refinery accountable for executing defined processes and procedures resulting in a tolerance for non-compliance with these processes and procedures."[49]
- The Mogford Report contains a discussion of five "underlying cultural issues":[50] (1) a lack of clearly defined and broadly understood context and business priorities; (2) the lack of safety and basic operations as a priority; (3) unclear accountabilities and inadequate communication because of a complex organizational structure; (4) the inability to see risk; and (5) the lack of a holistic early warning system for process safety exposures. The report concluded that "a poor level of hazard awareness and understanding of process safety on the site resulted in people accepting levels of risk that are considerably higher than comparable installations."[51]
- The Texas City refinery commissioned a study that was conducted by the Telos Consulting Group to better identify and understand cultural issues at the refinery, and a report summarizing the results of that study was issued in January 2005. Texas City's plant manager's summary of the Telos findings indicated that (1) the site has had a greater safety focus over the past two years,

(2) accountabilities for protection were unclear and sometimes conflicting, (3) concern about the condition of the assets and infrastructure existed, (4) HSSE procedures were perceived as complex, and (5) training was inadequate in terms of quality, quantity, and delivery.

- Texas City's 2005 HSSE Business Plan noted as among the key risks that "safety not being viewed as the #1 priority" and that the site "kills someone in the next 12-18 months."

BP commissioned several of the assessments listed above specifically to identify and help address what BP recognized as significant safety culture issues at Texas City. The Texas City refinery implemented a number of plans and initiatives to improve the safety culture, but it appears to the Panel that they were largely ineffective.

A significant reason for the safety culture issues at Texas City is the pervasive, long-standing mistrust among the various constituencies at the refinery. Refinery-level interviews and various BP documents establish that conflict between management and the union, between the union and contractors, and, to a lesser extent, between management and the contractors, marks the culture at the Texas City refinery. The Texas City refinery evidently has a history of difficult relations with the union that long pre-dates BP's merger with Amoco. Disputes between labor and management from many years ago remain fresh in the minds of many employees in Texas City. For example, many operators interviewed reported that a number of the safety-related problems at that refinery stem from Amoco's elimination of the unionized chief operator position back in 1985. As the Mogford Report noted, "high distrust between leadership and the workforce had developed over a number of years. . . ."[52] That distrust has permeated the environment in the Texas City refinery for years.

Significant tension also appears to exist between the union and contractors in the Texas City refinery. Many of the unionized workforce interviewed believed that the non-unionized contractors are taking jobs away from the union. Most operators interviewed believe that the contractors perform substandard work. Many of the union workers and the contractors interviewed reported their belief that they were held to a higher safety standard than the other group. Moreover, many of the hourly workers interviewed indicated that contractors were not fluent in English and that this lack of fluency created an additional barrier to good relations. The Mogford Report also notes the "poor working relationship" between employees and contractors.[53]

Overcoming these deeply-rooted tensions in Texas City will be critical in establishing a good safety culture. The Panel agrees with the conclusion in the August 2006 report prepared by the organizational expert retained by BP under the 2005 OSHA settlement:

> One of the challenges to be addressed at Texas City is the divide among different communities—union and management, refining and chemical, union and contractors, office and plant, etc. These divides are historical in nature and largely based in myth, story and prejudice. In order to build a first-class, safe site, it will be important for BP management to find creative and innovative ways to build bridges between these communities and to become intolerant of attitudes and behaviors that are counter-productive to a strong safety culture. These divides also use up a certain amount of "air time" and drain what could be constructive energy into non-constructive conversations. While addressing these kinds of cultural issues is a difficult and often long journey, it is critical to the future of Texas City to set out on this path.

Interviews also confirmed that Texas City has a long-ingrained culture of noncompliance with HSSE policies and procedures.[54] Hourly workers interviewed reported that prior to the ISOM accident, policies and procedures commonly were not followed, and they explained that generally Texas City fostered a culture of "casual compliance." Many management employees interviewed echoed this concern and additionally explained that no one enforced the consistent implementation of policies and procedures.

Many of the hourly workers interviewed in January and February 2006 reported their belief that "profit comes before safety" and that they were encouraged to perform their work in a safe manner unless it interfered with production or profit. Hourly workers interviewed also generally appeared to have little awareness of process safety; refinery-level interviewees indicated that both refinery management and hourly workers had a much greater focus on personal safety than process safety. Hourly workers almost uniformly reported their belief that first Amoco, and then BP, was unwilling to spend adequate money to maintain the refinery properly and that budgetary restraints prevented the refinery from being staffed properly.

The hourly workers interviewed also expressed concern about first level leaders and supervisors. Many hourly workers indicated their perception that BP rewarded or punished those managers based on the commercial performance of their units and that this reward/punishment system contributed to a culture among mid-level supervisors of ignoring safety issues. Moreover, some hourly workers perceived that first level leaders and supervisors in Texas City were selected on the basis of their relationship with superintendents as opposed to their qualifications, had entrenched positions, and were given considerable leeway in running their units. In their opinions, a "good old boy network" has long existed in which some people are free to cut corners and disobey safety processes and procedures without fear of retribution. Additionally, many hourly workers characterized Texas City as having for many years separate "fiefdoms" or "kingdoms." Some reported that they did not raise safety-related issues and concerns out of fear of retribution from first level leaders and supervisors, and many expressed a stark lack of trust and confidence in those levels of supervision.

Many interviewees, both hourly and management, also noted that the significant turnover of refinery plant managers had a negative impact on the process safety culture. According to those interviewed, the lack of continuity at that position, along with numerous reorganizations at the site, created blurred accountabilities and an inconsistent management focus.

Hourly workers interviewed also indicated substantial concerns about training and levels of process safety knowledge. They widely believed that the computer-based training was inadequate, and they noted how many have learned to manipulate the computer testing (for example, by taking a test, seeing the correct answers, and then retaking the same test). Hourly workers also provided instances in which supervisors took the training tests for workers.

Some hourly workers interviewed traced the decline in training, as well as the state of process safety generally, to Amoco's elimination of the chief operator position, an hourly position that monitored the unit and supervised the operators. Hourly workers making this comment indicated their belief that they were more comfortable reporting process safety concerns to chief operators; they also said they believed that chief operators were more free to discipline operators and that gun drills in which hypothetical problem scenarios were posed to operators to test their response were conducted more frequently under chief operators.

Some hourly workers also complained that safety policies were sometimes vague, with implementation being left to first level leaders and supervisors. According to those interviews, this vagueness allows each superintendent or supervisor to interpret these policies differently from unit to unit and shift to shift, depending on who was working at the time, resulting in differing degrees of effectiveness in implementing safety policies.

Many hourly workers also reported significant hostility toward contractors. These hourly workers indicated they believed that contractors took "no ownership" in the plant or the units, that contractors' work was inadequate and presents safety risks, and that language barriers with contractors impede effective communication between employees and contractors.

The refinery management interviews conducted approximately four months later confirmed many of the hourly workers' impressions about conditions in the past. A significant number of these managers agreed that for many years Texas City had viewed production as a higher priority than safety, maintenance at the plant had not received adequate funding, training generally had been inadequate, and the refinery had significant process safety deficiencies.

All levels of management reported their belief, however, that a significant shift in safety culture had occurred since the commencement of the start-up in March 2006.[55] They also reported their belief that hourly workers now felt that their refinery was serious about process safety and that production would no longer take priority over safety. Moreover, almost all managers interviewed indicated that during the start-up process a change had occurred in management's willingness to listen to the workforce and that the workforce now believed that virtually every decision takes into account safety implications. Managers described a number of instances in which the refinery delayed the start-up to make sure that a relatively minor process safety issue could be resolved, and they uniformly indicated that this type of decision-making likely would not have occurred in the past. They also explained how Texas City was revamping its training programs by adding trainers and moving away from its heavy reliance on computer-based training. While there appeared to be great uncertainty about whether these changes would last, managers at all levels gave credit to BP for how it conducted the start-up, the funding the company has committed, and the consistent safety message from refinery leadership in 2006—all of which have contributed to a change in the direction of safety culture at Texas City.

Responses to the process safety culture survey, administered in May 2006, reflect the long road BP has to travel to nurture a positive safety culture in the Texas City refinery. For example, on 62 of the 65 survey items, the nine process safety functional groups at Texas City yielded positive response rates that were lower than the average positive response rate for the nine process safety functional groups across the five U.S. refineries.

Like the relatively low positive response rates at Texas City, corresponding high negative response rates reveal perceptions of several potential process safety cultural weaknesses, some of which are similar to sentiments expressed during refinery interviews. For example, as indicated in the table below, relatively high percentages of contractors, maintenance/craft technicians, and operators expressed a belief that in their work groups, process safety concerns were secondary to achieving production goals. As also indicated below, however, HSSE employees, engineering professionals, maintenance management, and operations management were more positive regarding the prioritization of process safety concerns.

Table 29

	Texas City Group	**Percentages of Agree/Tend to Agree Responses**
"In my work group, process safety concerns are secondary to achieving production goals."	Contractors	46
	Maintenance/Craft Technicians	37
	Operators	33
	Full-Time HSSE Employees	15
	Engineering Professionals	11
	Maintenance Management	11
	Operations Management	7

Again similar to interviewees, many survey respondents indicated their impression that at Texas City, minor process-related incidents, accidents, and near misses were going unreported. Representative responses are contained in Table 30 below.

Table 30

	Texas City Group	Percentages of Agree/Tend to Agree Responses
"In general, workers don't bother to report minor process-related incidents, accidents, or near misses."	Contractors	61
	Maintenance/Craft Technicians	56
	Operators	47
	Maintenance Management	38
	Full-Time HSSE Employees	36
	Engineering Professionals	31
	Operations Management	29

While responses to items regarding beliefs about testing and maintenance of process equipment were more favorable than the responses provided above, they nonetheless indicate that segments of the Texas City workforce perceived potential deficiencies in the frequency with which equipment was tested and maintained. Responses from contractors, maintenance/craft technicians, and operators were particularly negative. On the other hand, responses from operations management, HSSE employees, engineering professionals, and maintenance management generally were more positive, especially in regard to the testing of process equipment.

Table 31

	Texas City Group	Percentages of Agree/Tend to Agree Responses	
		A	B
"Process equipment is not regularly: [A]. Tested [B]. Maintained."	Contractors	42	41
	Maintenance/Craft Technicians	31	34
	Operators	26	33
	Operations Management	15	19
	Full-Time HSSE Employees	12	12
	Engineering Professionals	11	21
	Maintenance Management	11	17

Finally, surveyed employees and contractors tended to echo interviewees' sentiments regarding training. For example, more than one-third of maintenance/craft technicians, contractors, and operators indicated that the training they had received did not provide them with a clear understanding of process safety risks at the Texas City refinery. Between 17 percent and 26 percent of operations management, HSSE employees, engineering professionals, and maintenance management responded in the same manner.

Table 32

"The training that I have received does not provide me with a clear understanding of the process safety risks at my refinery."

Texas City Group	Percentages of Agree/Tend to Agree Responses
Maintenance/Craft Technicians	42
Contractors	39
Operators	35
Maintenance Management	26
Engineering Professionals	20
Full-Time HSSE Employees	17
Operations Management	17

The Panel believes that the survey responses reflect a need for continued cultural change at Texas City and that interviews convey uncertainty about whether the improvements that so many perceived with respect to the refinery's start-up will be temporary or permanent. As one senior manager in Texas City recently stated, "Now the culture is changing, but it needs to be sustained. If we were to stop now, the old culture would be more prevalent in six months."[56]

Toledo process safety culture. The Toledo refinery, which BP has owned far longer than the other four U.S. refineries, has a weak safety culture. The refinery has a history of poor communications; distrust between management, the union, and contractors; and significant management turnover. Toledo's unionized hourly workers have poor morale and are generally far more pessimistic than Toledo's management about the refinery. That being said, Toledo's management generally is more negative than management at the other refineries about issues concerning process safety culture.

BP's own assessments of Toledo reflect the refinery's significant process safety culture weaknesses. An October 2002 gHSEr audit of Toledo found that a "strong perception of production and cost over safety" existed, that "leaders do not actively encourage reporting of all incidents and employees noted reluctance or even feel discouraged to report some HSE incidents," and that a heavy reliance was placed upon experience and knowledge, not systems and procedures.

A third-party consulting firm authored an assessment of Toledo in June 2004 and made the following conclusions:

- "Safety, as a value, does not exist in and throughout the leadership and the organization."
- "Consistently, cost and production are said to override safety concerns."
- "The poor relationship between the union and management must be addressed."
- "There is significant individual cynicism within the refinery; this individual cynicism is extensive and promotes an organizational cynicism. The industry has said safety is number one for years, when it really was not and the workforce knew it."

The assessment noted that these problems and issues were very deeply rooted. While observing that many commended the then-plant manager for her focus on safety, the assessment added that many "remained cynical as to whether or not [the plant manager] can overcome years of cost cutting, production push, management turnover, lack of continuity, and unsafe work habits that had eclipsed the refinery environment." The consulting firm's assessment went on to discuss Toledo's "toleran[ce] of non-conforming behaviors" at all levels of the refinery, bad morale and apathy, hostility between the unionized workforce and management, and a lack of accountability or consequences for noncompliance.

The interviews of Toledo hourly workers and management revealed perceptions of a poor safety culture that was plagued with morale issues, worker conflicts, and refinery operations that were neglected and underfunded. Responses to the process safety culture survey largely substantiated these perceptions.

The Toledo refinery has a history of tension between management and the unionized BP employees, and between the unionized BP employees and contractors. Management and the unionized BP employees have had a rather adversarial relationship over the years, and distrust between them continues. A 2004 report by a third-party consultant noted that most of the people interviewed for the report agreed that "the level of awareness and approach to safety is fragmented across the plant" for a number of reasons, including "distinct cultures of BP and the union that have not been well-integrated." The report summarized that

> [m]ost say that the level of trust between the union and management is not good while others say it is almost nonexistent. This relationship is described as adversarial and said to curtail the possibility of issues being openly discussed, whether they pertain to safety or not, for fear of retribution.

Many of the interviews of Toledo hourly workers and management confirmed the ongoing union-management tension at that site. Many hourly workers and managers interviewed characterized the union-management relationship as strained; some described it as toxic. Almost everyone interviewed agreed that this tension permeated the refinery and contributed to the lack of trust between refinery management and the workforce. The Panel concurs with a third-party consultant's conclusion that if Toledo is to make sustained progress on its safety culture, "the poor relationship between the union and management must be addressed."

Substantial tension also exists in Toledo between the unionized workforce and contractors. The hostility between the unionized BP employees and the maintenance contractors apparently can be traced to the refinery's decision in the 1990s to reduce the size of its in-house maintenance department and move towards contractors as the primary maintenance workforce. According to the interviewees, many hourly employees believed that the contractors did not have the necessary skills, did not understand the equipment, and did not take ownership in the refinery the same way that employees do. At the same time, contractors interviewed stated that BP's in-house maintenance workers refused to perform difficult jobs or work hard, and many BP managers interviewed shared this view of in-house maintenance workers.

Toledo has had four refinery plant managers in the last six years, and it has experienced substantial turnover of superintendents and engineers as well. According to many interviewees, this turnover has harmed morale, raised questions as to BP's commitment to the refinery, and negatively impacted the employees' willingness to buy into and accept new initiatives—including safety initiatives. The workforce is aware that BP contemplated selling the Toledo refinery at different times between 2000 through 2004, and many remain unconvinced that the refinery fits into BP's long-term plans. Moreover, many of the interviewees perceive that each new leadership team has had a different focus that is usually short-term oriented (cost-cutting and reorganization two plant managers ago, personal safety one plant manager ago, and now, equipment reliability with the current plant manager), making it difficult to establish with the workforce a shared vision about process safety as a core value. Many interviewees also reported that the frequent turnover of refinery plant managers had contributed to an alienation between upper refinery management and the hourly workers.

The interviews of the Toledo workforce revealed numerous issues reflecting a poor safety culture at that refinery:

- Most hourly workers interviewed indicated they believed that refinery management placed a higher priority on production than safety.
- Many hourly workers and managers interviewed indicated they believed that Toledo was underfunded and received inadequate corporate attention and support because of its small size.
- Many hourly workers interviewed indicated they did not believe that incidents, near misses, and safety concerns could be freely raised without fear of reprisal.
- The vast majority of employees interviewed indicated they believed that the refinery was generally understaffed, and that this had caused people to assume positions before they were qualified.

- Hourly workers interviewed largely believed that maintenance was "run by the numbers," with machinery and equipment not getting repaired or replaced because of budgetary constraints, and some managers shared that belief.
- Many hourly workers and managers interviewed expressed the belief that incident investigations were flawed, superficial, and tended to blame workers as the root cause of incidents.
- Many interviewees also complained of outdated procedures, inadequate training, and a general lack of accountability for safety.

Many of the Toledo managers interviewed acknowledged the beliefs of the hourly workforce, but in many instances they claimed that the hourly workers were simply wrong. For example, management interviewees generally recognized the hourly worker perception that maintenance was poorly performed and limited by budgetary constraints, but they asserted that the maintenance function was well performed, properly handled, and has had ever-increasing budgets since 2002. These widely divergent perceptions highlight the poor communication and lack of trust between management and the hourly workers in the refinery. Based upon the Panel's interviews, it is apparent that the hourly workers generally have low morale, distrust management, and do not believe that safety is a high priority.

The low morale that most of the hourly workers in Toledo reported—whether because of management turnover, workforce-management tension, understaffing, perceived unfair incident investigations, poor maintenance, or uncertainty about BP's commitment to the refinery—was generally reflected in the process safety culture survey data from Toledo. Responses from Toledo were frequently less positive than responses from the other refineries. Indeed, on 56 of the 65 survey items, Toledo's nine process safety functional groups yielded positive response rates that were lower than the average positive response rate for BP's five U.S. refineries. For 18 of those items, the positive response rate for Toledo's nine process safety functional groups was at least 10 percentage points lower than the refinery-wide average.

Toledo survey respondents were particularly likely to express negative perspectives regarding process safety reporting, commitment to process safety, and worker professionalism and empowerment. As the tables below demonstrate, operators and maintenance/craft technicians tended to express the most negative perceptions of these cultural aspects, whereas operations management tended to express the most positive perceptions.[57] This response trend suggests a disconnect at Toledo between hourly workers and management.

The following table captures negative response rates from the identified employee groups and contractors regarding various aspects of process safety reporting at the Toledo refinery. As indicated, there were some high negative response rates.

Table 33

	Toledo Group	Percentages of Disagree/Tend to Disagree Responses
"This refinery provides adequate training on hazard identification, control and reporting."	Contractors	57
	Maintenance/Craft Technicians‡	44
	Operators	27
	Full-Time HSSE Employees‡	26
	Operations Management	16
	Engineering Professionals	11
"I am confident that process safety issues are . . . [a]ppropriately resolved."	Maintenance/Craft Technicians‡	50
	Operators	45
	Full-Time HSSE Employees‡	21
	Contractors	19
	Engineering Professionals	19
	Operations Management	19
"I am satisfied with process safety reporting system at this refinery."	Maintenance/Craft Technicians‡	40
	Operators	38
	Full-Time HSSE Employees‡	26
	Contractors	20
	Engineering Professionals	19
	Operations Management	7

‡ Fewer than 25 respondents were in this group.

Some of Toledo's negative response rates were similarly high for survey items addressing the refinery's commitment to process safety. Operators and maintenance/craft technicians were most likely to respond negatively to the three items highlighted in the table below. In fact, more than 40 percent of those groups responded negatively from a process safety perspective. Several other work groups yielded negative response rates exceeding 20 percent; however, there were a few groups that provided fairly positive results, as reflected by the somewhat low percentages of negative responses below.

Table 34

	Toledo Group	Percentages of Disagree/Tend to Disagree Responses
"Refinery management puts a high priority on process safety through actions and not just empty slogans."	Operators	54
	Maintenance/Craft Technicians‡	44
	Contractors	26
	Full-Time HSSE Employees‡	26
	Engineering Professionals	19
	Operations Management	12
"Operational pressures do not lead to cutting corners where process safety is concerned."	Operators	49
	Maintenance/Craft Technicians‡	44
	Contractors	36
	Engineering Professionals	27
	Full-Time HSSE Employees‡	16
	Operations Management	14
"At this refinery, process safety improvement is a long-term commitment that is not compromised by short-term financial goals."	Maintenance/Craft Technicians‡	56
	Operators	45
	Full-Time HSSE Employees‡	21
	Engineering Professionals	19
	Operations Management	19
	Contractors	13

‡ Fewer than 25 respondents were in this group.

Finally, there were also mixed responses to items regarding worker professionalism and empowerment at the Toledo refinery. Responses from maintenance/craft technicians, operators, and in some cases contractors were the most negative. Of particular note, 52 percent of operators, 50 percent of maintenance/craft technicians, and 49 percent of contractors expressed a belief that they could not challenge process safety-related decisions by refinery management without fear of negative consequences. As indicated in the table below, other groups' responses to that item were also quite negative, albeit to a lesser degree. There was not, however, a consistent trend in responses to the other two survey items. Some of the negative response rates were fairly high (*e.g.*, 49 percent), and some were fairly low (*e.g.*, seven percent).

Table 35

	Toledo Group	Percentages of Disagree/Tend to Disagree Responses
"I feel that I can influence the process safety policies implemented at this refinery."	Operators	39
	Maintenance/Craft Technicians‡	31
	Engineering Professionals	19
	Full-Time HSSE Employees‡	16
	Operations Management	12
	Contractors	8
"When a process safety issue is involved, I can challenge decisions made by [refinery management] without fear of negative consequence."	Operators	52
	Maintenance/Craft Technicians‡	50
	Contractors	49
	Engineering Professionals	30
	Full-Time HSSE Employees‡	28
	Operations Management	24
"Creating unapproved shortcuts around process safety is not tolerated at my refinery."	Contractors	40
	Operators	35
	Maintenance/Craft Technicians‡	31
	Full-Time HSSE Employees‡	21
	Engineering Professionals	15
	Operations Management	7

‡ Fewer than 25 respondents were in this group.

The Toledo refinery's process safety culture weaknesses appear to be largely rooted in the mistrust between BP hourly workers and management and between BP hourly workers and contractors. The problems appear to have persisted despite the Toledo refinery's efforts to improve the process safety culture.

Summary of U.S. refinery process safety cultures. Each of BP's U.S. refineries has a unique process safety culture. The two ARCO-legacy refineries, Cherry Point and Carson, have healthier safety cultures than the others, with Cherry Point having a particularly strong safety culture due in part to geographic and historical influences. The positive safety culture at both of these refineries appears to pre-date BP's acquisition of ARCO. Even Cherry Point and Carson, however, have some significant process safety culture issues. Whiting's safety culture is far more mixed, but appears to be improving. Texas City long had the poorest safety culture of the five, but as a result of BP's commitment of resources, improved safety message in 2006, and most importantly, slow and deliberate restart of the refinery following thorough inspections, the safety culture at that refinery appears to be changing for the better. Toledo has a weak safety culture, largely because of chronic morale problems and a history of poor relations between refinery management and the unionized workforce.

Finding:

Each of BP's five U.S. refineries has its own separate and distinct process safety culture. Some are far more effective than others in promoting process safety, but significant process safety culture issues exist at each of BP's five U.S. refineries, not just Texas City.

SHARED PROCESS SAFETY CULTURE ISSUES

Although the refineries do not share a common process safety culture, they do share similar process safety cultural weaknesses. Based upon the interviews of the refinery workforce, the process safety culture survey, the technical reviews that the Panel's consultants performed, and a review of BP documents, the Panel finds that of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks existed at each of BP's U.S. refineries.

Texas City. Deviations from safe practices, lack of operating discipline, and apparent complacency toward serious process safety risk at the Texas City refinery have been well chronicled in a variety of BP documents. For example, the Mogford Report observed that at Texas City

> [t]here was a general inability to see key process risks, and both management and the workforce appear to routinely tolerate a high level of risk. Numerous observations pointed to a high level of risk having become accepted. This was largely due to poor hazard/risk identification skills throughout management and the workforce, exacerbated by a poor understanding of process safety.[58]

The Mogford Report further concluded that "[s]upervisors and [s]uperintendents did not verify that procedures were available and correct or being followed. . . . In general, employees were unaware of the risks of operating without procedures...."[59]

The Stanley Report similarly includes among its key findings complacency toward serious process safety risks and a lack of awareness of risk reflected in day-to-day operational activity.[60] That report also notes that "[i]nconsistent compliance with rules and procedures across the refinery has reduced the effective management of risks that the procedures are designed to address."[61] Various other documents reflect these same issues at Texas City.[62]

Interviews of the Texas City workforce, particularly hourly workers, indicated that workers often did not follow policies or procedures. Interviewees cited a number of reasons for this, including a lack of training regarding applicable policies and procedures, a lack of knowledge regarding where to locate a particular policy, and insufficient time to follow procedures called for by applicable policies. Many hourly workers explained that prior to March 2005, policies were not enforced strictly and few consequences existed if an employee did not follow a policy.

Like the interviews, certain survey responses support the conclusion that the Texas City refinery accepts deviations from safe practices and appears to be complacent toward serious process safety risk. As shown below, for example, toleration of deviations from safe operating practices is indicated by the relatively high percentages of the identified employee groups and contractors who expressed a belief that workers sometimes worked around process safety concerns rather than report them.

Table 36

	Texas City Group	Percentages of Agree/Tend to Agree Responses
"Workers sometimes work around process safety concerns rather than report them."	Maintenance Management	61
	Maintenance/Craft Technicians	52
	Operators	50
	Contractors	50
	Full-Time HSSE Employees	48
	Operations Management	45
	Engineering Professionals	44

Across BP's five U.S. refineries, an average of 37 percent of all employees in the nine process safety functional groups responded negatively to the item described above. While that percentage is somewhat high, the average negative response rate at Texas City is even higher—50 percent. Noteworthy is that 61 percent of Texas City's maintenance management indicated that workers sometimes worked around process safety concerns. The comparable response rates at other refineries ranged from seven percent to 21 percent.[63]

Relatively high percentages of employees in certain process safety functional groups also responded negatively to two companion survey items addressing whether written operating procedures were followed regularly and kept up to date. Specifically, 22 percent of maintenance management and 21 percent of HSSE employees conveyed their perceptions that operating procedures were not followed regularly. In addition, 47 percent of the operators and 33 percent of operations management expressed a belief that procedures were not kept up to date overall. Unlike these employee groups, however, contractors provided a low negative response rate of 11 percent and, concurrently, responded more positively.

Finally, relatively high percentages of contractors and employees in several process safety functional groups expressed a belief that the Texas City refinery tolerated unapproved shortcuts around process safety. The highest negative response rates from the nine process safety functional groups came from maintenance/craft technicians (42 percent) and operators (33 percent). Many other respondent groups provided negative response rates in excess of or approaching 20 percent—26 percent for HSSE employees; 24 percent for contractors; 22 percent for maintenance management; 21 percent for engineering professionals; and 18 percent for operations management.

Different from the response trends described above, Texas City employees generally responded positively to two companion survey items addressing whether supervisors ensured that procedures relating to operations and maintenance were safe before such activities were initiated. In that same regard, there were generally low negative response rates from operators, HSSE employees, engineering professionals, operations management, and maintenance management.

Toledo. The Panel's review of the Toledo refinery indicates the existence of similar deficiencies in operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks.

Several BP studies and assessments noted these issues at Toledo. An October 2002 gHSEr audit found that a "heavy reliance" was placed upon experience and knowledge, not systems and procedures. The gHSEr audit report contains several examples of noncompliance with procedures, including using job safety analysis procedures inconsistently, conducting maintenance work without the necessary permits, and board operators changing alarm set points without following required management of change procedures. The audit team further notes a "strong perception of production and cost over safety."

A 2005 behavioral safety culture assessment that a consultant conducted describes "the occurrence of at-risk behaviors and normalized deviations" at the Toledo refinery. The consultant further describes a perception among workers that safety is not the highest priority among the refinery workforce. The consultant notes a belief that equipment is run to failure or near failure and problems are not fixed "until something bad happens."

The Panel's interviews of members of the Toledo workforce, and particularly hourly workers, reflect these weaknesses. Many hourly workers interviewed expressed their belief that the prevailing culture tolerated noncompliance with processes and procedures, concerns about the adequacy of training on hazard identification, and lack of faith in the management system for identifying and reducing risk. Interviewees also described numerous instances in which refinery management ignored or dismissed hazards or safety concerns that hourly workers raised.

Data from the process safety culture survey also reflect some negative perceptions regarding acceptance of process safety risks at the Toledo refinery. For example, 39 percent of Toledo employees in the nine process safety functional groups indicated their impressions that workers sometimes worked around process safety concerns rather than reporting them. As indicated in Table 37, the negative response rates were relatively high for all nine groups, but the highest negative response rates came from maintenance/craft technicians (63 percent),[64] HSSE employees (47 percent),[65] engineering professionals (44 percent), and operators (44 percent).

Table 37

"Workers sometimes work around process safety concerns rather than report them."	Toledo Group	Percentages of Agree/ Tend to Agree Responses
	Maintenance/Craft Technicians‡	63
	Full-Time HSSE Employees‡	47
	Operators	44
	Engineering Professionals	44
	Contractors	31
	Operations Management	23

‡ Fewer than 25 respondents were in this group.

As addressed earlier in this section, contractors, operators, maintenance/craft technicians, and HSSE employees were also somewhat likely to express a belief that the Toledo refinery tolerated unapproved shortcuts around process safety. Engineering professionals and operations management, however, responded more positively.

Furthermore, relatively high percentages of contractors and employees in certain process safety functional groups at Toledo also responded negatively to the two companion survey items addressing whether procedures related to operations and maintenance were made safe before such activities were initiated. Contractors and maintenance/craft technicians provided particularly high negative response rates (ranging from 40 percent to 68 percent), but more than 20 percent of operators also responded negatively. Negative response rates were, however, much lower for operations management and engineering professionals, ranging from only 7 percent to 11 percent.

Finally, relatively high percentages of operators (22 percent) and maintenance/craft technicians[66] (50 percent) at Toledo expressed a belief that written operating procedures were not followed regularly. Similarly high rates of operators (31 percent) and maintenance/craft technicians (56 percent) [67] indicated a perception that written operating procedures were not kept up to date. On the other hand, there were several responses indicative of a different view. For example, engineering professionals and operations management responded positively overall and, similarly, provided low negative response rates that ranged from zero percent to 15 percent.

Whiting. BP documents indicate concern with operating discipline, noncompliance with procedures, and apparent complacency toward process safety risks. For example, a "Whiting Safety Culture" summary prepared in November 2004 noted that workers "tolerate[] too much risk in their activities and environment leading to working outside of the controls put in place to safeguard them." A 2005 behavioral culture assessment of Whiting reported conflicting messages about safety, ingrained deviation from certain safety requirements among workers, over-emphasis on output metrics rather than individual safety performance, and heavy workloads that appeared to prevent supervisors and team leaders from asserting strong safety leadership.

Interviews of Whiting hourly workers revealed issues with operating discipline, noncompliance with procedures, and apparent complacency toward process safety risks. Many hourly employees identified the absence of certain plant-wide safety practices as a major reason personnel fail to follow safe operating procedures. In the absence of uniform safety practices, safety expectations fluctuate sharply among the various process units and leave each unit to create, enforce, and maintain its own safety identity. One example that a number of interviewed hourly workers cited is the absence of a uniform Lock Out Tag Out policy (LOTO). Because no single policy is enforced, each unit applies its own LOTO policy, creating uncertainty for operators and contractors. Hourly workers also expressed concern that a number of new first level leaders are underqualified for their positions. This concern leads to situations in which many veteran employees disregard the instructions they receive from their inexperienced supervisors.

The technical consultants' findings relating to rupture disks on relief valves in the Whiting refinery further illustrates toleration of serious deviations from safe operating practices and apparent complacency toward serious process safety risks. See Appendix D for a more complete discussion of the Whiting rupture disk investigation.

Process safety culture survey data also suggest complacency toward process safety risk at the refinery. For instance, 37 percent of employees in the nine process safety functional groups, as a whole, expressed a belief that workers sometimes worked around process safety concerns rather than reporting them. Operators, HSSE employees, and maintenance/craft technicians provided the highest negative response rates, which ranged from 39 percent to 45 percent. As indicated below, other employee groups and contractors also provided negative response rates exceeding 20 percent.

Table 38

<table>
<tr><td rowspan="8">"Workers sometimes work around process safety concerns rather than report them."</td><th>Whiting Group</th><th>Percentages of Agree/Tend to Agree Responses</th></tr>
<tr><td>Operators</td><td>45</td></tr>
<tr><td>Full-Time HSSE Employees</td><td>41</td></tr>
<tr><td>Maintenance/Craft Technicians</td><td>39</td></tr>
<tr><td>Engineering Professionals</td><td>32</td></tr>
<tr><td>Operations Management</td><td>32</td></tr>
<tr><td>Contractors</td><td>29</td></tr>
<tr><td>Maintenance Management</td><td>21</td></tr>
</table>

In response to other survey items addressing safe operating practices, employees in the nine process safety functional groups at Whiting were more positive. This is reflected in part by the fact that they sometimes provided negative response rates that were lower than the average negative response rates for the nine process safety functional groups across BP's U.S. refineries. For example, when asked whether the refinery tolerated unapproved shortcuts around process safety, Whiting employees provided a 16 percent negative response rate, as compared to the five refinery average of 21 percent. Similarly, when asked whether supervisors ensured that procedures relating to operations and maintenance were safe before such activities were initiated, only ten percent of Whiting employees responded negatively, as compared to a 14 percent five-refinery average. Likewise, when asked whether written operating procedures were followed regularly, the average negative response rate for Whiting's employees was only ten percent, while the average for the five refineries was 14 percent.

Carson. The Panel's review suggests that certain process safety cultural problems are less significant at Carson than at Texas City, Toledo, or Whiting. For example, employees in several process safety functional groups at Carson tended to respond positively to the two companion survey items addressing whether written operating procedures were followed regularly and kept up to date. Unlike at Texas City and Toledo, where many employee groups provided negative response rates exceeding 20 percent, Carson's employee groups provided similarly high negative response rates in only two instances: more than 20 percent of operators and operations management indicated a belief that written operating procedures were not kept up to date.

The Carson refinery, however, appears to have some issues related to operating discipline, risk identification, toleration of deviations from safe operating procedures, and apparent complacency toward serious process risks. A third-party behavioral safety culture assessment that BP commissioned indicates that the Carson refinery suffers to some extent from normalized deviations from safety practices, although the assessment found these deviations to be more common in personal safety procedures. It also found a number of factors driving at-risk behavior at Carson: (1) a culture that does not accept failure, (2) the normalization of deviations from safety practices through repetition and the resulting failure to either recognize or report risk, (3) positive reinforcement of unsafe behaviors as well as the lack of positive reinforcement of safe behaviors, and (4) the open-endedness of procedures that invites individual interpretation.

Additionally, interviews with Carson employees revealed that employees may not fear disciplinary action from unsafe behavior because of a perception that the union will protect employees and that discipline will only occur when at-risk behavior results in an injury.

Data from the process safety culture survey also reveal perceptions among some contractors and employees that the Carson refinery tolerates noncompliance and is complacent regarding process safety risks. For example, as shown in Table 39, more than 20 percent of contractors and all but one of the six listed employee groups indicated an impression that workers sometimes worked around process safety concerns rather than report them. Maintenance management, however, responded more favorably, as reflected by their 17 percent negative response rate below.

Table 39

<table>
<tr><th></th><th>Carson Group</th><th>Percentages of Agree/Tend to Agree Responses</th></tr>
<tr><td rowspan="7">*"Workers sometimes work around process safety concerns rather than report them."*</td><td>Engineering Professionals</td><td>39</td></tr>
<tr><td>Contractors</td><td>38</td></tr>
<tr><td>Maintenance/Craft Technicians</td><td>34</td></tr>
<tr><td>Operations Management</td><td>32</td></tr>
<tr><td>Operators</td><td>29</td></tr>
<tr><td>Full-Time HSSE Employees</td><td>24</td></tr>
<tr><td>Maintenance Management‡</td><td>17</td></tr>
</table>

‡ Fewer than 25 respondents were in this group.

Also indicative of perceived noncompliance with operating procedures and complacency toward risk, 33 percent of maintenance management[68] expressed a belief that the refinery tolerated unapproved shortcuts around process safety. More than one-third of maintenance/craft technicians (35 percent) and contractors (34 percent) also responded in that manner. In contrast, HSSE employees, operations management, and engineering professionals provided relatively low negative response rates that reflect a more positive perspective of this process safety issue.

A similar data trend was evident in responses to the two companion survey items addressing whether supervisors ensured that procedures relating to operations and maintenance were safe before such activities were initiated. Maintenance management, maintenance/craft technicians, and contractors provided negative response rates ranging between 30 percent and 54 percent. Maintenance management yielded the highest negative response rates: 54 percent for the survey item related to operations procedures and 46 percent for the survey item related to maintenance procedures.[69] On the other hand, three of Carson's other employee groups—HSSE employees, engineering professionals, and operations management—provided much lower negative response rates for both items. This response trend helps to underscore the point that many employees at Carson expressed generally positive views regarding toleration of deviations from safe operating practices and complacency toward serious process safety risks.

Cherry Point. Like Carson, Cherry Point appears to have a stronger culture relating to operating discipline, toleration of deviations from safe operating practices, and complacency toward serious process safety risks than do the other refineries. Unique challenges, however, confront organizations or sites with generally strong safety cultures. Success, if it leads to overconfidence, ironically can be one of the forerunners of accidents. The strong safety culture at Cherry Point may inadvertently foster an overconfidence among refinery personnel.

For example, as discussed in greater detail in the technical consultants' report attached as Appendix E, at least two sources external to Cherry Point recommended changes to the refinery's inspection and testing program, especially with respect to the manner in which the site uses (or does not use) its inspection database—PCMS. A BP audit team first raised concerns around overdue inspections at Cherry Point during a 2002 Process Safety Management audit. During the Panel's review in 2006, the Panel's technical consultants concluded that the Cherry Point refinery extended the test intervals in PCMS for relief valves beyond the amount permitted by the refinery's inspection and testing procedure. The technical consultants also learned that the refinery does not use the schedules established by PCMS, but instead determines relief valve test intervals based on turnaround schedules and the individual judgments of refinery personnel.

Some managers at the refinery quickly rejected the conclusion of the Panel's technical consultants. However, because a BP audit team previously expressed similar concerns, the Panel's technical consultants believe that some individuals at the refinery are too confident in their systems, some of which have inherent limitations (such as relying on individual judgments of personnel to determine testing intervals). Such a resistance to external perspectives can undermine an otherwise strong safety culture.

Surveyed contractors and employees in the nine process safety functional groups at Cherry Point routinely responded more positively than their counterparts at BP's other refineries, but Cherry Point responses nonetheless revealed some pockets of concern. For example, 25 percent of operators indicated an impression that workers sometimes worked around process safety concerns rather than report them. In addition, 30 percent of maintenance/craft technicians expressed a belief that the refinery tolerated unapproved shortcuts around process safety. Finally, between 35 percent and 45 percent of contractors and maintenance/craft technicians disagreed or tended to disagree that supervisors ensured that procedures relating to operations and maintenance were safe before such activities were initiated.

Again, notwithstanding these apparent pockets of concern, Cherry Point personnel generally provided positive responses to survey items addressing deviations from safe operating practices and complacency toward serious process safety risks. Interviews of the Cherry Point workforce similarly revealed few issues with operating discipline, risk identification, tolerance of noncompliance, or risk complacency.

Finally, the Panel notes that BP has recently acknowledged this general deficiency in risk identification in the safety culture of its U.S. refineries. In August 2006, BP appointed Rick Porter, the refinery plant manager at Cherry Point, to the newly created position of Vice President of Operations Management System/Process Safety Management Program Implementation. As Porter explained to the Panel, one of the primary reasons BP created this new position was because it recognized that its refineries had "gotten to the point where they could not see risk" and as a result were taking risks that should not be acceptable. As Porter noted, the "normalized risk" across Refining was too great, and BP "needs to reset its values." While Porter's new role encompasses all of BP's global refineries, his initial focus will be on the U.S. refineries. Although the Panel is concerned with refinery plant manager turnover generally, the Panel commends BP for recognizing the need to address risk identification, the creation of a new position to champion risk identification (among other roles), and the selection of Porter to lead this effort.

Finding:

> ***Instances of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks existed at each of BP's five U.S. refineries.***

ENDNOTES FOR SECTION VI.A

[1] Meredith Armstrong Whiting and Charles J. Bennett, The Conference Board, *Driving Toward '0': Best Practices in Corporate Safety and Health* (Research Report No. R-1334-03-RR) (2003), p. 4 (emphasis in original).

[2] *Ibid*, p. 7 (emphasis in original).

[3] BP ascertained four primary cultural themes: (1) a focus on operations ("getting the basics right"); (2) a bias for continuity (recognizing that "change needs to be a deeply thought out process"); (3) a disciplined approach (requiring follow through, holding people accountable, and ensuring that systems are working over the long term); and (4) teamwork and inclusion (making everyone feel that their concerns matter).

[4] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 165.

[5] As discussed in Section I, the Panel generally does not report survey data for the maintenance/turnaround planners, learning-and development/training personnel, and project management groups individually, largely because small sample sizes hindered the Panel's ability to make inter-refinery comparisons. The Panel does, however, provide data from these groups when it is particularly relevant to the discussion at hand.

[6] BP p.l.c., Sir John Browne, Chief Executive, "Addressing global climate change," Address at Stanford University, May 19, 1997, pp. 2, 4. Then-Sir John acknowledged that "the concentration of carbon dioxide in the atmosphere is rising, and the temperature of the earth's surface is increasing." *Ibid*, p. 2. He outlined a five-step strategy to assist in lowering emissions including to control emissions, to fund scientific research, to take initiatives for joint implementation, to develop alternative fuels, and to contribute to the public-policy debate. *Ibid,* p. 3.

[7] Sir John Browne, "The Environment: A Progress Report," *World Energy,* Vol. 4, No. 1 (2001), p. 20-21.

[8] *See, e.g.,* Sir John Browne, "The Environment: A Progress Report," *World Energy,* Vol. 4, No. 1 (2001); BP p.l.c., Sir John Browne, Chief Executive, "Addressing global climate change," Address at Stanford University, May 19, 1997; BP p.l.c., "A Personal Commitment" (Interview of Sir John Browne), *Horizon* (June 2006); Sir John Browne, "Balancing Profit and Purpose," *World Energy*, Vol. 8, No. 1 (2005); and Sir John Browne, "Governance and Responsibility: A Progress Report," *World Energy*, Vol. 4, No. 2 (2001).

[9] Meredith Armstrong Whiting and Charles J. Bennett, The Conference Board, *Driving Toward '0': Best Practices in Corporate Safety and Health* (Research Report No. R-1334-03-RR) (2003), p. 5.

[10] BP p.l.c., "From the Top; Browne: Take Action to Put Safety First," *Horizon* (October 2000); BP p.l.c., "A Personal Commitment" (Interview of Sir John Browne), *Horizon* (June 2006), p. 10.

[11] BP p.l.c., "From the Top; Browne: Take Action to Put Safety First," *Horizon* (October 2000).

[12] BP p.l.c., "A Personal Commitment" (Interview of Sir John Browne), *Horizon* (June 2006), p. 10.

[13] During that interval, BP experienced two significant problems in its Exploration and Production business. On August 7, 2006, BP announced that it was partly closing its Prudhoe Bay, Alaska oil field after discovering corrosion in pipelines bringing oil to the Trans-American Pipeline system. BP p.l.c., Press Release, "BP to Shutdown Prudhoe Bay Oil Field," August 7, 2006. On September 18, 2006, BP announced that production from its Thunder Horse field in the Gulf of Mexico would be delayed until 2008 due to safety concerns stemming from the metallurgical failure of components in its oil platform. BP p.l.c., Press Release, "BP Says That Repair Of Subsea Equipment Will Delay Thunder Horse Until 2008," September 18, 2006. The Panel suspects that these integrity-related incidents may well have contributed to the change in Browne's perspective.

[14] *See* Section V.

[15] Thomas R. Krause et al., *The Behavior-Based Safety Process: Managing Involvement for an Injury-Free Culture* (United States: John Wiley & Sons, Inc., 2d ed. 1997), pp. 324-25.

[16] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 144.

[17] James Reason, "Achieving a Safe Culture: Theory and Practice," *Work & Stress*, Vol. 12, No. 3 (1998), pp. 302-03.

[18] *Ibid*, p. 302 (emphasis in original).

[19] Fewer than 25 respondents were in this group.

[20] *James Reason, "Achieving a Safe Culture: Theory and Practice," Work & Stress, Vol. 12, No. 3 (1998), pp. 302-03.*

[21] BP p.l.c., "getting HSE right Audit Report, BP South Houston, Audit No. 2003-41," September 22, 2003, p. 2.

[22] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 165.

[23] BP p.l.c. and A.T. Kearney, "Texas City Refinery Retrospective Analysis: Summary of Results," October 28, 2002, pp. 4, 9.

[24] *Ibid*, p. 9.

[25] *See ibid*, p. 4.

[26] *Ibid*, p. 3.

[27] Shortly after the release of the Kearney report, BP developed strategies for addressing some of the issues raised by the Kearney report. For example, BP developed South Houston Infrastructure for Tomorrow, which had the stated objective of "provid[ing] a safe working environment while restoring the operability, reliability, and profitability of the BPSH infrastructure to a sustainable License to Operate (LTO) state." Applying this plan, Texas City completed 21 projects in 2003 and 2004 at a cost of about $35 million. Additionally, Texas City created the Piping Integrity Program. The project's goals were, in part, to investigate pipe work failures, identify systemic causes contributing to those failures, and review and make recommendations for improving pipe work integrity.

[28] *See* BP p.l.c. and A.T. Kearney, "Texas City Refinery Retrospective Analysis: Summary of Results," October 28, 2002, p. 11.

[29] *See generally ibid*, p. 11.

[30] *Ibid*.

[31] *Ibid*.

[32] *Ibid*.

[33] The Telos Group, "BP Texas City Report of Findings," January 21, 2005, p. 31.

[34] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, pp. 60-61.

[35] *Ibid*, p. 145.

[36] BP p.l.c., John Mogford, Senior Group Vice-President, Safety & Operations, "The Texas City Refinery Explosion: Lessons Learned," Address at the Center for Chemical Process Safety, 2nd Global Congress on Process Safety, April 24, 2006, p. 1.

[37] Joel Podolny and John Roberts, *British Petroleum (A2): Organizing for Performance at BPX*, case study S-IB-16A2 (Graduate School of Business Stanford University, revised April 2, 2002), p. 7.

[38] *Ibid*.

[39] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 164; BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[40] The Panel does not believe that the BP Management Framework equates accountability with fault, and the Panel does not imply in any fashion that any particular person is at fault for the ISOM accident.

[41] Fewer than 25 respondents were in this group.

[42] Fewer than 25 respondents were in this group.

[43] BP p.l.c., Press Release, "BP Issues Final Report on Fatal Explosion, Announces $1 Billion Investment at Texas City," December 9, 2005.

[44] BP p.l.c., "Good Practice Sharing Assessment: BP South Houston Final Report," (August 2002).

[45] *Ibid*, p. 8.

[46] BP p.l.c., "getting HSE right Audit Report, BP South Houston, Audit No. 2003-41," September 22, 2003, p. 2.

[47] *Ibid*.

[48] BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[49] *Ibid*.

[50] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 163.

[51] *Ibid*, p. ii.

[52] *Ibid*, p. 153.

[53] *Ibid*.

[54] *See ibid*, p. ii; BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[55] By 2004, the former refinery plant manager and some senior managers recognized serious deficiencies in safety culture at the Texas City refinery. Interviewees at both the hourly and management levels at Texas City described the beginnings of a shift in safety culture prior to the March 2005 accident. However, it was not until after the March 2005 accident and the shutdown of the entire plant for Hurricane Rita that a significant positive shift in safety culture began to take place at Texas City.

[56] Nelson Schwartz, "Can BP Bounce Back?," *Fortune*, Vol. 154, No. 8, October 16, 2006.

[57] Maintenance management is not included in the following tables due to the small number of respondents (fewer than 15) in that group.

[58] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 141.

[59] *Ibid*, p. 81.

[60] BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[61] *Ibid*, p. 6.

[62] BP p.l.c., "Good Practice Sharing Assessment: BP South Houston Final Report," (August 2002), (noting that "the site often thrives on 'train wrecks' as opposed to focusing on meticulous planning and being boringly efficient" and expressing "serious concerns about the potential for a major site incident due mainly to the very large numbers of hydrocarbon escapes . . . .").

[63] Toledo's maintenance management personnel are not included in this comparison due to the small number of respondents (fewer than 15) in that group.

[64] Fewer than 25 respondents were in this group.

[65] Fewer than 25 respondents were in this group.

[66] Fewer than 25 respondents were in this group.

[67] Fewer than 25 respondents were in this group.

[68] Fewer than 25 respondents were in this group.

[69] Fewer than 25 respondents were in this group.

B. Process Safety Management Systems

Safety culture, as discussed elsewhere in this report,[1] plays an important role in process safety performance. A positive process safety culture is a necessary but not sufficient condition for effective process safety performance. Unless an organization also has a system—a "network of interdependent components that work together to try to accomplish the aim of the system"[2]—by which the organization's desire for effective process safety performance is translated into processes and procedures that can be managed, then the organization will not likely achieve or sustain a high level of process safety performance. As a result, if management has not implemented an effective process safety management system, an organization may have an overall positive process safety culture but still have relatively poor process safety performance. The literature[3] suggests, and the Panel believes, that the underlying or root causes of the large majority of process accidents are deficiencies in the systems that a facility uses to prevent these process-related accidents.

An effective process safety management system identifies, assesses, and prioritizes process hazards so that management can take appropriate measures to reduce the likelihood and/or severity of process-related incidents. The compliance guidelines to OSHA's process safety management standard describe process safety management as "the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in process, procedures or equipment."[4]

A management system has design, execution, and monitoring elements. Design elements lay out the structure and requirements for implementing process safety management activities. Execution elements describe the method and quality requirements for doing process safety work under the management system. Monitoring elements lay out the control system for ensuring that management system results meet the designed expectations. The failure to execute or monitor effectively a process safety management system, even if properly designed and even if an overall positive process safety culture exists, can result in poor process safety performance. Additionally, if the management system is to improve over time, the system should include a process for reviewing performance and ensuring the continued suitability, adequacy, and effectiveness of the system.[5]

Process risk management involves the interaction of various systems operating within an organization and various types of controls that relate to identifying, evaluating, and controlling process hazards and/or preventing process-related incidents. The process safety management system includes two types of control elements: hardware (such as engineered safety features and equipment, physical barriers, alarms, process design and technology), and software (such as standards, rules, operating and other procedures, training, drills, operational and maintenance activities, non-routine activities and procedures, supervisory oversight, and workers).[6] Because a process safety management system interacts with other organizational systems that continue to evolve, managing process risks also requires analysis of the impact of change on process hazards and on controls, both hardware and software, relating to those hazards.

In 2005, the American National Standards Institute (ANSI) approved "a voluntary consensus standard on occupational health and safety management systems."[7] While the standard is oriented toward occupational rather than process safety, the Panel believes that the standard provides a useful tool in analyzing safety management systems generally. The ANSI Z10 standard emphasizes "continual improvement and systematically eliminating the underlying or root causes of deficiencies."[8] The standard indicates that an organization's management should provide leadership and assume overall responsibility for

- implementing, maintaining, and monitoring performance of the safety system;
- providing appropriate financial, human, and organizational resources to plan, implement, operate, check, correct, and review the system;
- defining roles, assigning responsibilities, establishing accountability, and delegating authority to implement an effective system for continual improvement; and
- integrating the system into the organization's other business systems and processes.[9]

Finally, because the nature and scope of an effective safety management system touches so many parts of the organization in which it operates, the system necessarily needs to involve all parts of the organization, starting with the top of the organization and extending through various levels of management and ultimately to hourly workers, including both employees and contractors.

Evaluating BP's process safety management systems. In evaluating the effectiveness of BP's overall process safety management system, the Panel relied heavily on process safety management reviews of BP's five U.S. refineries that the Panel's technical consultants conducted. The Panel also relied to some extent on the process safety culture survey administered on behalf of the Panel, interviews of refinery-level and corporate-level management and personnel, and an examination of various documents.

In preparing for the process safety technical reviews, the Panel first developed a comprehensive scope of work based upon the CSB urgent recommendation, the Panel charter, applicable process safety regulatory requirements, and other aspects of process safety management that the Panel considered to represent best practices. The scope of work is included in the technical consultants' report, which is attached as Appendix E. In developing this scope of work, the Panel emphasized the importance of ensuring not only that BP's U.S. refineries had the appropriate process safety management systems in place, but also that those systems were not merely paper systems. In other words, the Panel sought a review of *actual* process safety performance at the refineries and the documentation of that performance.

For additional information relating to the scope of the reviews by the technical consultants, see Section I.

The Panel's goal in the evaluation process. The Panel's overriding goal in evaluating BP's corporate process safety management system was to determine the system's effectiveness in controlling process risk at BP's U.S. refineries as a basis for possible recommendations for improvement of that system. The Panel accomplished this goal through a multi-step process.

First, the Panel's technical consultants conducted reviews of BP's refineries. These reviews generated refinery-specific findings regarding process safety performance and management systems at the refineries. The technical consultants made a finding when they found a process safety deficiency that was determined either to exist broadly and systemically at an individual refinery or to be of such significance, as a single instance at an individual refinery, that it represented a serious process safety concern. For this purpose, the technical consultants used the term "serious" to convey their judgment of the gravity of the concern and not to correlate to any legal definition or to have any regulatory connotation.

Second, the Panel's technical consultants reviewed the refinery-specific findings and identified 12 "system findings." These "system findings" were findings identified at multiple refineries that, in the judgment of the technical consultants, represented a risk-significant situation with company-wide process safety management effectiveness implications.

Third, the Panel, with the assistance of the technical consultants, identified common elements of these 12 system findings and grouped them into four broad categories: (1) process safety knowledge, (2) compliance with internal standards and procedures, (3) implementation of external codes and practices, and (4) timely correction of identified deficiencies.[10]

Finally, the Panel considered the results of the technical reviews in light of the other information that the Panel developed during its review.

The Panel's findings. As a result of its evaluation, the Panel has made findings on the effectiveness of process safety management systems that BP uses for its U.S. refineries. In particular, the Panel has made findings in the following areas of BP's process safety management systems:

- identification and analysis of process hazards,

- compliance with internal process safety standards and programs,
- implementation of external good engineering practices that support and could improve process safety performance,
- defining and ensuring sufficient levels of process safety knowledge and competency, and
- translating corporate expectations into measurable criteria for the management of process risk and defining the appropriate role of qualitative and quantitative risk management criteria.

Findings in these areas also lead the Panel to conclude that material deficiencies in process safety performance exist at BP's U.S. refineries and that BP has not implemented an integrated, comprehensive, and effective process safety management system for its U.S. refineries.

IDENTIFICATION AND ANALYSIS OF PROCESS HAZARDS

The Panel's examination of BP's process safety management system indicates that, as discussed in more detail below, this system does not ensure adequate identification and rigorous analysis of process hazards of BP's U.S. refineries. The discussion below also indicates that the extent and recurring nature of this deficiency is not isolated, but systemic.

As a part of the Panel's assessment of the effectiveness of BP's process safety management system, the Panel's technical consultants reviewed, among other things, the process hazard analysis (PHA) programs at BP's U.S. refineries. A PHA is a qualitative study for evaluating and identifying design and operational process safety weaknesses, and it represents a primary tool for formally understanding risks arising from refining processes. PHAs should evaluate all the hazards of the process under review, including all chemical hazards. Management can then use PHA results to take action to control the identified hazards and related risks.

In their report to the Panel, the technical consultants identified important weaknesses in BP's PHAs at four refineries. In addition, the technical consultants identified problems with rupture disks under relief valves at four of the refineries.

> Identified weaknesses in BP's process hazard analyses

The technical consultants found that all five BP refineries had active PHA programs and that all PHA reports reviewed were completed on schedule. However, based on items sampled at the refineries, the technical consultants found three important weaknesses in PHA programs at multiple refineries.

At the Toledo and Whiting refineries, the technical consultants found that the sampled PHAs did not adequately consider the hazards of the process associated with other than normal operation. For example, hazard scenarios involving failures of equipment during start-up, such as start-up of a fired heater, were not considered. The PHAs also did not evaluate hazard scenarios during alternate feed circulation schemes. As a result, the technical consultants concluded that the relevant refineries may not have a complete view of the risk involved with operating the process units and that safeguards may be less than adequate for the process hazards, equipment failures, or process upsets that may occur during other than normal operation.

At the Carson refinery, the technical consultants found that six of eleven sampled PHAs did not fully consider all process chemical hazards. For example, at the Carson refinery, the PHA for a unit that included a process to remove hydrogen sulfide from water did not address the hazards of hydrogen sulfide for that process.

At the Carson, Cherry Point, and Toledo refineries, the sampled PHAs did not evaluate the reasonable worst case consequences of the identified hazard scenarios. The OSHA process safety management standard and EPA risk management program rule require that PHA teams evaluate not only the engineering and administrative controls but also the consequences of failure of those controls. The technical consultants found that PHA teams at these three refineries assumed that some safety systems worked instead of assuming that the engineering and administrative controls providing active safeguards did not work. As a result, the technical consultants concluded that these PHAs probably did not adequately evaluate the risk significance of many hazard scenarios.

> Rupture disk issues

Importance of rupture disks. A rupture disk is a device that is designed to relieve excessive pressure in a process. When the pressure on one side of the disk exceeds the design limit, which is based on a designated difference in pressures on opposite sides of the disk, the disk bursts or opens to relieve the pressure. Once a rupture disk opens, it cannot reclose.

A relief valve is a pressure relief device that can reclose after opening. A relief valve generally is designed to open when the pressure in process equipment exceeds the relief valve's set pressure. Once that pressure is exceeded, the relief valve remains open until the pressure is reduced below the set pressure, after which the relief valve closes to seal the system.

A common design strategy uses rupture disks in combination with relief valves to prevent damage to the relief valve from exposure to process fluid during normal operation. If the system pressure on the process side of the disk rises above the rupture disk burst point, the rupture disk will open, exposing the relief valve to the system overpressure. The relief valve will then open to relieve the system pressure. For this design strategy to work properly, the rupture disk must not leak or fail prior to the increase in system pressure. In a well-designed and maintained system, the space between the rupture disk and the relief valve is normally at atmospheric pressure.

A rupture disk can fail in a number of ways. For example, it can experience a pinhole leak, or it can prematurely burst. If the rupture disk bursts, the relief valve will still operate as long as the process fluid against which it was being protected does not degrade the integrity or operation of the relief valve. On the other hand, if the rupture disk experiences a pinhole leak, the pressure in the space between the rupture disk and the relief valve can equalize with the system pressure. In this situation, the rupture disk will not burst at the system pressure at which it was designed to burst because the rupture disk relies upon the difference in pressures on its opposite sides. If the pressure on both sides is the same because of a small leak, the rupture disk will open only at a pressure much higher than the designed system relief pressure. As a result, the system/vessel may be exposed to a much higher pressure than intended, thereby creating a potentially serious process safety hazard.

For these reasons, it is important to monitor the pressure in the space between the rupture disk and the relief valve to determine whether the rupture disk has failed prematurely. It is a recognized good industry practice to continuously monitor and alarm or frequently monitor and log the pressure of the rupture disk/relief valve space. If refinery staff detects a higher than intended pressure in the space between the rupture disk and the relief valve, the situation can be investigated, evaluated, and remedied. Although less than one percent of the relief valves in BP's five U.S. refineries have rupture disks under them, the instances in which vessels have the rupture disk/relief valve combination nevertheless are important because of the potential consequences of a failed pressure relief system. All of BP's U.S. refineries have procedures and administrative controls to monitor and log the rupture disk/relief valve space pressures.

The technical consultants' findings relating to rupture disks. As a part of the technical consultants' reviews, or through reviews that BP conducted after the technical consultants visited the Whiting refinery in March 2006, rupture disk/relief valve spaces at the Carson, Texas City, Toledo, and Whiting refineries were found to have been pressurized without timely follow-up or corrective action.

For example, at the Whiting refinery the technical consultants reviewed quarterly operator logs for the previous two years for a single pressure vessel, a fluid catalytic cracking fractionator tower. Each of these logs indicated that seven out of eight rupture disks/relief valves reported higher than intended pressure in the space between the rupture disk and the relief valve. Despite the elevated pressure in the rupture disk/relief valve space, work orders were not written to repair the problem, as BP procedures require. Based upon refinery records and interviews, the technical consultants believe that the refinery operations and maintenance personnel did not understand that a pinhole leak in a disk could compromise a pressure relief device even though internal standards clearly defined the issues. As a result, refinery personnel did not correct the problem with appropriate urgency. Instead, they intended to address the problem at a future unit turnaround by changing the metallurgy of the relief valves, thereby eliminating the need for the rupture disks.

Because the technical consultants had concerns about the adequacy of BP's root cause analysis of the Whiting rupture disk situation, the consultants conducted a follow-up review. For a more extended discussion of the rupture disk issue at the Whiting refinery, including the results of BP's investigation and the Panel's follow-up, see Appendix D.

After the technical consultants found the rupture disk/relief valve issue at Whiting in March 2006, BP issued a high potential (HiPo) incident alert to its other refineries to advise them of the issue. When the technical consultants conducted their work at Carson and Toledo in May 2006, both refineries had evaluated all of their rupture disk/relief valve installations in response to the Whiting HiPo. At one or both of the refineries, BP found instances of rupture disk/relief valve spaces with pressure, rupture disk/relief valve spaces with no method of determining if pressure existed, or lack of regular monitoring of the pressure of the rupture disk/relief valve space.

The Texas City refinery also evaluated rupture disk/relief valve spaces after the Whiting HiPo. Even after Texas City had performed its own evaluation, the technical consultants identified a deficiency. On one piece of equipment, pressure gauges indicated that four of eleven rupture disk/relief valve spaces had elevated pressure. BP Texas City operations personnel were aware of the condition but had not responded because they believed the pressure gauges were not accurate. When BP Texas City replaced the gauges after the technical consultants identified the issue, no elevated pressure was indicated. As a result of its actions, however, the refinery had allowed the rupture disk/relief valve space to indicate pressure without determining whether the rupture disk/relief valve pressure indication was not accurate or whether the pressure relief system had been compromised.

For a brief discussion of citations of alleged violations issued by Indiana OSHA in November 2006 relating to rupture disks at the Whiting refinery, see Section VI.C.

> Other indications of deficiencies in risk identification and assessment

A review of prior gHSEr audits, the Mogford Report, and process safety management audits that BP conducted indicates that BP identified deficiencies in the ability of its U.S. refineries to identify and assess process risk. OSHA citations issued in 2006 relating to BP's Toledo refinery also indicate deficiencies at that refinery in process risk identification and assessment.

gHSEr audits. BP's internal audits of performance under the gHSEr management framework, including audits of U.S. refineries, point to a number of deficiencies relating to identifying and analyzing process hazards and risks. For example, an internal audit report[11] summarizing key issues across 35 gHSEr audits conducted in 2003 in all three of BP's business segments, including 13 refineries, found that existing risk assessment and management processes were often incomplete in the subjects they covered. The report also found that risk assessment was not always embedded throughout the organizations being audited. For example, the report indicates that risk assessment was not always applied to contractor operations.

The 2003 audit report for BP South Houston, which at that time included the Texas City refinery, also found deficiencies relating to risk identification. That report found that "[t]he practice of risk identification and the development of mitigation plans is not evident across the site."[12]

Another BP internal audit report in 2004 reviewed 29 gHSEr audits of business units in BP's Refining and Marketing segment, including the U.S. refineries, as well as other BP business segments in order to identify systemic issues. This report concluded, among other things, that the application of effective risk analysis and mitigation to routine and repetitive operations was variable and that where it was weak, it desensitized individuals to the potential for injury or material damage.

The Mogford Report. The Mogford Report cites several examples of the Texas City refinery's failure to identify process hazards adequately or to analyze process risks rigorously. For example, the Mogford Report found that a particular process hazard analysis technique[13] that had been used for an operating unit involved in the incident under investigation was not robust enough to consider all modes of operation or process upset scenarios for the unit. The report states that none of the process hazard reviews would be adequate if real incident and historical data were not considered. Additionally, the report notes that the ability to identify the major risks at the Texas City site was highly dependent upon the level of risk awareness of the individuals involved in the process and that the lack of reporting of process incidents hinders all types of hazard analyses.[14]

The Mogford Report also found that both management and the workforce were generally unable to see key process risks and appeared to routinely tolerate a high level of risk. The report indicates that this was largely due to poor hazard/risk identification skills throughout refinery management and the workforce, exacerbated by a poor understanding of process safety.[15]

BP's process safety management audits. The most recent process safety management audits conducted at BP's U.S. refineries under OSHA and EPA regulations also found various deficiencies relating to process hazard identification and analysis.[16] These audits found various deficiencies relating to hazard identification or assessment, including

- various hazards, including the hazard associated with hydrogen sulfide in a sulfur plant, not being identified (Cherry Point, 2005);
- some equipment failures being categorized as "operability" rather than safety issues, resulting in less management oversight (Cherry Point, 2005);
- severity of hazard scenarios not being classified accurately (Texas City, 2005);[17]
- process hazard analysis updates not including incidents that have occurred since the previous hazard analysis (Texas City, 2005);[18] and
- process hazard analysis action items not including risk ranking (Toledo, 2004).

OSHA citations at the Toledo refinery. Findings that OSHA made in 2006 relating to BP's Toledo refinery provide additional examples that BP's safety management systems have not adequately identified or rigorously analyzed process hazards. In April 2006, OSHA cited BP for alleged violations of OSHA regulations at the Toledo refinery, seeking more than $2.4 million in penalties. OSHA conducted an inspection that identified a number of violations, which OSHA described as being similar to those found during an investigation of the March 2005 accident at Texas City. The OSHA citations included findings that Toledo's process hazard analyses did not adequately consider facility siting. For additional discussion of the OSHA findings relating to the Toledo refinery, see Section VI.C of this report. The Panel understands that BP is challenging the OSHA citations, findings, and penalties.

<u>Finding</u>:

> ***BP's safety management system does not ensure adequate identification and rigorous analysis of process hazards at its five U.S. refineries.***

COMPLIANCE WITH INTERNAL PROCESS SAFETY STANDARDS AND PROGRAMS

In addition to not consistently ensuring the adequate identification and rigorous analysis of process hazards at BP's U.S. refineries, BP's safety management system does not ensure timely compliance with internal process safety standards and programs at the refineries. As part of its assessment of BP's corporate and site safety management systems, the Panel examined the implementation of, and each U.S. refinery's compliance with, BP's internal standards and programs for managing process risks.[19] In some cases, BP developed these internal standards at the Group or segment level. In other cases, internal standards originated locally at the refinery level, including legacy standards that the Carson, Cherry Point, Texas City, and Whiting refineries developed prior to BP's acquisitions of ARCO and Amoco.

The Panel based its assessment of BP's compliance with internal standards primarily upon the review that the Panel's technical consultants conducted, the results of the process safety culture survey, internal BP audits, and other information. During their review, the technical consultants also observed what they considered to be some positive notable practices and a good process safety management practice relating to process safety minimum expectations, or PSMEs, as described later in this section. Although the technical consultants and the Panel observed some positive elements of BP's overall process safety management system, the Panel found that BP's safety management system does not ensure timely compliance with its own internal process safety standards and programs.

> Results of the technical reviews

The Panel's technical consultants made system findings concerning individual refinery compliance with BP's internal standards in five areas:

(1) rupture disks under relief valves (discussed earlier in this section),
(2) equipment inspections,
(3) critical alarms and emergency shut-down devices,
(4) area electrical classification, and
(5) near miss investigations.

Because external codes and practices also apply to area electrical classification, the findings of the technical consultants in that area will be discussed later in this section. For a detailed discussion of the technical consultants' findings on near miss investigations, see Section VI.C.

Equipment inspections. A refinery monitors the condition of refinery process equipment, instrumentation, and safety systems to promote sustainable fitness for service. This monitoring typically includes internal and external visual inspections, non-destructive testing, or functional testing. Some of this testing also involves predictive analysis of future performance based on existing readings, such as vibration or oil analysis on rotating equipment done primarily for reliability assurance rather than safety reasons. While various organizations, such as the API and the American Society of Mechanical Engineers, have developed consensus codes and standards that generally provide guidance on the frequency of this inspection and testing, a refinery has some flexibility in determining its monitoring frequencies and methods. Based upon the technical consultants' experience, most refineries augment the guidance from codes and standards with plant-specific experience to determine inspection and testing frequencies. Some refineries in the United States have begun to adopt risk-based inspection principles to optimize these frequencies.

After a refinery specifies the frequencies for its inspection and testing program, the site should reliably execute the program at the designated frequencies to support the safe operation of the refining processes. If a refinery does not perform inspections and tests in a timely fashion, the refinery will be less able to monitor the fitness-for-service condition of its processes and process equipment. For example, equipment that begins to degrade more quickly than previously predicted or that experiences a hidden failure may go undiagnosed for an extended period, thereby increasing the risk of process operation. In addition, not following specified inspection and testing intervals may send a signal to the workforce that it is not important to follow established requirements, thereby diminishing the overall effectiveness of a refinery's process safety management systems.

All of BP's U.S. refineries had extensive inspection and testing programs that qualified BP staff had implemented and that qualified contractors had augmented, as necessary. In addition, all of these refineries had inspection scorecards that refinery personnel maintained to highlight the status and performance of the inspection and testing program. Nonetheless, during their reviews the technical consultants found extensive inspection and testing backlogs for fixed equipment, rotating machinery, and instrumentation systems at all of these refineries. Some inspections were past due for years. Examples of inspection and testing deficiencies at BP's U.S. refineries are described in more detail in the technical consultants' report attached as Appendix E.

Critical alarms and emergency shut-down devices. Refining processes have instrumented control systems that monitor operating parameters for various processes. Some of these parameters have associated alarms and serve interlock or safety shut-down functions. Operators must sometimes bypass or temporarily render these alarms and emergency shut-down devices inoperative so they can either be tested to ensure dependable operation or repaired. Because the process unit typically remains in operation while these alarms or emergency shut-down devices are temporarily out of service, the ability to monitor the process units during this period for possible process upsets or possible need for shutdown of the process is diminished. As a result, it is important for a refinery to minimize the bypass time, communicate awareness of the degraded operational safety condition to all refinery personnel who need to know, and keep records documenting the rationale for, and confirming the restoration of, the bypassed components.

Based upon their sampling done at each of BP's U.S. refineries, the technical consultants determined that Carson, Cherry Point, Toledo, and Whiting had insufficient procedures or did not execute established procedures for bypassing critical alarms, interlocks, and emergency shut-down devices. In addition, numerous instances existed in which functional testing of these systems was overdue, increasing the probability that latent failures will not be discovered or corrected and that the systems will not operate when called upon. The details relating to the consultants' finding are described in the technical consultants' report attached as Appendix E.

> Results from the process safety culture survey

Several items in the process safety culture survey solicited impressions of personnel at BP's U.S. refineries relating to testing, maintenance, and inspections of process safety-related devices and process equipment. The survey data from these items reveal mixed impressions: in some instances, data indicate that respondents at BP's U.S. refineries had quite positive process safety impressions; in other instances, data indicate quite negative impressions. The following discussion focuses primarily on responses that signaled potential areas of concern regarding the regularity of testing process safety equipment, the regularity of maintaining process safety devices and equipment, and the prioritization of inspection and maintenance.

Please read Section I of this report for a discussion of considerations and limitations relating to survey data and the Panel's method of analyzing that data. The analysis of survey data contained in this section is qualified by, and should be read in conjunction with, the discussion of those considerations and limitations in Section I.

Testing of process safety related devices and process equipment. Surveyed contractors and employees in six process safety functional groups often indicated their beliefs that interlocks, alarms, and other process safety-related devices were tested regularly. As shown in Table 40 below, none of the identified respondents at Carson, Cherry Point, Texas City or Whiting had negative response rates in excess of 18 percent. Moreover, at Cherry Point, the negative response rate ranged from zero percent to a mere six percent. Survey data, however, revealed some potential process safety concerns at the Toledo refinery: 41 percent of operators, 31 percent of maintenance/craft technicians, and 22 percent of engineering professionals disagreed or tended to disagree that process safety-related devices were tested regularly.

Table 40

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"Interlocks, alarms, and other process safety-related devices are regularly . . . [t]ested."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	11	6	13	41	14
Maintenance/Craft Technicians	11	4	16	31‡	11
Full-Time HSSE Employees	11	0	7	11‡	8
Engineering Professionals	18	4	10	22	10
Operations Management	7	3	7	7	5
Maintenance Management	12‡	6‡	9	*	0
Contractors	5	4	6	5	4

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Responses regarding testing of process *equipment* were less positive overall than responses regarding testing of process safety-related *devices.* Across BP's five U.S. refineries, for example, negative response rates to a survey item on whether process equipment was tested regularly ranged from a low of seven percent (Cherry Point) to a high of 46 percent (Toledo) for operators, with percentages of negative responses at Carson, Texas City, and Whiting all being equal to or in excess of 20 percent; from a low of 19 percent (Whiting) to a high of 50 percent (Toledo) for maintenance/craft technicians; and from a low of 42 percent (Texas City) to a high of 59 percent (Toledo) for contractors. Relatively high percentages of negative responses also came from maintenance management at Carson (37 percent) and HSSE employees at Toledo (26 percent). However, responses from operations management at all five U.S. refineries were much more positive. In that regard, the negative response rates for that group were 15 percent or less. At Cherry Point, five of the six identified employee groups responded very positively and as shown in the table below, they had negative response rates of 13 percent or less.

Table 41

Percentages of Agree/Tend to Agree Responses to Survey Item:
"Process equipment is not regularly . . . [t]ested."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	25	7	26	46	20
Maintenance/Craft Technicians	42	32	31	50‡	19
Full-Time HSSE Employees	8	4	12	26‡	13
Engineering Professionals	8	5	11	19	13
Operations Management	15	5	15	14	14
Maintenance Management	37‡	13‡	11	*	3
Contractors	44	43	42	59	46

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Maintenance of process safety related devices and process equipment. Surveyed contractors and employees in six process safety functional groups generally indicated that interlocks, alarms, and other process safety-related devices were maintained regularly. There were, however, some exceptions. For example, at Texas City more than a quarter (27 percent) of operators responded negatively. Moreover, at Toledo, 42 percent of operators, 31 percent of maintenance/craft technicians, 26 percent of operations management, and 22 percent of engineering professionals also responded negatively.

Table 42

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "Interlocks, alarms, and other process safety-related devices are regularly . . . [m]aintained."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	13	9	27	42	19
Maintenance/Craft Technicians	6	6	18	31‡	14
Full-Time HSSE Employees	8	4	14	11‡	13
Engineering Professionals	18	4	18	22	18
Operations Management	10	3	12	26	12
Maintenance Management	12‡	6‡	15	*	0
Contractors	7	4	6	4	5

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

A comparison of responses regarding the frequency with which process equipment was tested (see Table 41 above) and the frequency with which it was maintained (see Table 43 below) reveals a few differences but many similarities. For example, across BP's U.S. refineries, more than 20 percent of operators (except at Cherry Point), more than 30 percent of maintenance/craft technicians (except at Whiting), and more than 40 percent of contractors indicated that process equipment was not maintained regularly. In addition, 37 percent of maintenance management at Carson and 26 percent of HSSE employees at Toledo responded in the same manner. Another similarity was the more positive views indicated by the responses from operations management. At all the refineries except Toledo, this group had negative response rates that were less than 20 percent. Finally, Cherry Point, the same five employee groups (HSSE employees, engineering professionals, operations management, operators, and maintenance management) responded positively and as shown in the table below, had negative response rates of 13 percent or less.

Table 43

Percentages of Agree/Tend to Agree Responses to Survey Item: "Process equipment is not regularly . . . [m]aintained."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	22	12	33	49	30
Maintenance/Craft Technicians	42	31	34	38‡	23
Full-Time HSSE Employees	5	4	12	26‡	13
Engineering Professionals	8	5	21	19	15
Operations Management	18	5	19	23	17
Maintenance Management	37‡	13‡	17	*	3
Contractors	45	43	41	56	47

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Prioritization of inspections and maintenance. Finally, as shown in the table below, employees in some process safety functional groups at Toledo, Texas City, and Whiting provided high negative response rates regarding the prioritization of inspection and maintenance at their refineries. At Toledo, for example, more than half of operators (56 percent), half of maintenance/craft technicians, 32 percent of HSSE employees, 30 percent of operations management, and 26 percent of engineering professionals expressed a belief that inspection and maintenance were not high priorities. At Texas City, 37 percent of operators, 36 percent of maintenance/craft technicians, 28 percent of maintenance management, and 21 percent of engineering professionals also expressed that belief. Finally, at Whiting, 26 percent of operators, maintenance/craft technicians, and HSSE employees responded in the same manner. Respondents at Carson and Cherry Point were far more positive. At these refineries, neither the contractors nor any of the six employee groups shown below had negative response rates in excess of 19 percent. At Carson, contractors and five employee groups had negative response rates of ten percent or less, with zero negative responses from operations management. At Cherry Point, contractors and four employee groups had negative response rates of ten percent or less.

Table 44

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"In order to ensure process safety at my refinery, inspection and maintenance are made high priorities."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	19	13	37	56	26
Maintenance/Craft Technicians	10	7	36	50‡	26
Full-Time HSSE Employees	5	4	19	32‡	26
Engineering Professionals	7	4	21	26	16
Operations Management	0	10	19	30	9
Maintenance Management	4‡	13‡	28	*	9
Contractors	8	6	15	10	11

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

> Results from various BP audits

In addition to results from the technical reviews and process safety culture survey, the Panel's review of BP's gHSEr audits and prior process safety management audits indicates that BP does not ensure timely compliance with internal process safety standards and programs at its five U.S. refineries.

2003 gHSEr audit. In the 2003 gHSEr report, a number of common themes emerged, largely related to behaviors, implementation, and follow through that have impacted HSE performance. According to this report, the most significant of these common themes included a "[w]idespread tolerance of non-compliance with basic HSE rules." In addition, the 2003 report contained a section captioned "Actions which could address these gaps." These action items stressed that activities to reduce non-compliance should include

- clear articulation of the "rules" and how compliance will be monitored;
- incentivization of staff (and contractors);
- leadership through engagement, personal behaviors, and challenges; and
- clear policies on how noncompliance will be dealt with throughout the line, not just at the operator level.

2004 Internal Audit. An internal audit report relating to 2004 but issued in August 2005 discussed noncompliance with BP's standards on health, safety, and environmental matters. Among other things, this report noted that

> [t]here have been senior management interventions, especially in the [Refining and Marketing] segment, to address this compliance issue leading to focus teams undertaking unannounced spot checks ("Monitoring Events") on assets to assess compliance in specific areas including control of work, driving safety and the 8 golden rules. The findings of the Monitoring Events have been directly communicated to the relevant Segment [Group Vice-President] but it is as yet unclear what sustained impact is achieved.
>
> Overall the issue identified in the 2003 summary paper does not appear to have materially improved during 2004 despite the increased attention by Senior Management. Whilst this is disappointing it is not unexpected due to the scale of the organisation and past experiences of attempts to fundamentally alter behavioural safety issues.

Prior BP process safety management audits. BP's own process safety audits also indicate that BP was not ensuring timely compliance with various internal process safety standards and programs at its U.S. refineries. Set forth below for each of BP's U.S. refineries are examples of findings from those internal audit reports in the area of inspections, testing, and/or maintenance.

Carson (2005)

- 134 pressure relief valves were past due inspection, which was a significant reduction since the 2002 compliance review.
- 46 pressure vessels were past due date for internal inspection, and 120 pressure vessels were past due for wall-thickness measurements.
- Out of a random sampling of ten turbines, only one had a record of being tested for overspeed trip.

Cherry Point (2005)

- Critical alarms were not generally tested, except at the hydrocracker unit. While the review found that a plan existed to implement such a testing program over a period of up to five years, the audit team advised that it considered this could be accomplished sooner.
- Management statistics for steam turbine overspeed trip testing were not readily apparent. According to the compliance report, this information is produced on a regular basis for assurance at other BP refineries.

Texas City (2004)

- There was below 100 percent compliance with testing of on stream and turnaround critical instruments, overspeed trips on rotating equipment, and relief valves, as well as with inspection of piping, pressure vessels, and storage tanks.
- Many procedures for testing of critical instruments and emergency shut-down systems were out of date and some were missing.
- Interval-based inspections and risk-based inspection tasks were not integrated into one inspection management system for execution and tracking.

Toledo (2004)

- 54 pressure safety valves were overdue for testing.
- Inspections of ten relief valves were being postponed without documented technical justification or risk assessment.
- 77 items of preventive maintenance were overdue by six months or more.
- Original equipment manufacturer manuals for certain critical alarms could not be produced.

Whiting (2006)

- Not all of the alarms and interlocks that serve a safety function were included in the mechanical integrity maintenance program.
- Numerous past due inspections and extended inspection due dates existed, and the management system to evaluate and control variances to test and inspection intervals was ad hoc or not well defined.
- Rupture disks positioned below relief valves may have failed in a manner that would have rendered the associated relief valves ineffective.

Finding:

BP's safety management system does not ensure timely compliance with internal process safety standards and programs at BP's five U.S. refineries.

IMPLEMENTATION OF EXTERNAL GOOD ENGINEERING PRACTICES

External codes, standards, industry best practices, recommended practices, and other external guidance (collectively referred to as codes and practices) play an important role in the management of process safety in refineries operating in the United States.[20] Some of these codes and practices have the force of law; others do not. Several process safety-related regulations apply to BP's U.S. refineries, and through these regulations, various generally accepted codes and practices also apply. OSHA specifically acknowledges various industry codes and practices. For example, the OSHA process safety management standard cites process safety guidance that the API,[21] the CCPS (an industry technology alliance of the American Institute of Chemical Engineers[22]), and the American Chemistry Council developed. Even if existing codes and practices do not have the force of law, they can provide valuable tools for managing and reducing risks associated with process hazards. These codes and practices relate to numerous topics, such as the classification of locations for installing electrical equipment at petroleum facilities[23] and instrumentation for fired heaters.[24] Following codes and practices relating to refineries helps ensure that refineries operate safely because the codes and practices represent an accumulation of the knowledge and experience of many industry experts. Systemic failure to consider and adhere to codes and practices can result in operations being conducted at a higher degree of risk than would be the case if the operations were conducted in conformity with the codes and practices.

Under the scope of work used in their review of BP's U.S. refineries, the technical consultants compared BP's process safety management programs, procedures, and performance not only to applicable regulations, but also to codes and practices. Under the terms of the Panel's scope of work, the technical consultants evaluated only a sampling of external codes and practices that apply to U.S. refineries as a basis for their conclusions. Specifically, the technical consultants reviewed BP's U.S. refineries' adherence to applicable codes and practices relating to four areas: safety shut-down systems, area electrical classification, fired heaters, and facility siting.

Based upon their assessment, the technical consultants found a process safety management system deficiency in each of the four sampled areas. In making these findings, the technical consultants identified the particular code and practice to which the finding relates. Based primarily on the findings of the technical consultants, the Panel finds that BP's safety management system does not ensure the timely implementation of external good engineering practices that support and could improve process safety performance at BP's U.S. refineries.

> Safety shut-down systems

Refinery process units have important instrumentation systems intended to detect process upsets and then safely shut down equipment prior to reaching unsafe conditions. These systems are usually designed with multiple layers of protection using redundant and highly reliable components. These systems typically remain dormant until an authentic process upset occurs, at which time they act to protect the process by putting it into a safe condition. Because these instrumentation systems are usually dormant, it is difficult to determine at any particular time whether they are fully functional. As a result, it is important to perform functional testing of these safety systems throughout their operational lives to ensure dependable operation when they are needed.

The technical consultants' report indicates that it is important to consider the entire "life cycle" of a safety system—taking care to properly design it, construct it, operate it, and maintain it. In 1996, the Instrumentation, Systems, and Automation Society (ISA) issued an industry consensus standard to outline the life-cycle care of instrumented safety systems (ISA 84.01-96). OSHA considers ISA 84.01 to be a recognized and generally accepted good engineering practice under the performance-based requirements of the OSHA process safety management standard. ISA published an amended version of this standard in 2004 (ISA 84.01-04).

In 2003, BP developed a series of engineering technical practices (ETPs) to provide guidance concerning the application of ISA 84.01. Based on the technical consultants' review, none of BP's U.S. refineries had a comprehensive plan for conforming to ISA 84.01, and only Toledo and Cherry

Point have implemented the standard for recent projects. The consultants also noted that the Whiting refinery did not implement ISA 84.01 for its newest process—a diesel hydrotreating unit scheduled for start-up in 2006.

Since ISA 84.01-96 was published ten years ago, the technical consultants expressed their belief that BP has not implemented this standard in a timely manner. Discussion with BP refinery instrumentation subject matter experts indicated that it might be another ten years before ISA 84.01 would be fully implemented in the BP U.S. refineries. As a result, the technical consultants also concluded that none of BP's U.S. refineries had an effective and credible plan to achieve full compliance with ISA 84.01 in a timely manner. The technical consultants' report indicates that they believe it to be feasible and reasonable for BP to expedite ISA 84.01 implementation and complete it at a much faster pace.

> Area electrical classification

OSHA's process safety management standard requires a facility to maintain process safety information for covered processes, including information regarding area electrical classification. Information regarding area electrical classification is important in refineries because ignition sources in refinery areas where flammable vapor clouds can form represent a hazard that a site should control to reduce the risk of fires and explosions.

Various organizations, such as the API and the National Fire Protection Association (NFPA), have published recommended practices, codes, and standards for controlling the design and placement of electrical devices in such areas. These practices, codes, and standards provide guidance about classifying areas according to the potential for formation of flammable vapor clouds, restricting or controlling the types of electrical devices that are allowed in the classified areas, and addressing the design of structures and ventilation systems within classified areas. Refinery buildings and equipment enclosures subject to such standards include control rooms, operator shelters, motor control centers, and instrument panels.

At all of BP's U.S. refineries, the technical consultants observed instances in which the refinery did not conform to area electrical classification guidance contained in API Recommended Practice 500 or NFPA Standard 496. These instances included rooms and enclosures where the ventilation and pressurization systems and seals were out of service or ineffective, inoperative or inadequate flammable gas detection in rooms/enclosures, and outdated electrical area classification drawings that inaccurately depicted classified area restrictions.

The technical consultants also observed uncontrolled vehicle access in electrically classified areas. Although API Recommended Practice 500 does not explicitly address vehicle access in such areas, the technical consultants consider internal combustion engines in vehicles as potential ignition sources. Some companies develop and implement restrictions on vehicle access to areas in close proximity to process units, including plant roadways, with reference to electrical classification. The technical consultants consider such a restriction to be a good engineering practice.

> Fired heaters

Refineries typically use fired heaters as an energy source for process units. The refining industry has experienced heater fires and explosions that have prompted industry organizations to develop design, operating, and maintenance practices for these units. The API, for example, has several standards and recommended practices on fired equipment design, operations, testing, and preventive maintenance, including API Recommended Practice 556 covering instrumentation and control system requirements for burner management systems.

The technical consultants found that while Amoco and ARCO had developed internal standards for fired heaters, the four BP refineries from those two companies (Carson, Cherry Point, Texas City, and Whiting) have not kept these standards up to date by ensuring that these internal standards reflected changes in external standards, such as API Recommended Practice 556. The consultants also found that BP has developed an engineering technical practice and internal guidelines for fired heaters and a handbook for furnace and boiler firing.

The technical consultants found that the refineries had not implemented the requirements of internal BP standards. In addition, the consultants found that fired heaters at Carson, Cherry Point, Texas City, and Whiting generally did not comply with API Recommended Practice 556. Also, the various refinery technical staffs could not otherwise establish for the consultants that the equipment as currently designed meets standards that are at least as stringent as those that the API established.

BP is developing its own process safety minimum expectation (PSME) for fired heaters that is expected to reflect API recommended practices. Refinery personnel also indicated that some recent fired heater installations complied with the anticipated requirements of the PSME being developed.

> Facility siting

Refineries that process volatile hydrocarbons face the hazard of explosions and fires. The refining and chemical manufacturing industries have experienced major accidents that resulted in damage to occupied buildings near the explosion, such as process control rooms, operator shelters, and maintenance shops, as well as injuries and fatalities to occupants. These types of accidents led OSHA to require consideration of facility siting when assessing process hazards under its process safety management standard.

The API subsequently published a facility siting recommended practice, known as API RP 752, which provides a methodology for evaluating the hazards associated with process plant buildings. The CCPS has also published additional guidance on how to conduct such a facility siting study using recognized consequence models, assumptions, and data. Taken together, these publications propose evaluating the risk to process plant building occupants from potential impacts like fires, explosions, or toxic releases, and taking steps to reduce identified risks, such as imposing occupancy criteria, strengthening existing buildings, or constructing new buildings that meet certain design criteria.

As a performance-oriented regulation, OSHA's process safety management standard does not impose a specific methodology for evaluating facility siting, define a level of unacceptable risk, or require a company to take specific steps to mitigate identified risks. OSHA, however, expects companies to follow reasonable and acceptable methodologies in evaluating facility siting. For this reason, many companies subject to OSHA's process safety management standard rely on API RP 752 or the CCPS facility siting guidelines.

The technical consultants evaluated the facility siting practices at all of BP's U.S. refineries—both for temporary portable buildings and for permanent buildings. They found that all five refineries met OSHA's requirements for facility siting by conducting facility siting studies, and updating them, in accordance with API RP 752.

In addition, the technical consultants noted that since the Texas City incident, all of BP's U.S. refineries had reevaluated the location of portable trailers in accordance with a new BP engineering technical practice. The consultants also observed that BP has relocated all of the trailers from the zones representing the highest hazard level. BP has indicated that it plans to complete this process for the remaining zones by the end of 2006. The technical consultants commended BP for moving expeditiously in response to facility siting issues on temporary buildings identified after the Texas City incident. The Panel also understands that BP is developing a new engineering technical practice on the construction of new permanent buildings.

Notwithstanding BP's prior implementation of recommended practices and the actions that BP took in response to the Texas City accident, the technical consultants identified additional steps that, in their judgment applying good engineering practices, BP should take to further reduce the facility siting risk to personnel. Specifically, the technical consultants identified some permanent buildings at all five refineries that are inside hazard zones and that were not designed to effectively protect the buildings' occupants in the event of an explosion.

In recognition of the hazard associated with potential explosions, the refineries had relocated control rooms into new structures that were either located some distance from the refining process area or designed to be blast resistant. These control rooms are staffed with process board operators, refinery operation supervisors, and engineers.

However, some outside operating and maintenance personnel in some units still use offices in the original control rooms that remain in the process areas. Because buildings such as these were not designed to withstand explosions, the technical consultants consider it a good practice to restrict their use even by essential operating personnel. The technical consultants recognized that BP has taken steps to secure some buildings and to prevent their use, but based on the site visits that the consultants made, it appears that these steps are not always effective.

The technical consultants noted in their report to the Panel that the Cherry Point, Texas City, and Toledo refineries are making a substantial effort to replace these process area operator shelters with blast-resistant structures. However, the consultants also noted that it appeared that it would be several years before BP completed this activity at all five of its U.S. refineries. The consultants also indicated that in their professional judgment, the pace at which these situations are being corrected is too slow.

Finding:

BP's safety management system does not ensure timely implementation of external good engineering practices that support and could improve process safety performance at BP's five U.S. refineries.

PROCESS SAFETY KNOWLEDGE AND COMPETENCE

During the course of its review, the Panel found that many members of BP's technical and process safety staff have the capabilities and expertise needed to support a sophisticated process safety effort as shown by the staff's publications, the internal standards BP produces, and the respect that many BP staff members receive in world-class technical bodies. Nevertheless, the Panel believes that BP's system for ensuring an appropriate level of process safety awareness, knowledge, and competence in the organization relating to BP's U.S. refineries has not been effective in a number of respects.

First, the Panel's review indicates that BP has not effectively defined the level of process safety knowledge or competency required of executive management, line management above the refinery level, and refinery managers. For example, the information that the Panel reviewed indicated that BP has not established specific process safety qualifications or competencies necessary to serve as a refinery plant manager, the top-ranking line manager at each refinery, and has not provided a specific training program around process safety for new refinery managers.

Second, BP has not adequately ensured that its U.S. refinery personnel and contractors have sufficient process safety knowledge and competence. The information and data that the Panel reviewed indicated, for example, that process safety education and training needs to be more rigorous, comprehensive, and integrated.

Third, the Panel found that at most of BP's U.S. refineries, the implementation of and overreliance on BP's computer-based training contributes to inadequate process safety training of refinery employees.

The Panel believes that in order for BP to have a high level of process safety performance in its U.S. refineries, those personnel and contractors having an active or monitoring role in that performance must have a level of process safety awareness, knowledge, and competence sufficient to allow them to discharge their responsibilities in the process safety management system. The awareness, knowledge, and competence should be appropriate for the job level and process safety responsibilities of the particular individual. Personnel and contractors at the site need process safety knowledge and competence, as do managers involved in measuring, monitoring, and evaluating performance and modifying the management system from time to time to support continuous improvement in the performance of the system.

> Knowledge and competence guidance standards

Guidance from external standards. The ANSI Z-10 standard provides guidance about training workers within a safety management system. That standard indicates that an organization should establish processes to

- define and assess the competence needed for both employees and contractors;
- ensure through appropriate education, training, or other methods that employees and contractors are aware of the applicable safety requirements and are competent to carry out their responsibilities as defined by the safety management system;
- ensure effective access to, and remove barriers to participation in, education and training;
- ensure that training is provided in a language that trainees understand; and
- ensure that trainers are competent to train employees.[25]

The OSHA process safety management standard also recognizes the importance of process safety knowledge and initial and refresher training.[26]

The ANSI Z490.1-2001 standard provides criteria for accepted practices in safety, health, and environmental training. That standard states that "[t]raining programs are most effective and efficient when managed under a well-defined and organized administrative system. Such a system is designed to assure that training is in an integrated program, rather than a series of non-related training events."[27] A well-integrated program should take into account management and administrative issues related to

- responsibility and/or accountability for the training program;[28]
- resources available to the trainer and trainees;[29]
- training, design, and development by appropriate, qualified people, using appropriate techniques;[30]
- delivery strategies appropriate and effective for the learning objectives;[31]
- appropriate evaluation strategies included in all training;[32] and
- overall quality of the program managed to assure consistency and continuous improvement.[33]

The standard makes clear that sufficient resources must be made available to properly implement an effective training program. Such resources include a sufficient budget to fund all elements of the training program; sufficient personnel and expertise for the development, delivery, and evaluation of training; sufficient technical expertise and information; and suitable training facilities.[34]

Multiple delivery methods may be used in a single training course or event. The entity or person providing the training should consider a variety of methods, which might include on-the-job training, lecture, computer-based training, discussion, classroom exercises, demonstrations, guided practice, activity-based interactive group(s), and distance learning.[35] The training provider should evaluate the suitability of each training method and implement the appropriate types of training given the needs of the organization and the information or competencies being taught.[36]

The standard also stresses the importance of evaluating the trainees' knowledge, skills, and abilities once the training is completed.[37] Tools used to evaluate knowledge, skills, and abilities may take many forms and may include written tests, oral examination, completion of an assigned project, demonstration of the skill in a simulated work setting, and on-the-job demonstrations of the skill in the trainer's presence.[38] Finally, once evaluations have taken place, the "information and results gathered from training evaluations should be used for continuous improvement of the course content, delivery methods, and learning environment."[39]

BP standards and guidance. BP's Group-level standards recognize the importance of a trained workforce.

For example, Element 3 of gHSEr provides that "our workforce will be carefully selected and trained, and their skills and competencies regularly assessed."[40] Expectation 3.4 indicates that BP's workforce will have the required skills and training to competently perform their tasks in a healthy, safe, and environmentally sound manner and that training will be evaluated to determine its effectiveness.

Additionally, the 2001 process safety/integrity management standard provided that

> All operating, maintenance and contractor personnel shall be competent and capable to safely perform their assigned tasks. They shall fully understand their role in the prevention and management of process safety/integrity management hazards. Approved procedures that are adequate and accurate shall be accessible to all personnel.
>
> All facilities must ensure that their workforce is trained in these work procedures and that they are qualified and competent to safely perform all duties assigned in the operation and maintenance of the facility. . . . Job qualifications shall be documented.

Moreover, the new 2006 integrity management standard indicates in Element 2 that staff with assigned integrity management responsibilities must have defined roles and must be competent to carry out integrity management related tasks. The standard also provides that each BP operation, including each U.S. refinery, must have in place, among other things,

- job descriptions that define the responsibilities and activities of integrity management-related jobs, together with the required attributes, competencies, qualifications, experience, training, and certification (required by applicable regulators);
- systems that quantitatively assess and record integrity management-related competencies; and
- a training and development process designed to bring integrity management-related staff up to the required level of competence for their role, along with refresher training.

> Executive management, line management above the refinery level, and refinery plant managers

During its review, the Panel attempted to determine the extent to which BP defined the process safety knowledge and capabilities required for different participants in BP's process safety system. Information and data available to the Panel indicates that BP had not effectively defined the level of such knowledge or competency required of executive management, line management above the refinery level, or refinery managers.

Executive management and line management above the refinery level. As discussed in Section VI.A, the information that the Panel obtained, including information from interviews with executive and corporate management, indicates that the executive management did not focus on process safety performance to the same extent as personal safety prior to the Texas City accident. These interviews indicate that conversations about safety at the executive level and at the corporate level are different now than they were prior to the Texas City incident and that post-Texas City, BP executive management has an increased awareness of and appreciation for process safety. The inclusion of some process safety performance indicators in the new 2006 integrity management standard and in the enduring milestones that BP is now tracking indicate this increased awareness. Having an appreciation of process safety at the executive level is particularly important for BP, with its system of cascading performance contracts, because the Chief Executive, Refining and Marketing plays a primary role in establishing the performance metrics for refining line management that drive performance and behavior in BP's U.S. refineries. For additional discussion of process safety performance metrics that BP uses, see Section VI.C. For additional discussion of BP's reliance on performance contracts, see Section VI.A.

As discussed in greater detail in Sections VI.A and VI.C, executive management focused primarily on personal injury rates rather than process safety performance. Admittedly, even for personal safety this focus involved reviewing aggregated information about injury rates such as days away from work frequency and recordable injury frequencies rather than information on a business unit or site-specific basis. Little operational information regarding process safety performance was reported regularly to executive management, other than the reporting of major incidents and high potential incidents. It appears that executive management did not monitor or have awareness around process safety management information on a basis comparable to personal safety. The Panel is not suggesting that executive management should be subject matter experts on process safety management in BP's U.S. refineries. On the other hand, some base level of process safety awareness and knowledge is required in order for executive management to monitor process safety performance effectively and to establish appropriate process safety performance metrics from time to time. Under the BP Management Framework, executive management delegates authorities and responsibilities to subordinate managers and establishes performance contract metrics that then cascade throughout the business organization. Some knowledge of process safety, or expertise from technical staff, is required for establishment of appropriate performance metrics, including what performance expectations need to be addressed and in what degree of operational specificity; the qualitative or quantitative criteria that should be used to define levels of process risks that will or will not be tolerated; and the standards that will be used to determine whether process safety performance is acceptable at the Group level.

Similarly, BP does not effectively define the level of process safety knowledge or competency required of line management above the refinery level. The Panel does not doubt that the current position holders, because of their prior refining operations experience, have an adequate level of process safety knowledge and competency. In order to ensure, however, an adequate level of process safety knowledge and competency for such key positions, BP should assess and define the process safety responsibilities and activities for these positions and the related process safety knowledge and competency required.

Refinery plant managers. Refinery plant managers are the leaders of the refineries and are accountable for all aspects of the refinery's performance, including commercial, process safety, personal safety, and environmental performance. Even though this position represents a critical leadership position at the refinery level, BP has not demonstrated to the Panel that BP either defines the process safety qualifications or competencies that an individual must have in order to serve as a refinery manager or provides any specific process safety training program for newly appointed refinery managers.

BP has detailed a "bottom-up" succession planning program that encompasses the refinery manager position. BP uses a refining assessment tool to appraise the experiences and competencies of a candidate for a position, and BP develops a pool of candidates for each position from persons reporting directly to a refinery manager on up. These competencies and experiences, however, are more conceptual than sharp-edged.[41] BP's assessment tool does not qualitatively evaluate a candidate's refinery experience, process safety understanding, or commitment to safety. While most individuals appointed as refinery managers had substantial prior refining experience, some did not—although they did have other experience, including experience in chemical plants, which BP considered comparable to prior refining experience.

The Panel's review indicates that BP has not established a specific, detailed training program for newly appointed refinery managers. BP provides a new manager with an array of documents pertaining to the refinery and generally attempts to have the new manager work side-by-side with the departing plant manager for some transition period. BP encourages new plant managers to use a "refinery leadership transition planner," which itself provides no specific training. Rather, the transition planner provides a checklist of items for an incoming manager to do or consider doing, including (1) reviewing relevant documents; (2) meeting with the outgoing manager and with direct reports; (3) formally communicating the change in position with all site personnel; (4) signing off on new accountabilities, objectives, expectations and risks; (5) preparing a self-assessment and development plan for the new position; and (6) meeting with key internal and external contacts. Rather than using a detailed training program for refinery managers, BP appears to rely primarily on a combination of prior experience of the manager, on-the-job training, and mentoring from other refinery managers and from the Refining Vice-President, U.S. Region. In addition, BP has on occasion sent refinery managers to refining management training conducted by outside parties to address perceived deficiencies.

In 2006, BP began using a management of change process to assess the impact of appointing a new refinery manager. Some of the procedures described above relating to refinery managers are incorporated into this new process.

Finding:

BP has not effectively defined the level of process safety knowledge or competency required of executive management, line management above the refinery level, and refinery managers.

> Refinery personnel and contractors

The Panel's review indicates a number of deficiencies in the process safety knowledge and competence of, and training and education programs for, personnel and contractors at BP's U.S. refineries. For years, BP has conducted various types of training programs for refining personnel, including training for operators, training on various health and safety matters, and entry level training on refining fundamentals. However, BP has not demonstrated to the Panel that the U.S. refineries use a comprehensive and integrated education and training program that adequately defines the required education and competency levels for all levels of refining personnel and refining managers. Training generally appears to include a number of unrelated training events rather than being an integrated program. Much of the training is and has been on-the-job training, and not all of that training has been effective in promoting a high level of process safety performance.

Training programs. Perhaps the most prevalent training deficiency that the Panel found at BP's U.S. refineries was that training programs were not sufficiently rigorous. Information that the Panel reviewed on this point includes the results from incident investigations, including the technical consultants' review of the Whiting rupture disk near miss and incident investigation that BP conducted; information from or relating to specific categories of workers; indications that BP does not always ensure adequate interactive training, such as through gun drills (*i.e.*, a test or evaluation in which a worker is given a hypothetical set of circumstances and is asked to communicate or demonstrate how he or she would respond in that situation) and mentoring; and not always ensuring adequate refresher training.

Results from incident investigations. Four incident investigations illustrate BP's failure to ensure sufficient process safety knowledge and competence among its refinery workforce.

Whiting rupture disk (2006). In its follow-up investigation relating to the Whiting rupture disk situation, the Panel's technical consultants found a breakdown in management oversight of training or assigning personnel to jobs with adequate technical knowledge relating to rupture disks. See Appendix D, "Whiting Rupture Disk: A Case Study for Review of BP's Process Safety Management Systems."

Mogford Report (Texas City 2005). The Mogford Report noted:

> [t]here was a lack of rigor and follow through in the area of training. Records showed incomplete training and there was little verification that all required training was occurring.[42]

Texas City oil spill (2004). A 2004 investigation into the causes of an oil spill at Texas City found that the incident was caused, in part, by inadequate recall of training, inadequate training effort, and no training provided. The investigation report indicates that operators were not evaluated for their understanding of the applicable procedure and that the refinery did not provide refresher training on the procedure. The report also states that the refinery provided inadequate training on monitoring tank status. Incident reports for other near misses and incidents at various of the U.S. refineries also cite to a lack of training as a cause or contributing factor.[43]

Toledo release (2001). A 2001 incident investigation at the Toledo refinery on the release of reformate and water to the atmosphere highlights the deficiencies in Toledo's training program. The investigation report concluded that "[the] current training system does not fully assess if a person has mastered the material being taught. . . . [The] operator had passed the written training test with a 100% and passed the field test with good ratings on the first try in 2000." However, subsequent to these tests, the operator had been taken off shift for retraining due to an earlier incident. The retraining consisted of reviewing procedures and walking through systems. A formal training plan or written field test was not given.

New employees. The Panel interviewed a number of recently hired employees, some of whom reported concerns about their training. For example, some recently hired employees expressed the concern that some of the supervisors who were training and testing the employees were themselves inexperienced; according to the interviewees, the supervisors and new hires were essentially learning together. As a result, interviews at some of the refineries indicated that a new employee could pass field examinations with incorrect steps and procedures because the supervisor performing the training also did not know the procedures. A number of training coordinators confirmed this situation and explained that the standards for becoming qualified on the units was not sufficiently rigorous and that some operators had been assigned to work on units without adequate knowledge of the units. According to a 2005 behavioral safety culture assessment report for Whiting, a number of hourly employees indicated that training lacks rigor and is focused on "training for compliance rather than training for execution excellence." The gap analysis report prepared for Texas City relating to the new integrity management standard noted that "[m]ost units do not have a testing process to verify that training has been understood." In addition, optimization managers interviewed in several refineries commented that their board operator training programs were not effective at preparing new board operators.

First level leaders (Supervisors). As the name suggests, first level leaders represent the first level of supervision for refinery operators. First level leaders work in close proximity to refinery hazards. They also supervise the activities of a number of operators, who also work in close proximity to refinery hazards. Corporate managers emphasized the importance of first level leaders, stating that such a position is "the single most important position" and that the first level leader "holds it all together."

The Panel found nothing to indicate that any of the refineries had a requirement that a new first level leader be tested on, or be familiar with, the equipment in the unit or that he or she have any minimum job tenure before promotion to that position. For example, the Carson refinery does not define the prerequisites for achieving first level leader status, the level of refresher training necessary to maintain first level leader status, or a curriculum for its first level leaders. Likewise, the Mogford Report states that "[t]he Investigation Team was unable to identify any specific management/supervisory training requirements for first level supervision or step-ups."[44] The Stanley Report also found that at Texas City "[t]here is no system for ensuring that 'step up' supervisors and supervisors have the necessary skill sets to be effective safety leaders."[45] Most first level leaders come from the ranks of the hourly workers, and it is common for an hourly worker such as an operator to accept a first level leader position and then supervise the same peers with whom he or she had been working. Hourly operators are also asked from time to time to "step up" to act as temporary unit supervisors, with responsibility for the supervision, instruction, and discipline of their hourly peers.

The lack of basic job experience among certain supervisors caused some Whiting refinery workers to express concern that new board operators and supervisory personnel did not have sufficient experience to lead shift operations. The lack of prerequisite knowledge and formal training systems can result in shift supervisors who are not experts on their process unit's systems.

BP has recognized the need for better training of first level leaders and has created the position of Vice-President for Organization Capability in its new Safety and Operations Group. During interviews, this new Vice-President indicated that training for first level leaders is one of the first programs that Safety and Operations would implement.

Refinery managers have also requested more training for first level leaders. In early 2005, the Refining technology group designed a training program for operations superintendents and piloted the program in Whiting in mid-2006. The 40-hour pilot program contained both computer-based training and a two-day workshop. No similar program exists, however, for first level leaders. The refinery plant managers have requested that a training program similar to the new program for superintendents be developed for first level leaders.

Engineers. During interviews, engineers routinely indicated that they believed they were not given sufficient training to do their jobs. A number of engineers interviewed also stated that no formal mentoring program was in place for engineers. A February 2003 third-party assessment report, which focused on the Carson refinery, states that "[e]ngineers were last trained about 2 years ago on the [management of change] process. There has been no additional training on this process despite significant personnel turnover in engineering positions—which are the primary initiators of process and equipment changes."

Interactive training. The Panel's assessment indicates that portions of the U.S. refining workforce desired more interactive training methods, such as gun drills and mentoring, to develop process safety skills. A 2006 process safety management audit report for Texas City determined, based on interviews of operators, supervisors, superintendents, and operating unit training coordinators, that "gun drills have proven to be an effective means of delivering meaningful refresher training, when executed for a mixture of both group exercises . . . as well as a one-to-one basis . . . ."

Hourly employees repeatedly indicated during interviews that formal gun drills were sporadic at best or not conducted at all. The 2005 Carson process safety management review reports that no gun drills were in place to regularly train operators on emergency "safe off" procedures for stopping operating units and equipment in a safe manner. The 2003 operator competency assurance model audit at Toledo found that gun drills and employee testing were inconsistent. The Mogford Report on the 2005 Texas City tragedy found that "[g]un drills were not being conducted" and that "[t]he lack of gun drills to reinforce practical knowledge meant that operators' theoretical knowledge was not complete and rarely witnessed."[46] The Stanley Report also found that at Texas City "the utilization of gun drills is inconsistent" with the "range of utilization go[ing] from once or twice a month to not having a gun drill in the past two years."[47] The 2006 third-party audit report for the Texas City refinery recommended that the refinery "[c]onsider revaluating the content and effectiveness of refresher training (including gun drills) on critical procedures for emergency operations and emergency shutdown . . . ."

Hourly employees at all refineries also stated during interviews that formal and informal mentoring was rare or nonexistent. According to a 2006 behavioral safety culture assessment report for Toledo, interviewees indicated that while a formal mentoring program exists, rarely are on-the-job training mentors formally assigned to new operators. The report concluded that "[t]he result of this may be that the unit training for new operators is unsystematic, somewhat disorganized, and susceptible to inconsistencies and contradictions." Similarly, the 2004 Cherry Point behavioral safety culture assessment report indicates that typically, the on-the-job training is assigned to supervisors who are already overloaded. The same report indicates that in some areas of the refinery, "newbies" were training "newbies" and that while on-the-job training was significantly behind schedule, employees were nevertheless being required to work at full-performance level.

Refresher training. Interviewed refinery workers also commented frequently about the inadequacy of refresher training on material that previously had been taught. Refinery management interviews indicated that routine refresher training on process hazard analysis or hazard and operability assessments was not generally available. Additionally, the Mogford Report states that

> [a]lthough efforts had been made to raise general process safety awareness and understanding in the early 1990s when OSHA promulgated the PSM rule, this training had not been effectively refreshed over the intervening years. There was little ongoing training in process hazards risk awareness and identification for either operators or supervisors/managers. PSM-related materials have been distributed through e-mails and VTA, but these communication channels do not appear to have been effective in maintaining awareness and understanding.[48]

The gap analysis performed at Texas City against the new 2006 integrity management standard also identified a deficiency in the periodic verification of personnel's understanding of training previously received. Moreover, the 2005 HRO assessment at Cherry Point noted the lack of an operator requalification program.

Rushed training. During interviews, some employees reported pressure to complete training and to rush employees into the field. One training coordinator explained that even though there was an insufficient number of trainers at Toledo, substantial pressure existed to increase the number of qualified operators.

Training resources. Information that the Panel reviewed indicates that BP has not always ensured the availability of adequate resources for training. The Panel is not aware of a refinery's specific request for training resources that BP corporate management denied. Nevertheless, through its review, the Panel noted symptoms associated with inadequate training, including poor hazard awareness in various situations, such as the Whiting rupture disk situation. In addition, the Panel noted that prior reductions in training staff had taken place. However, some of these reductions at Texas City occurred before BP acquired the Texas City refinery.

Information relating to BP's Texas City refinery clearly demonstrates prior deficiencies in resources for training. For example, the Texas City refinery performed a gap analysis against the new integrity management standard indicating that the refinery had insufficient resources dedicated to training. The Mogford Report states that at Texas City, the "[s]pending level and headcount [for the refinery's Learning & Development Department] peaked in 1998 . . . ."[49] The same report shows the following training budget and declining headcount for the period 1997-2005.

Table 45

Learning and Development Department Training Budget (Texas City)

Year	Actual Spending $000	Resource Allocation Full Time Employees
1997	1,728.40	30
1998	2,847.90	28
1999	1,114.47	21
2000	1,413.51	~17.5
2001	1,250.75	~11.5
2002	1,111.76	10
2003	1,220.30	9
2004	1,429.70	8
2005	1,700.00*	9

* Budgeted amount

Although the Panel requested this type of information for the other refineries, BP was not able to provide it in the same form or in the same level of detail.

In 2003, BP conducted an operator competency assurance model audit at Toledo. While some bright spots were found, the audit concluded that training at Toledo was "reactive instead of proactive" and that there was a failure to establish and maintain a training department because there were "no well-defined comprehensive training plans/budgets/resources."

Additionally, hourly, supervisory, and managerial-level refinery employees commonly commented about insufficient resources dedicated to safety training. For example, operators, managers, and training coordinators said that BP did not provide enough trainers to assure that all operators received the requisite level of training to operate safely. The 2003 operator competency assurance model audit at Toledo found an insufficient number of training coordinators at the refinery.

Both the Stanley Report and the Mogford Report discuss evidence indicating that training personnel at Texas City were not spending sufficient time actually engaged in training activities. The Stanley Report states that unit trainers were expected to spend 85 to 90 percent of their time on unit training needs, but were in fact only spending 30 to 80 percent of their time on training activities.[50] Likewise, the Mogford Report found that one unit training coordinator only spent approximately 5 percent of his time on training activities and that the site average was only estimated to be about 30 percent.[51]

Information from refinery-level interviews and other information that the Panel obtained also indicates that training manuals used at the refineries were often outdated. The 2005 Carson process safety management audit indicates that some training manuals being used for operator initial qualification training were not current, including an observation that one manual in use dated to 1988. One 2003 article in the Toledo Tower Magazine on the training of new hires notes that "[o]ne area that they felt could be improved involved outdated training materials, both initial and unit specific." The gap analysis performed at Texas City against the new integrity management standard identifies out-of-date training manuals as a gap that needed to be addressed. In 2005, the operations and maintenance foremen at Carson held a series of meetings under a program called "Operation People" in which participants discussed what it would take to make Carson a better refinery. In October 2005, a document summarizing the feedback from that meeting was released, which relayed the recurring theme that training manuals were out of date.

The Panel's review also obtained information indicating that greater use of simulators might reasonably be expected to improve the training of some portion of the refinery workers. Cherry Point has had a simulator for many years, and interviews indicate that the operators there believe that the simulator has been effective to increase skill levels. Cherry Point management and consultants have suggested that BP purchase simulators for the other refineries. The Mogford Report on the Texas City tragedy likewise observes the lack of simulator training for operators at Texas City and recommends that process simulators be provided:

> While it is very difficult to quantify "incidents that won't occur" and "improved operator performance" the [investigation] team believes that the advantages to the site from the use of simulator training would be significant. In order to leverage the use of simulators to their best value, a clear simulator strategy is needed, outlining most-likely-to-be-realized benefits, and critical success factors. This needs to be backed by resources to develop meaningful ongoing training and optimization programs.[52]

The process safety culture survey and other information. Several items in the process safety culture survey solicited impressions of employees and contractors at BP's U.S. refineries relating to process safety training—training on hazard identification, control, and reporting; training to provide an understanding of process safety risks; training necessary to perform jobs safely; training on prevention of process-related incidents, accidents, and near misses; and training on recognizing when a process should be shut down. Survey data from these items reveal mixed impressions: in some instances, data indicate that respondents at BP's five U.S. refineries had quite positive process safety impressions; in other instances, data indicate quite negative impressions. As with much of the survey data in other areas, respondents at BP's Carson and Cherry Point refineries tended to have more positive impressions of training, while respondents' impressions at Texas City and Toledo tended to be more negative. Survey responses from Whiting were generally in between Carson and Cherry Point, on the one hand, and Texas City and Toledo, on the other.

Survey data on identifying, controlling, and reporting process hazards. At each of BP's U.S. refineries, at least 30 percent of contractors indicated that their refineries did not provide adequate training on hazard identification, control, and reporting. At all refineries except Whiting, there were similar responses from more than 20 percent of employees in at least one of the six process safety functional groups shown in the table below. At Carson, there were two such groups (maintenance/craft technicians and maintenance management); at Cherry Point, there was one (maintenance/craft technician); and at Texas City and Toledo, there were three (operators, maintenance/craft technicians, and HSSE employees). On the other hand, at Cherry Point, five of the six employee groups had generally positive responses, as reflected by the fact that their negative response rates were less than ten percent. At Whiting, moreover, responses from employees in each of the six groups were generally positive.

Table 46

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"This refinery provides adequate training on hazard identification, control and reporting."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	15	5	22	27	11
Maintenance/Craft Technicians	33	28	30	44‡	14
Full-Time HSSE Employees	8	8	36	26‡	10
Engineering Professionals	15	7	19	11	2
Operations Management	10	2	19	16	5
Maintenance Management	29‡	0‡	18	*	3
Contractors	30	36	32	57	38

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

In contrast, many contractors and employees in most process safety functional groups indicated that they had received training on hazard identification, control, and reporting within the last 12 months. Generally, 15 percent or less of these workers responded that they had not received training during that time period. But the percentages of workers responding negatively were higher in a couple of instances. For example, 32 percent of HSSE employees at Toledo[53] and 21 percent at Texas City responded that they had not received training during the preceding 12 months. Notwithstanding these exceptions, the overall positive data appears to indicate that worker perceptions regarding training inadequacy were based not on an absence of training but primarily on the quality and effectiveness of the training received. Responses to other survey items discussed below support this conclusion.

Survey data on understanding of process safety risks. Impressions of employees and contractors at BP's U.S. refineries were very mixed on whether the training they had received provided them with a clear understanding of process safety risks at their refineries. Several employee groups had relatively positive responses, as indicated by the fact that at all refineries except Texas City, one or more groups provided negative response rates below ten percent. On the other hand, some of the highest percentages of negative responses came from maintenance/craft technicians and from contractors. Specifically, negative response rates for maintenance/craft technicians ranged from a low of 19 percent at Cherry Point to a high of 44 percent at Toledo, and four refineries had negative response rates in excess of 30 percent. In addition, negative response rates for contractors ranged from a low of 29 percent at Carson and Cherry Point to a high of 39 percent at Texas City.

Table 47

Percentage of Agree/Tend to Agree Responses to Survey Item:
"The training that I have received does not provide me with a clear understanding of the process safety risks at my refinery."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	18	10	35	26	18
Maintenance/Craft Technicians	35	19	42	44‡	32
Full-Time HSSE Employees	8	15	17	42‡	8
Engineering Professionals	8	12	20	11	17
Operations Management	10	10	17	7	21
Maintenance Management	0‡	6‡	26	*	12
Contractors	29	29	39	35	38

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Survey data on adequacy of training. As seen in the following four tables, survey responses revealed that workers had mixed perceptions about whether they and others had received necessary process safety training to do their jobs safely. In regard to an item addressing the training of *new workers*, responses were generally positive, especially at Carson and Cherry Point. Concurrently at these two refineries, the negative response rates did not exceed 15 percent for contractors or any of the six employee groups shown in the table below. Four employee groups at Carson had negative response rates of ten percent or less, and all six employee groups at Cherry Point had negative response rates of less than ten percent. At Texas City, however, operators, maintenance/craft technicians, HSSE employees, and engineering professionals had negative response rates of 20 percent or more. In addition, at Toledo, operators and maintenance/craft technicians had negative response rates in excess of 20 percent.

Table 48

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "The following receive the necessary process safety training to do their job safely: New workers."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	15	8	26	29	18
Maintenance/Craft Technicians	13	7	29	38‡	11
Full-Time HSSE Employees	3	8	26	11‡	18
Engineering Professionals	10	7	20	19	10
Operations Management	0	2	17	9	8
Maintenance Management	0‡	6‡	11	*	6
Contractors	12	13	13	9	14

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

In regard to a similar survey item addressing the training of *experienced workers*, responses again were generally positive, particularly at Carson and Cherry Point. At Texas City, however, operators, maintenance/craft technicians, HSSE employees, and engineering professionals had negative response rates exceeding 20 percent. Moreover, at Toledo, 22 percent of operators and 23 percent of engineering professionals responded negatively.

Table 49

Percentages of Disagree/Tend to Disagree Responses to Survey Item: "The following receive the necessary process safety training to do their job safely: Experienced workers."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	8	6	23	22	17
Maintenance/Craft Technicians	8	4	25	13‡	17
Full-Time HSSE Employees	5	8	31	16‡	16
Engineering Professionals	11	2	22	23	11
Operations Management	3	2	17	5	7
Maintenance Management	0‡	6‡	16	*	3
Contractors	8	8	11	5	9

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Another survey item addressing supervisors' training also yielded generally positive responses from Carson and Cherry Point but more negative responses at Texas City and Toledo. At Carson and Cherry Point, all employee groups in the table below (other than Carson operators) had negative response rates of ten percent or less. Moreover, the negative response rates for Carson operations management and maintenance management[54] were zero percent. At Texas City, however, 24 percent of maintenance/craft technicians and 20 percent of operators responded negatively. Moreover, at Toledo, there were negative responses from 31 percent of maintenance/craft technicians and 30 percent of operators.

Table 50

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"The following receive the necessary process safety training to do their job safely:
My supervisor."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	12	8	20	30	17
Maintenance/Craft Technicians	10	4	24	31‡	11
Full-Time HSSE Employees	3	4	17	16‡	13
Engineering Professionals	10	2	12	19	6
Operations Management	0	5	14	9	4
Maintenance Management	0‡	6‡	4	*	3
Contractors	6	8	11	9	13

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

For the series of four survey items addressing whether particular types of workers received the necessary training to do their job safely, the highest overall percentages of negative responses stemmed from an item addressing whether *contractors* had received necessary process safety training. For that item, the highest negative response rates came from Texas City, Toledo, and to a lesser extent Whiting. When compared to data for the other three items discussed above, these data indicate a perception among a significant portion of several respondent groups at multiple refineries that contractors in particular were not receiving process safety training needed to perform their jobs safely. The Panel notes that this data could be affected by the substantial tension that exists between hourly employees and contractors at Texas City and Toledo. Responses from Carson and Cherry Point, however, were more positive than responses from the other refineries. Of the six employee groups for these two refineries indicated in the table below, only one group—Carson maintenance/craft technicians— had a negative response rate in excess of 20 percent. Moreover, our employee groups at both Carson and Cherry Point had very positive responses.

Table 51

Percentages of Disagree/Tend to Disagree Responses to Survey Item:
"The following receive the necessary process safety training to do their job safely:
Contractors."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	18	11	39	38	12
Maintenance/Craft Technicians	21	8	37	56‡	21
Full-Time HSSE Employees	3	8	37	21‡	21
Engineering Professionals	3	5	18	27	8
Operations Management	3	2	31	12	1
Maintenance Management	0‡	13‡	22	*	6
Contractors	15	18	16	20	21

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Survey data on adequacy of training to prevent incident. Survey data provide a mixed message regarding perceptions of whether process safety training was adequate to prevent process-related incidents, accidents, and near misses. Responses were fairly positive overall at Carson and Cherry Point. However, a relatively high percentage of certain workers in various process safety functional groups at Texas City, Toledo, and Whiting expressed a belief that such training was inadequate. At Texas City, for example, 31 percent of operators, maintenance/craft technicians, HSSE employees, and engineering professionals responded negatively. Twenty-nine percent of operators and 25 percent of maintenance/craft technicians at Toledo[55] responded in the same manner, as did 23 percent of operators and 20 percent of maintenance/craft technicians at Whiting.

Survey data on adequacy of training to shut down a process. Finally, pockets of concern were evident in responses to a survey item about whether process safety training enabled workers to recognize when processes should be shut down if safety critical interlocks, alarms, or other process safety devices failed or became unavailable during operation. Thirty-eight percent of maintenance/craft technicians at Texas City and Toledo[56] did not believe that their training allowed them to recognize when a process should be shut down in such a situation. At Whiting, 29 percent of maintenance/craft technicians responded in the same manner. Other personnel who had relatively high negative response rates included operators at Toledo (22 percent); HSSE employees at Toledo (32 percent)[57] and Cherry Point (23 percent); engineering professionals at Toledo (31 percent), Texas City (27 percent), and Whiting (22 percent); and contractors at Whiting (28 percent) and Cherry Point (22 percent). With the exception of maintenance management at Texas City (20 percent negative response rate), however, management tended to produce relatively low percentages of negative responses.

Other information relating to training and competency. Additionally, a number of hourly, refinery management and supervisors, and corporate level managers who were interviewed indicated that the training for operators at BP's U.S. refineries often is not sufficiently rigorous or extensive to prepare operators for the full range of their job responsibilities. According to BP's 2005 Integrity Management Report that BP Group Technology prepared, 46 percent of integrity management major incidents in the BP Group were linked to a lack of competence, which includes a lack of appropriate training. While this figure is not limited to Refining, it does include incidents from Refining.

In a 2005 behavioral safety culture assessment report for Whiting, hourly employees indicated that training lacked rigor and was focused on training for compliance rather than training for execution excellence. Moreover, the same report states that "[t]here is concern that employees are not adequately skilled in 'picking out weak signals' and are not able to deal effectively with weak signals when they do recognize them." The

Whiting report also states that "many interviewees expressed concern that they would not be adequately prepared should a significant 'upset' occur." This same concern was mirrored in the Carson and Toledo behavioral safety culture assessment reports, which indicate that employees expressed concern that the lack of hands-on training put them at risk of not being able to respond to a significant upset. Likewise, a 2006 audit report at Texas City that a consulting firm conducted under the terms of the 2005 OSHA settlement found that three of fourteen employees could not adequately describe the actions required for an emergency shutdown and/or emergency operation selected for an impromptu gun drill for their unit. According to a 2004 behavioral safety culture assessment report relating to Cherry Point, employees consistently reported "that job-specific training is inadequate, not all employees are sufficiently competent in the basics, and not all employees are adequately prepared to '*get out of situations safely.*'"

At the Texas City, Toledo, and Whiting refineries many hourly employees who were interviewed reported that contractors were not sufficiently trained in process safety and that such contractors put the refineries at risk because they did not fully understand many of the safety hazards with which they were working. Hourly employees often stated during interviews that contractors were not sufficiently trained or qualified to perform specific tasks at the refinery, which they felt resulted in a lower quality of work so as to put the refinery at risk. However, employees at the Carson and Cherry Point refineries commonly stated that contractors had a good safety culture and that they were sufficiently trained to do their jobs. The Panel recognizes that some of the negative comments regarding contractors may arise from tension between BP employees and contractors that are unrelated to actual process safety concerns.

Information that the Panel gathered during its review indicates that BP does not always assure that the contract companies that work at its refineries are sufficiently qualified and have conducted the necessary audits to ensure the competency of their employees. For example, a 2005 behavioral safety culture assessment report for Carson indicates that some contract companies were being hired to work at the Carson refinery even though these companies did not have a current audit or had not resolved deficiencies uncovered in their most recent audit. The same report also observes that subcontractors were not systematically being screened on their safety record. Additionally, subcontractors did not always have a current or acceptable audit on file that would demonstrate a competence to work at the refinery. Likewise, the 2003 gHSEr Audit—Summary of Findings, which outlines key issues found in multiple gHSEr audits, indicates that the BP contractor management system was not rigorously applied, resulting in a tolerance of noncompliance with regards to contractors.

Finding:

BP has not adequately ensured that its U.S. refinery personnel and contractors have sufficient process safety knowledge and competence.

Computer-based training. Based upon information it received, the Panel believes that at most of BP's U.S. refineries, the implementation of and overreliance on BP's computer-based training contributes to inadequate process safety training of refinery employees. BP has multiple training methods at its disposal for training operators at its U.S. refineries. Such training methods include computer-based training, gun drills, mentoring, on-the-job training, and classroom training, and each of these methods has advantages and limitations. For example, computer-based training, while useful for informing personnel about changes and effective in teaching certain types of subject matter, is less effective at developing adequate process safety awareness and the skills and ability needed to apply knowledge in actual operations.

At all of the refineries except Cherry Point, both hourly and management level interviewees reported that training was inadequate because it tended to rely too heavily on computer-based training. Comments from corporate-level managers generally reinforced this view, confirming that BP's U.S. refineries rely too heavily on computer-based training programs and indicating that BP's refinery training program needs to consist of a better blend of hands-on and computer-based training. Additionally, the Mogford Report, in addressing the training at Texas City, states that "[t]he heavy reliance on computer based training . . . appears to limit the overall effectiveness of the training program."[58]

Feedback that the Panel received during its review indicates that effectiveness of the computer-based training itself suffers from an apparent lack of rigor and an inability to adequately assess a worker's overall knowledge and skill level. Both hourly and management-level employees stated during interviews that computer-based training was "easy" to pass and that a correlation did not always exist between a given employee's ability to pass the computer-based training tests and his or her abilities in the field. For example, a 2001 root cause analysis report relating to an incident at the Toledo refinery involving an operator stated that the training system does not fully assess if a person has mastered the material being taught, noting that the operator in question passed a training test with a 100 percent score. Although employees must eventually pass the computer-based tests, BP's U.S. refineries commonly provide repeated opportunities for employees to retake the same tests if needed. Some employees suggested that these repeat opportunities were almost unlimited. Interviewees also indicated that an employee could take an exam, find out what questions he got wrong and why, and then immediately retake the exact same exam with the same questions. Moreover, employees interviewed at different refineries stated that because of this system of repeatedly retaking the same computer tests, it was virtually impossible for workers ultimately to fail the computerized tests. Hourly workers also mentioned instances in which supervisors took the training tests for workers.

Finding:

At most of BP's U.S. refineries, the implementation of and over-reliance on BP's computer-based training contributes to inadequate process safety training of refinery employees.

> Inadequate process safety knowledge and competency is a theme common to other panel findings

The Panel also believes that deficiencies relating to process risk knowledge and competence in BP's U.S. refining organization are likely contributing causal factors for other findings elsewhere in this report. For example,

- Instances of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks existed at each of BP's U.S. refineries.
- BP has not adequately established process safety as a core value across its five U.S. refineries.
- BP mistakenly used improving personal safety performance (*i.e.*, personal injury rates) as an indication of acceptable process safety performance at its five U.S. refineries; BP's reliance on this data and inadequate process safety understanding created a false sense of confidence that it was properly addressing process safety risks at those refineries.
- BP's investigation system has not instituted effective root cause analysis procedures to identify systemic causal factors.
- BP's process safety management system likely results in under reporting of incidents and near misses at BP's U.S. refineries.

As discussed elsewhere in this report, the Panel believes that the effects of widespread deficiencies in process safety training and education have manifested themselves in a number of ways at BP's U.S. refineries.

> Steps BP has taken to date

In recognition of the need to better determine the qualifications and competencies required of its workforce, including its U.S. refining workforce, BP has established in its Safety and Operations functional group a new position titled Vice-President of Organization Capability. BP has advised that the responsibilities of this position include developing plans to identify the skills and capabilities that are required for different work groups within the BP organization, including the U.S. refineries; assessing the capabilities of the workforce; and addressing any gaps or deficiencies in skills and capabilities through, among other things, training and development programs. BP has also advised that

- its Safety and Operations functional group is developing Group-wide training programs for leaders, including first level leaders (supervisors), superintendents, and operators;
- the training programs being developed for leaders include new training protocols and standards on safety across the Group;
- Refining has instituted an operations superintendent training program;
- its human resources function is developing Group-wide training programs for all managers and supervisors; and
- its Safety and Operations functional group is developing a set of standardized principles and expectations for board operator training.

In addition, the Panel understands that BP has taken or has begun to take a number of actions at Texas City relating to training and skill development. For example, BP has advised that at Texas City, it has instituted leadership development and other training programs involving a projected 300,000 training hours per year and has implemented enhanced training programs for all employees, including orientation for new hires, start-up and distillation training, and education on safety and environmental compliance, operations, and operator competency. For a brief listing of measures that BP has undertaken or announced since March 2005, including measures relating to training, see "BP Post-Texas City Measures" in Appendix F.

TRANSLATING CORPORATE EXPECTATIONS INTO MEASURABLE CRITERIA AND DEFINING THE APPROPRIATE ROLE OF QUALITATIVE AND QUANTITATIVE RISK-MANAGEMENT CRITERIA

Much of what already has been discussed in this section relates to areas of BP's process safety management system that the Panel has found to have been executed ineffectively. These systemic issues involve hazard identification and analysis; timely compliance with internal standards, including equipment and plant inspections and maintenance; and timely implementation of external good engineering practices. Section VI.C discusses in more detail BP's efforts to measure, evaluate, and improve process safety performance through the use of performance metrics, including both lagging and leading performance indicators.

The remainder of this section discusses the Panel's finding that notwithstanding BP's Group-level aspirational goal and expectation of "no accidents, no harm to people, and no damage to the environment," BP's safety management system does not effectively translate its corporate expectations into measurable criteria for the management of process risk or define the appropriate role of qualitative and quantitative risk management criteria.

An effective process safety management system identifies hazards, assesses risk, and prioritizes process risk reduction opportunities so that management can take appropriate measures to reduce the likelihood and/or severity of process-related incidents. Such a system builds upon the Plan-Perform-Measure-Improve cycle that is described in Section VI.C. In the process safety area, this improvement cycle should include, in practice, continuous reduction of process risk and improvements in safety performance according to some measurable criteria. Continuous improvement means

- improving controls for process hazards, including improving process safety knowledge and competence of workers;
- improving process safety leadership of supervisors;
- improving process engineering to identify and then design to remove or mitigate the effects of process hazards;
- going beyond legal compliance to best practices to reduce risks;
- going beyond mere compliance with internal standards, but learning from operating experiences, incident and near miss investigations, hazard studies, audits, and other assessments to improve those internal standards; and
- identifying and implementing not only those external standards that must be observed, but also those that represent best practices that can lead to process safety excellence.

An effective process safety management system should also prioritize process risk reduction opportunities so that management can take appropriate measures to reduce the likelihood and/or severity of process-related incidents. This statement raises various questions. For example, how should risks be measured so that they can be prioritized? By what criteria should risks be assessed? How should the benefits of risk reduction be measured or taken into account? If risk elimination is not possible, to what extent should process risk be reduced? What elements or tools does the management system use to accomplish risk reduction objectives? What tools does the management system provide to local refineries to make practical decisions that affect process safety performance? How should a refinery determine what amount of resources to devote to any of a number of process safety uses that could improve process safety performance?

> BP group standards, guidance, and expectations

As discussed in Section V and elsewhere in this report, BP has simply described the goal of its health, safety, and environmental system: "no accidents, no harm to people, and no damage to the environment."[59] BP's gHSEr management framework articulates the expectation for accomplishing this goal in 13 elements and 11 related key processes; together, such elements and key processes "encompass the complete spectrum of health, safety and environmental risk management . . . ."[60] According to gHSEr, local managers of businesses, which include plant managers for BP's U.S. refineries, are accountable for implementing appropriate documented systems and processes for each expectation.[61]

gHSEr also discusses briefly some key concepts of and strategies for risk management. Key HSE Process 3 in gHSEr defines the term "risk assessment" as "the process of estimating the likelihood of an accident occurring, estimating the magnitude of the consequential loss and making a judgment about the significance and tolerability of the risk."[62] The guidance from that same Key HSE Process indicates that risk is a function of both frequency and consequence and that risk may be expressed either qualitatively or quantitatively (in dollars or expected mortality per year). In addition, the same guidance states that "[s]trategies [for risk management] must be cost effective; if they are not, the organization *may* be safe but will certainly *not* be competitive."[63]

As discussed in Section V, other Group standards on process safety/integrity management also provide high-level guidance for implementing gHSEr expectations relating to process safety. Among other requirements, the 2001 standard provided that each facility must "systematically identify hazards within its boundary arising from normal and abnormal operations and shall eliminate/control/mitigate the hazards so that residual risks are as low as is reasonably practicable." BP's new 2006 integrity management standard sets out ten integrity management standard elements and related mandatory requirements necessary to satisfy the BP Group values. Compliance with the new standard is required by the end of 2008.

BP's engineering technical practice (ETP) relating to major accident risk also provides guidance on managing process risks. Under this guidance, the Company's business units assess societal risk by determining the risk of multiple fatalities and environmental risk from potential major accident scenarios at a particular site. The assessment technique considers potential catastrophic and major incidents, such as fires and explosions, on a high level. It is designed to provide a measure of overall risk compared to a Group reporting line, based upon typical industry criteria, to highlight if a risk reduction program should be a priority. This Group guidance indicates that a process of continuous risk reduction should be applied both to major accident risks that are above the Group reporting line level, which are required to be reported to the Group level, and to risks below that reporting line, which are required to be reported to the appropriate level within the business segment. As a result, this engineering technical practice permits management to take appropriate action to reduce risks as the high expectations of gHSEr contemplate.

> Programs for reducing process risk

Programs and practices that address process risks. The Panel notes that BP has implemented a number of programs and practices designed to address and reduce, to some extent, process risks in BP's five U.S. refineries. As discussed elsewhere in this report, these programs and practices include

- *the 2006 Group integrity management standard* (see Section V) and gap analyses designed to bring actual practices at BP's five U.S. refineries into compliance with the standard by the end of 2008, including development of a hazard and risk register at each refinery;
- *engineering technical practices* that provide guidance on numerous topics including major accident risk and the design and location of occupied portable buildings;
- *local refinery process safety management programs*, including conducting process hazard analyses, performing management of change analyses, training programs, and programs for inspecting and maintaining equipment;
- *process safety minimum expectations*, which the Panel's technical consultants recognized as an excellent practice (see Section V.C.);
- *periodic audits and assessments* of process safety and integrity management performance and process safety management;
- *establishment of Texas City and U.S. program offices* for the purpose of addressing and tracking responses to recommendations that have been made to improve the U.S. refineries from lessons learned from the Texas City incident and from various cultural assessments; and
- *introducing new process safety performance metrics* of action item closure, compliance with process safety minimum expectations, overdue inspection rates, and loss of containment measurements.

In early 2005, prior to the Texas City incident, BP also initiated a program known as the maintenance accelerator program (MAP). BP's U.S. refineries are currently in the process of implementing this new program. The MAP was designed primarily to improve availability through maintenance principles and practices, and the stated vision of the MAP is to optimize availability, to maximize overall commercial delivery, and to create a "step change in asset availability." The MAP incorporates process safety into its minimum requirements and includes an expectation that process safety requirements are met.

BP's MAR program. Of the programs and practices listed above that address process risk, only BP's major accident risk (MAR) program appears to provide measurable criteria for the management and ongoing reduction of process risk. BP's various other programs and standards, including the process safety minimum expectations or PSMEs, do not provide such measurable criteria. For example, the PSMEs establish minimum expectations for various hazardous substances and processes, including hydrofluoric alkylation. BP's U.S. refineries monitor compliance with those minimum expectations through gap analyses conducted periodically. When gaps are identified, a plan is developed to eliminate the gap. However, the PSMEs do not contemplate or provide for continuous risk reduction beyond the minimum expectations. The new integrity management standard requires that each U.S. refinery identify and mitigate integrity management hazards and risks and that BP Refining identify in its annual engineering plan the top five integrity management risks. Yet, the standard provides no further measurable criteria or guidance for process risk management or reduction except to require all BP operations with the potential for a major incident to assess their risks using the MAR process as described below. Other than the MAR process, BP's standards and practices neither define nor provide guidance to the U.S. refineries on the appropriate role of qualitative or quantitative risk management criteria.

Inherent limitations of BP's MAR program. BP's MAR program attempts to identify potential incidents that could result in multiple fatalities and/or severe damage to the environment or impact on the reputation of the BP Group. The MAR assessment focuses on incidents that could have such a large consequence that they could threaten the sustainability or existence of the entire BP Group. BP's refining process safety/integrity management audit protocol and its new 2006 integrity management standard mandate the MAR program for assessment of major accident risks.

The MAR program has significant limitations and is not intended to be the sole hazard evaluation and risk management tool available to BP refinery management. Other hazard management tools available to manage risks include management of change procedures, hazard identification, hazard and operability studies, quantified risk assessments, and internal standards or guidance, such as BP's engineering technical practices.

As described in the Mogford Report, Texas City conducted a MAR assessment for the Texas City site in March and April 2003. While the assessment addressed the top 80 risks of the site, it did not recognize or include any risks from blowdown drums or the ISOM unit that was involved in the Texas City accident.[64] The Mogford Report notes that a site environmental assessment at Texas City identified the blowdown drums during shutdowns and relief valve releases as the second highest ranked item. The Mogford Report also notes that "it is apparent that the blowdown drums did not receive the same focus for safety risks as they did for environmental risk."[65]

The MAR engineering technical practice and continuous risk reduction. The ETP that prescribes the MAR process states that all BP operations should have a process in place to demonstrate continuous risk reduction. This ETP further provides:

> Because of regional cultural differences (e.g. over the applicability of cost benefit approaches) there is no Group mandated approach. Segments, with input from the Regions, should decide how this can best be achieved and what metrics should be adopted.

The ETP then provides two examples of possible ways to establish risk reduction. First, the ETP provides as an example the establishment of target timescales to progressively reduce risks as shown by a plot of possible cumulative frequency of events resulting in some number of fatalities. For example, the target timescale might be to reduce total risks to be at least some factor below the Group reporting line in some specified number of years. Second, the ETP provides an example of continuous risk reduction using a risk reduction matrix based on risk rankings of scenarios that the MAR process generates. In this approach, targets could be established based on priority ranking. For example, 100 percent of priority 1 risks and 95 percent of priority 2 risks within the segment could be targeted for reduction by at least one priority level within X years.

The ETP also indicates that a cost-benefit type analysis may be used and that continuous risk reduction may be achieved by "[p]eriodically confirming that existing risks are being reduced towards a level where further expenditure to reduce risk would be disproportionate to the benefit achieved." This ETP provides some general examples of potential risk reduction measures that should be considered, but stops short of providing specific guidance or measurable criteria for risk reduction. The general examples of potential risk reduction include

- closing down or relocating the operation,
- relocating people,
- reducing the inventory of hazardous fluids,
- selecting a lower risk process over a higher risk one,
- mitigating the consequences of an accident,
- adding safety instrumented systems or upgrading the safety integrity level for an existing safety instrumentation system,
- developing new or modified procedures, and
- increased inspection or use of better inspection techniques.

The Panel did not see any credible indication that BP's five U.S. refineries were using these, or any other process or program, to drive in a comprehensive and systematic manner the reduction of process risks.

> The U.S. refineries gap analyses

For risks falling below the Group reporting line established under the MAR process, the current refinery practices described in Table 52 below confirm that BP has not implemented a systematic plan with qualitative or quantitative criteria to manage or continuously reduce process safety risks at its U.S. refineries.

In connection with the implementation of BP's 2006 Group integrity management standard, the U.S. refineries conducted a gap analysis to determine, among other things, steps that need to be taken to bring the refineries into compliance with the new standard. Each U.S. refinery responded to questions about how the process of continuous risk reduction is managed at that refinery, what gaps existed to meet the new integrity management standard, and what actions were needed to close identified gaps.

The table below contains the substance of the responses from the refineries to those questions.

Table 52

Gap Analysis under BP 2006 Integrity Management Standard Relating to Continuous Risk Reduction

Refinery Name	How is process of continuous risk reduction managed? Current Practices/Processes	Gaps to Meet IM Standard Expectation	Actions Needed to Close Gaps; Comments
Carson	No formalized process	No formalized process to manage continuous risk reduction.	Develop a formalized process for managing continuous risk reduction.
Cherry Point	Hazard operability studies, management of change, root cause finding analysis, and major accident risk analysis all identity potential risks that the Cherry Point refinery continually manages.	None.	None. [Comment: For the Refining SPU, this will be managed at an SPU level. New process required.]
Texas City	Hazard and operability study revalidations, risk studies.	[None identified.]	Implement Refining recommendations in this area. [Comment: For Global Refining, this will be managed at the Refining level. New process required.]
Toledo*	*	*	*
Whiting	The current process is managed by evaluating and prioritizing Availability Risks on a continuous basis. A matrix is used . . . to continually rank top items. Asset Operations Management reviews the top ranked items and appropriates/-schedules funding to promptly address acute hazards. .	Quantitative risk analysis using BP Group Standards are not in place. The Availability Risk Register may not currently be inclusive of all [Integrity Management] Risks by definition.	Assign accountability for completing major accident risk assessment to Integrity Management single point of accountability. Educate the site on how risks are assessed and managed to closure. Establish performance metrics to be included in the site annual performance plan. Consider associating risk reduction metrics with site VPP. [Comment: For the refining SPU this will be managed at an SPU level. New process required.]

* BP did not provide to the Panel a response from the Toledo refinery for this item.

The responses above indicate an absence of a comprehensive, holistic plan to reduce risk. The variety in the responses also indicates that the refineries do not know what is expected of them in terms of continuous process risk reduction programs. Each refinery had a different response, including one response (Carson) acknowledging no formal process risk reduction process. Two refineries, Cherry Point and Texas City, had similar descriptions of how risks were being managed, but different assessments of actions needed to close deficiencies. Refineries had different proposed plans to close gaps, ranging from a refinery plan to close the gap (Carson) to reliance on corporate management at the refining strategic performance unit level (Texas City, Whiting).

> The Mogford Report

The Mogford Report found that no plans existed at Texas City to systematically reduce safety risks at the refinery and that no individual or group seemed to have the accountability for driving process risk reduction across the site. For example, the report found that no plans existed regarding the ultimate replacement/reconfiguration of the blowdown stacks. The report also specifically found that site management did not appear to be focused on understanding and reducing the highest risks.[66]

> BP'S use of compliance audits

BP appears to have used to some extent infrequent process safety management audits, which are required to be conducted every three years, to manage toward continuous process risk reduction rather than to have implemented a management system that embodies continuous risk reduction criteria and methodologies. For example, the cover letter transmitting the report for the 2005 Carson process safety management audit states that

> [t]he review reflects the requirements of the Process Safety Community of Practice [Process Safety Integrity Management] compliance protocol that provides the bridge from the high-level gHSEr and [Process Safety Integrity Managment] expectations to actual plant [Process Safety Management] and [Risk Management Program] activities.
>
> Priority 2 actions reflect an opportunity and resolution is important to the continuous improvement of the Carson [Process Safety Integrity Management] and [Risk Management Program] processes.

Letters accompanying the process safety management audits for other refineries during the last few years have been substantially similar to the 2005 Carson letter.

gHSEr audit findings support this apparent misplaced use of compliance audits and reviews, rather than management systems. For example, the summary of findings relating to 2003 gHSEr audits found that "[t]here is a need for greater clarity on HSE monitoring (as part of an HSE management system), specifically . . . an entity's responsibility to monitor and audit its own processes to ensure that they are robust and operating as intended (rather than rely on external audits)."

> Conclusion on continuous risk reduction

Even though the MAR engineering technical practice, together with examples, illustrates techniques by which a program of continuous process risk reduction might be managed, the Panel's examination found no indication that Refining and Marketing generally, or BP's U.S. refineries specifically, have adopted or implemented any such risk reduction tools. Furthermore, the Panel's examination indicated that BP has not translated its aspirational, high-level corporate goals and expectations as provided in gHSEr and the 2001 process safety/integrity management Group standard into specific, operational criteria for managing process risk at the U.S. refineries. While the 2001 standard did express the "as low as reasonably practicable" standard for risk reduction, some senior leaders at the U.S. refineries appear generally not to have been aware of that risk reduction standard—and BP corporate-level management appears to have taken no meaningful steps prior to the Texas City incident to enforce that standard or to translate it into operational reality at its U.S. refineries.

Similarly, the Panel's examination did not detect any indication that BP defined for its U.S. refineries the appropriate role of qualitative or quantitative risk-management criteria. The new Group integrity management standard appears to maintain the status quo regarding continuous risk reduction by directing that such risk reduction process be managed at the segment level and continuing the requirement that global business units, such as Refining, identify their top five integrity management risks.

Interviews with various members of BP's corporate management confirmed a management expectation that safety, including process safety, will be continuously improved and that risks will be continuously reduced. Those same interviews confirmed that while the business segments were acknowledged within the organization to be responsible for developing a system for continuous risk reduction, Refining and Marketing has not implemented for the U.S. refineries in a systematic fashion the use of any risk reduction tools of the type described above in the engineering technical practice.

In the absence of more tangible guidance from corporate management, the information that the Panel obtained indicates that each of BP's U.S. refineries, acting chiefly as a separate business unit, essentially determined for itself how and when it would comply with the broad BP corporate process safety expectations and guidance on continuous risk reduction. The Panel did not receive information indicating that implementation of such a risk reduction system was a high priority for Refining and Marketing segment leadership, for Refining leadership, or for leadership at the U.S. refineries. In the absence of guidance from BP to the contrary, BP's U.S. refineries gave higher priority to other matters, including various initiatives from BP corporate. Most of the U.S. refineries continued to rely primarily on their legacy process safety management systems that did not use risk management decision-making tools to promote continuous risk reduction. The refineries did not effectively use qualitative or quantitative risk-management criteria by which to make decisions about managing process risks. BP corporate management provided no meaningful impetus to cause the refineries to do anything differently. As discussed in Section VI.C, periodic audits were performed against the OSHA process safety management standard, but those audits were never intended to provide a substitute for a management system to drive continuous risk reduction. While risk reduction was acknowledged to be a responsibility of each segment, it appears that BP Refining and Marketing leadership did not initiate continuous risk reduction processes or provide local refineries with tools, measurable criteria, and qualitative or quantitative criteria to accomplish such continuous risk reduction. Management interviews indicated that only after the Texas City accident did BP Refining and Marketing leadership begin to appreciate the lack of a holistic system to promote continuous risk reduction.

Finding:

> ***BP's process safety management system does not effectively:***
> ***(1) translate corporate expectations into measurable criteria for the management of process risk, or***
> ***(2) define the appropriate role of qualitative and quantitative risk management criteria.***

MATERIAL DEFICIENCIES IN PROCESS SAFETY AT BP'S U.S. REFINERIES

As discussed above in this section, the Panel's review indicates that material deficiencies in process safety performance exist at BP's U.S. refineries. Some of these deficiencies are common among multiple refineries. Some of the deficiencies appear to relate to legacy systems in effect prior to BP's acquisition of the refineries.

Even more than five years after BP acquired four of its U.S. refineries from Amoco and ARCO, those refineries continue to rely heavily on legacy systems, standards, and procedures, some of which need substantial updating to bring them into conformity with current good or recommended practices. Many of these deficiencies relate to basic operational matters, including

- thoroughly identifying and evaluating hazards and establishing effective controls for those hazards or taking steps to mitigate those hazards;
- testing, inspecting, and maintaining plant and equipment in fit-for-purpose condition;
- implementing external codes and practices that provide guidance for mitigating process hazards; and
- developing and maintaining adequate levels of process safety knowledge and skill levels throughout BP's refineries.

In the absence of BP's corporate management providing process safety performance guidance to the U.S. refineries in operational terms the refinery leadership could understand, process safety performance at BP's U.S. refineries was not emphasized. Each refinery established or maintained its own process safety program and practices, with some efforts by non-line networks or communities of practice to provide some monitoring of performance and sharing of best practices. As discussed in more detail in Section VI.C, process safety performance was not effectively defined, measured, or evaluated. As discussed in more detail in Section VI.A, cultural factors in some of the refineries contributed to lack of effective communications and sharing of process safety information that could be used to make the refineries safer. In light of these and other factors, material deficiencies in process safety performance developed at BP's U.S. refineries.

BP is implementing changes in its process safety management practices that affect BP's U.S. refineries, including the development of new standards, engineering technical practices, and other internal guidance, as well as the provision of substantial resources. See Appendix F.

Finding:

Material deficiencies in process safety performance exist at BP's five U.S. refineries.

BP'S PROCESS SAFETY MANAGEMENT SYSTEM

BP appears to have established a relatively effective personal safety management system by embedding personal safety aspirations and expectations within the U.S. refining workforce. BP has not been effective in implementing across all of its U.S. refineries the aspirational guidelines and expectations articulated in its gHSEr management system framework, its 2001 process safety/integrity management standard, and other Group-level guidance relating to process risks. In addition to the results from the reviews that the Panel's technical consultants conducted and the results from the process safety culture survey as discussed above in this section, the Panel's review of BP's internal audit reports and other information further support the Panel's finding that BP has not implemented an integrated, comprehensive, and effective process safety management system for its U.S. refineries.

> 2003 gHSEr audit report

The 2003 gHSEr audit outlines key issues found across 35 gHSEr audits conducted across BP's business segments and one functional group. The purpose of this report was to highlight common and systemic findings from these audits, especially those in which root cause may warrant focus at the BP Group or segment level so that the safety management system could be improved. The report indicates that while most entities audited had a significant number of processes in place to manage safety performance, a number of common themes emerge, "largely related to behaviours, implementation, and follow through which have already impacted HSE delivery and will continue to impact future performance until improvement is well-established." According to this report, the most significant of these common themes include

- widespread tolerance of noncompliance with basic HSE rules,
- poor implementation of HSE Management Systems, reducing the effectiveness and efficiency of activities to manage HSE risks and deliver sustainable performance,
- lack of leadership competence and understanding to effectively manage all aspects of HSE, and
- insufficient monitoring of key HSE processes to provide management visibility and confidence in their ability to deliver as required and any intervention needed.

In addition, this report contains a section captioned "Actions which could address these gaps." These action items include

- a need for greater clarity on what constitutes an HSSE management system and a plant manager's accountability for implementation,
- a need to look at how to improve competency in all areas of HSSE management either through improving executive knowledge and/or greater expertise in decentralized deployed HSSE staff to enable them to coach effectively, and
- a need for greater clarity on HSSE monitoring as part of an HSSE management system including more advice and coaching on how to develop a robust HSSE monitoring system.

> 2004 gHSEr audit report

A BP internal audit report in 2004 outlines key issues found across 29 gHSEr audits conducted across BP, including the Refining and Marketing segment. This report also supports the Panel's conclusion that BP did not have an effective process safety management system. For example, this report indicates, among other things, that while the implementation of business unit HSSE management systems had improved slightly since 2003, concern still existed about the overreliance on key personnel rather than systems. The report also states that

> [a] root cause of this is believed to be a lack of understanding through the organisation as to what constitutes a management system as opposed to operational controls or procedures. Without this understanding it is difficult for leaders to monitor their systems effectively and provide assurance up the line that risks are being managed.

The report goes on to highlight a "lack of HSE awareness and skills amongst leaders."

> Internal audits in 2004

BP's internal audit group audited the Refining and Marketing segment in 2004. The results of this audit are also instructive in understanding implementation of BP's HSE management systems relating to the U.S. refineries. This audit report states that the Refining and Marketing segment was demonstrating a clear commitment to improving safety, environmental, and integrity performance, and that the segment's performance was improving. The audit report notes improvements in *personal* safety performance. For example, the report states that between 2002 and 2003, the recordable incident frequency had improved 12 percent and that spills had decreased 11 percent. The report also notes that with respect to prevention of fatalities, programs had been implemented to improve the effectiveness of workplace controls and a new driving standard was being rolled out across the segment.

Additionally, the report explains that although basic characteristics of the management system were in place, improvement was needed in the areas of communication of strategic vision, performance monitoring, and intervention management. For example, with respect to communication of strategic vision, the report states that

> [n]o explicit safety, environmental, or integrity management strategies were articulated or communicated by Segment leadership beyond the Group's vision of "no accidents, no harm to people, no damage to the environment." This lack of a concise safety, environmental, and integrity management strategy lead to some frustration and inefficiencies in both resource allocation and implementation of Group standards.

An appendix to this 2004 audit report elaborates on this finding and provided management's response as indicated in the table below.

Table 53

Excerpts from Appendix 4 to Internal Audit Report, 179 R&M Safety, Environmental and Integrity Management Systems Audit, November 2004

Finding	Management Response
Segment HSSE strategy and alignment—Lack of a concise safety, environmental, and integrity management strategy for the Segment and/or [Strategic Performance Unit] sometimes results in frustration at the [Business Unit] level and results in resource allocation difficulties (when limited resources are squeezed by new initiatives; e.g. compliance with the new Driving Functional Standard).	Again, this is another recognized deficiency and a [Business Unit] frustration that has been well articulated. Businesses are being given flexibility in developing implementation schedules for standards based on the business risk. For example, the Control of Work Standard, expected in 1Q, will have the implementation window extended from 3 years to 5 years. *When faced with multiple requirements competing for resources (i.e. Driving Standard, Control of Work, and US HSSE Compliance Framework) businesses will be allowed to slow or delay implementation in the areas of lowest business risk.* High business risks (i.e., Driving Safety for Logistics) would be covered first or at a more rapid pace than other lower risk activity. There has been a bit of uncertainty in terms of which Standards will ultimately [sic] approved. This had added to [Business Unit] frustration.

The excerpts from the 2004 gHSEr audit report and the Refining and Marketing 2004 audit indicate a lack of understanding of what constitutes an HSSE management system, compounded by (1) a focus on personal safety performance, (2) a lack of a specific HSSE strategy that is communicated to the business unit level including the U.S. refineries, (3) the imposition of numerous initiatives on the business units including the U.S. refineries with insufficient resources to implement all the initiatives concurrently, and (4) flexibility allowed to the refineries, as distinct business units, to prioritize implementation of initiatives on their own timetable. These excerpts support the conclusion that BP has not implemented an integrated, comprehensive, and effective process safety management system. Corporate management did not provide to the U.S. refineries specific guidance about process safety performance expectations. Local plant managers were faced with multiple initiatives, including a driving standard with limited application for refineries; each initiative competed for limited resources that were available for implementation. Because, in the face of limited resources, not all initiatives could be implemented at the same time, some initiatives were prioritized over others. The driving standard, admittedly directed towards a genuine concern in some parts of the BP group, was prioritized over others including health, safety, security, and environmental.

Finding:

> ***BP has not implemented an integrated, comprehensive, and effective process safety management system for its five U.S. refineries.***

OBSERVATIONS ON NOTABLE PRACTICES AND PROCESS SAFETY MINIMUM EXPECTATIONS

The Panel wishes to commend BP's U.S. refineries for several practices that the Panel's technical consultants observed as being notable in a positive way or, in the case of the BP's process safety minimum expectation program, as being excellent process safety management practice. For this purpose, the technical consultants defined a notable practice as an effective process safety practice that is either unique in its design or implementation or, in the experience of the technical consultants, one that has been implemented in "upper-tier" companies. These notable practices are described below.

Engineering authority (All U.S. refineries). As discussed in Section V, under the new integrity management standard, BP has established or is in the process of establishing at each U.S. refinery the position of engineering authority. The engineering authority will have authority relating to technical aspects of design, operation, and maintenance activities as they affect engineering issues. The engineering authority at a site will have the ability to elevate technical engineering issues to the engineering authority at the Refining level, the Refining and Marketing level, and ultimately the Group Engineering Director in Group Technology. The Group Engineering Director has authority to overrule a refinery plant manager on such issues. As a result, the technical consultants believe that such engineering issues will be addressed in a more uniform manner.

WYE program (Cherry Point). The Cherry Point refinery has implemented a unique version of an employee-based safety awareness program, known as the What's Your Exposure (WYE) program. WYE prompts employees to think about safety and making the right safety choices before starting a work activity. WYE encourages personnel to identify potential safety exposures, issues, or conflicts with a proposed or active work plan. WYE also empowers employees to take action to make appropriate changes to create a safe work place. Based on their brief observations, the technical consultants believe that WYE is an effective means for engaging employees and contractors in hazard identification and reporting. Conceived by an hourly employee, the WYE program has its own budget and has been fully implemented by the hourly workforce.

Personnel emergency-locater badge system (Cherry Point). The technical consultants also believe that a new "GPS-badge-based" control of access and emergency headcount procedure at Cherry Point is an industry-leading practice. Refinery personnel and contractors have badges with embedded global positioning system tracking devices. In the event of an emergency, if an evacuation occurs, the badge system can be used not only for quickly accounting for people, but also to determine the location of people that may be unable to evacuate.

Shut-down plan/start-up plan procedure (Toledo and Whiting). Following the Texas City accident, the Whiting refinery implemented a procedure to review thoroughly and document plans to manage the risk associated with planned shutdowns and start-ups of process units. Process units typically contain start-up and shut-down procedures as a part of the normal operating procedure manual. The start-up and shutdown of a unit not only offer unique challenges to personnel to maintain safe control of the unit, but also can affect nearby areas of the refinery.

Whiting has implemented a procedure for every planned shutdown and subsequent start-up. Under this procedure, a group of people review the applicable procedures, the group makes modifications to the applicable procedures as needed, plans are made for communicating the transient condition to potentially affected areas and workers, and plans are made for controlling the physical area within and nearby the operating unit.

In addition, the Toledo refinery creates similar procedures for start-up, shutdown, and malfunction plans for each process unit to help comply with the maximum achievable control technology standards resulting from the Clean Air Act. Those standards are designed to prevent or minimize hazardous air pollution releases from process units during unit start-ups and shutdowns.

Turnaround deferral procedure (Carson). During a turnaround, a process unit is shut down in a planned fashion so that refinery workers can perform necessary maintenance, inspection, refurbishment, and replacement of equipment within the unit. Some operating units have annual turnarounds, although most units have multi-year cycle turnarounds. Sometimes a refinery desires to defer a turnaround because of operational needs. However, for safety reasons, the effects of a proposed delay of an otherwise planned turnaround must be assessed. The Carson refinery has a formal procedure for deciding whether it is acceptable to defer a turnaround. This procedure involves the evaluation of various factors, including known equipment conditions, operational needs, the availability of material and personnel, and the risk impact of the delay itself. Having a formal procedure with specified issues that knowledgeable personnel must address helps ensure that the risk of a proposed turnaround deferral is fairly evaluated before the turnaround is deferred.

The Panel commends the BP refineries for adopting these notable practices and encourages BP to consider these practices for possible implementation in refineries in which such practices or comparable practices have not yet been implemented.

Process safety minimum expectations. As described in Section V, BP has developed a set of internal standards called process safety minimum expectations (PSMEs). These PSMEs establish minimum design conditions and operational performance requirements for some specific types of process units, such as hydrofluoric acid alkylation units and fluid catalytic cracking units; certain generic chemical hazards, such as hydrogen sulfide and nitrogen; and specific classes of process safety-related equipment and instrumentation, such as isolation systems and critical alarms. The PSMEs, which are periodically reviewed and revised, contain BP-imposed requirements for process or hazard-specific items, such as

- safety analysis issues beyond the normal types of studies performed as a part of the process safety management system;
- operating, safety, and emergency procedures;
- emergency preparedness and emergency response;
- special training;
- safe operating limits;
- minimum engineering design conditions, including those for safety systems and critical alarms; and
- equipment mechanical integrity program activities, including testing frequencies, materials of construction, maintenance practices, and spare parts.

When BP completes a new PSME, the refineries perform an analysis to determine the gap between current practices and the minimum expectations and then develop a plan to close the gap. The technical consultants checked some of the PSMEs to verify that a gap analysis had been performed and that the identified gaps were closed or were being closed. The technical consultants noted that the PSME program was an excellent process safety management practice that appeared to be followed and monitored rigorously.

ENDNOTES FOR SECTION VI.B

[1] *See* Section III and Section VI.A.

[2] W. Edwards Deming, *The New Economics: For Industry, Government, Education* (Cambridge: The MIT Press, 2d ed. 1994), p. 50.

[3] Isadore Rosenthal et al., "Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks," *Process Safety Progress*, Vol. 25, No. 2 (June 2006), p. 147.

[4] 29 C.F.R. § 1910.119, Appendix C (2006).

[5] *See* American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/ AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 22.

[6] *See* James Reason, *Managing the Risks of Organizational Accidents* (Burlington, Vermont: Ashgate Publishing Ltd., 1997), p. 8.

[7] *See* American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/ AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. iii.

[8] *Ibid*, p. v.

[9] *Ibid*, p. 5.

[10] This section of the report discusses the system findings related to (2) and (3), as well as part of (1). The system findings related to (4) and a part of (1) are discussed in Section VI.C of the report.

[11] The stated purpose of the report was "to highlight common and systemic findings from [the 35] audits, especially those where elements of the root cause may warrant focus at Segment and/or Group level so that the HSE management system can be improved."

[12] BP p.l.c., "getting HSE right Audit Report, BP South Houston, Audit No. 2003-41," September 22, 2003, p. 6.

[13] The report referred to a "What If" analysis technique, which is a method in which a multi-disciplinary team with personnel who are familiar with the particular process brainstorm questions about possible undesired events due to hazards. This technique does not use an inherent structure, as do other forms of process hazard analysis such as hazard and operability studies. The report stated that the "What If" checklist used did not specifically address certain issues, including previous incidents, facility siting, and consequences of failure of controls. *See* BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 64.

[14] *Ibid*, p. 67.

[15] *Ibid*, p. 141. *See also* BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3, (including, as a key finding, "[c]omplacency towards serious process safety risk, driven by a lack of awareness of potential consequences").

[16] Not all of the findings related to the identification of hazards; some related to other aspects of conducting process hazard analyses, including timely correction of action items.

[17] BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 17.

[18] *Ibid*, pp. 18-19.

[19] External codes and practices also govern the conduct of BP's U.S. refining operations. BP's implementation of those externally generated codes and practices will be discussed later in this section.

[20] The relatively large number of external standards applicable to the refining industry may be attributable, at least in part, to the fact that the refining industry developed in the U.S. in the early part of the twentieth century, when there was not extensive government regulation. A number of industry consensus standards developed in the absence of governmental regulations.

[21] The API has published many recommended practices, standards, publications, and bulletins relating to health and safety matters at refineries. In October 2005, the CSB issued two urgent safety recommendations to the API and the National Petrochemical & Refiners Association (NPRA) relating to safe placement of trailers for workers. The first recommendation called on API to develop new industry guidance "to ensure the safe placement of occupied trailers and similar temporary structures away from hazardous areas of process plants." U.S. Chemical Safety and Hazard Investigation Board, "Urgent Trailer Siting Recommendations to American Petroleum Institute and National Petrochemical & Refiners Association," October 25, 2005, *accessed at* http://www.csb.gov/news_releases/docs/CSBSitingRecResolution.pdf

on December 4, 2006. In that recommendation, the CSB noted that the then-existing safety guidance, API Recommended Practice 752, does not prohibit the placement of trailers in close proximity to hazardous process units. A separate urgent recommendation, directed jointly to API and NPRA, called on those organizations to immediately contact their members urging "prompt action to ensure the safe placement of occupied trailers away from hazardous areas of process plants" before the new API safety guidance is completed. *Ibid*.

[22] Center for Chemical Process Safety, "2006 Process Safety Report, Mission Statement," *accessed at* http://www.aiche.org/uploadedFiles/CCPS/About/CCPSAnnual2006.pdf on November 15, 2006.

[23] American Petroleum Institute, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2, API Recommended Practice 500* (Washington, D.C.: API Publishing Services, 2d ed. 1997).

[24] American Petroleum Institute, *Instrumentation and Control Systems for Fired Heaters & Steam Generators*, *API Recommended Practice 556* (Washington, D.C.: API Publishing Services, 1st ed. 1997).

[25] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 15.

[26] 29 C.F.R. § 1910.119(d), (g) (2006).

[27] American Society of Safety Engineers, *American National Standard Criteria for Accepted Practices in Safety, Health, and Environmental Training Z490.1-2001* (Des Plaines, Illinois: American Society of Safety Engineers, 2001), p. 8.

[28] *Ibid*.

[29] *Ibid*.

[30] *Ibid*.

[31] *Ibid*.

[32] *Ibid*.

[33] *Ibid*.

[34] *Ibid*, p. 9.

[35] *Ibid*, p. 11.

[36] *Ibid*.

[37] *Ibid*, p. 16.

[38] *Ibid*.

[39] *Ibid*, p. 17.

[40] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 12.

[41] BP evaluates (1) "Level 5 Leadership Competencies" such as "Operates from intrinsic motivation & inner will," "Thinks strategically," "Catalyses change," "Thinks and acts systematically," "Creates space and empowers others," and "Embodies self-management and humility"; (2) "Group Behavior Expectations," including "Setting Context," "Establishing Priorities," "Providing support," "Assessing external environment," "Developing relationships," "Integrating values," and "Role Modeling Code of Conduct"; and (3) "Experience," including "Technical," "Commercial," "Manufacturing Operations," "Leading Big Teams" and "Delivering Business Results."

[42] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 90.

[43] A 2003 incident report states that personnel involved in a fire at the coker feed at the Toledo refinery did not recognize the hazards and lacked knowledge and training. A 2002 incident report states that the failure of a compressor at the water pump station of the Toledo refinery was in part caused by millrights who were neither competent nor trained for the job. A 2004 incident report provides that a failure to fully close a discharge block valve at the Texas City refinery was caused in part by inadequate recall of training and no training provided. A 2005 incident report relating to an explosion at the Cherry Point hydrogen plant cites inadequate training as a cause.

[44] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 87.

[45] James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 24.

[46] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 90.

[47] James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 23.

[48] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 89.

[49] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 83.

[50] James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 23.

[51] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 90.

[52] *Ibid*, p. 88.

[53] Fewer than 25 respondents were in this group.

[54] Fewer than 25 respondents were in this group.

[55] Fewer than 25 respondents were in this group.

[56] Fewer than 25 respondents were in this group.

[57] Fewer than 25 respondents were in this group.

[58] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, pp. 90-91.

[59] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 7.

[60] *Ibid*, p. 3.

[61] *Ibid*, p. 9

[62] *Ibid*, p. 29.

[63] *Ibid*, p. 29 (emphasis in original).

[64] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 66.

[65] *Ibid*, p. 139.

[66] *Ibid*, p. 140.

C. Performance Evaluation, Corrective Action, and Corporate Oversight

In order to maintain and improve the effectiveness of a complex management system, such as a process safety management system, management must periodically evaluate the system's performance and address any identified deficiencies or opportunities for improvement. Continual improvement, which the total quality management concept of Plan-Do-Check-Act contemplates, represents a fundamental objective of management systems generally and safety management systems specifically.[1] As noted in the ANSI Z10 standard, an organization should evaluate its system's performance "through monitoring, measurement, assessment, incident investigations, and audits."[2] Upon identifying deficiencies within the system, the organization should then take corrective actions.[3]

An organization also should establish and implement a process for management to review the overall effectiveness of its safety management systems and make needed improvements. In a complex organization with multiple levels of management and with safety management systems having a site-specific element, some level of oversight at the corporate level (*i.e.*, above the operating business units) is required to evaluate the overall effectiveness of the corporate management system. Such a corporate-level review should take place at least annually and culminate in any improvements necessary to ensure the continued suitability, adequacy, and effectiveness of the systems.[4] This corporate oversight of the overall performance of the management systems provides the primary means by which an organization's leaders can assure themselves that the system is functioning as intended and that the organization is achieving its established performance goals.

These evaluations represent an essential element of BP's Plan-Perform-Measure-and-Improve cycle, which in turn serves as a fundamental element of the continuous improvement contemplated by BP's health and safety management system.[5] In this part of the Panel's report, the Panel will review the extent to which BP has implemented this continuous improvement cycle, with a particular focus on the "Measure-and-Improve" portion of the cycle.

BP's record. BP has a mixed record of evaluating process safety performance, taking corrective actions, and implementing an effective continual improvement cycle. The Panel's review indicates that significant deficiencies existed in BP's site and corporate systems for measuring, monitoring, and evaluating process safety performance; investigating prior incidents and near misses; auditing system performance and compliance with applicable standards; and addressing previously identified process safety-related action items in a timely and thorough manner. Based on these deficiencies, the Panel believes that BP has not effectively implemented the Measure-and-Improve elements of its own system for continuous improvement of process safety management.

In addition, the Panel observes that many of the process safety deficiencies it identified during its review are not new to BP. Many of these same deficiencies were identifiable to BP based upon lessons from previous process safety incidents, including three major process incidents that occurred at BP's petrochemical complex in Grangemouth, Scotland in 2000. As a government report investigating the Grangemouth incidents noted,

> [i]nadequate performance measurement and audit systems, poor root cause analysis of incidents, and incorrect assumptions about performance based on lost time accident frequencies (DAFWCF—days away from work case frequencies) and a lack of key performance indicators for loss of containment incidents meant that the company did not adequately measure the major accident hazard potential.[6]

The Grangemouth review also "suggested major weaknesses . . . in monitoring, audit[,] and review."[7]

The Panel considers the similarities between the "lessons" from Grangemouth and the Texas City incident to be striking: a lack of leadership and accountability,[8] insufficient awareness of process safety,[9] inadequate performance measurement,[10] a safety program too focused on personal safety,[11] and a failure to complete corrective actions.[12] Although the incidents occurred five years apart at different sites in different countries, many of the underlying deficiencies identified after the incidents appear to be the same, especially as they relate to evaluating process safety performance and then taking corrective actions.

MEASURING PROCESS SAFETY PERFORMANCE

Regular measurement and monitoring of process safety performance allows an organization to evaluate the effectiveness of steps taken to control and reduce process risk.[13] The process of measuring and monitoring should provide "information to determine whether the day-to-day arrangements for hazard and risk identification, prevention, and control are in place and operating effectively . . . ."[14]

In order to measure the safety performance of their operations, many companies have incorporated leading and lagging indicators, also known as metrics or key performance indicators, into their safety management systems. Managers use these metrics to track safety performance, compare or benchmark safety performance against the performance of other companies or facilities, and set goals for continuous improvement of safety performance. The Panel notes that regulatory agencies, industry groups, and labor organizations have undertaken efforts to advance the state of the art in terms of developing process safety indicators. See Section III for a more complete discussion of indicators. The USW, for example, developed one such indicator in 1996. The CCPS and the UK HSE also have devoted significant efforts to the issue of process safety indicators since the mid-1990s. UK HSE, which regulates workplace health and safety in the United Kingdom, recently published Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries.[15] In the United States, the CCPS has renewed its work with a project on the development of process safety metrics.[16]

Reactive monitoring: use of lagging indicators. When considering the measurement element of the continuous improvement cycle for process safety, it is critical to distinguish between reactive versus active measuring and monitoring. Reactive monitoring of process safety includes the identification, reporting, and investigation of process-related injuries, incidents, and property damage.[17] Reactive monitoring allows an organization to identify and correct deficiencies in response to specific incidents or trends. Reactive monitoring uses lagging indicators to measure historical, after-the-fact performance.[18] These indicators show when the desired safety outcome has not been achieved and the safety control system has failed to prevent an incident. Examples of lagging indicators include the number of unexpected loss-of-containment incidents and failures of safety critical instrumentation/alarms.[19] Because of their nature, lagging indicators of process safety performance suffer from the disadvantage that they only suggest corrective actions after an accident.

The refining industry commonly uses personal safety lagging indicators or injury rates. Largely derived from OSHA reporting, injury rates such as days away from work and recordable injury frequency have become established and generally accepted measures of personal safety performance. Companies collect and report these metrics at regular intervals. Additionally, many companies set goals based upon reducing lagging indicators such as recordable injury frequency. Although companies may set performance targets based upon reducing lagging indicators related to personal injury rates, the Panel believes (as BP aspires) that the ultimate goal for safety performance should be zero incidents.

Although recognized and generally accepted lagging indicators exist in the United States for personal safety, there is no universally agreed upon lagging indicator for process safety. Because process safety accidents occur infrequently and are often unrelated to each other in their causal factors, past process safety accidents have limited value in predicting future process-related incidents. Consequently, for purposes of managing process risks, organizations should develop leading process safety performance indicators that, if monitored, can be used to avoid or prevent process incidents.

Active monitoring: use of leading indicators. Active monitoring evaluates the present state of a facility through the routine and systematic inspection and testing of work systems, premises, plant, and equipment,[20] including rotating equipment, pressure vessels, piping, relief valves, and other safety-related equipment. Organizations may use active monitoring requirements as leading indicators to provide feedback on performance before an accident or incident occurs.[21]

As the term implies, leading indicators attempt to measure variables that are believed to be indicators or precursors of future safety performance so that the desired safety outcome (*i.e.,* no incidents) can be achieved. While useful in predicting future process safety performance, leading indicators are not absolutely predictive. For example, the percentage of equipment that is past due for inspection can be considered a process safety leading indicator because the metric relates to the physical condition of the facility as well as the effectiveness of oversight systems. However, even if equipment inspections are current, equipment failures can still occur.

Using both leading and lagging indicators. Effective measuring and evaluation systems utilize both leading and lagging indicators. The UK HSE recently proposed using a system of "dual assurance" with both leading and lagging indicators.[22] The UK HSE believes that employing both sets of indicators will provide assurances on the effectiveness of a site's risk control systems.[23] Trends in these indicators may provide advance notice of problems.

> BP's measurement of safety performance

BP recognizes the importance of performance indicators for all aspects of its business operations, including operational (Solomon availability benchmarks), financial (gross margin), and safety performance (primarily personal safety metrics such as recordable injury frequency). Expectation 13.1 of gHSEr, which relates to Element 13: *Assessment, Assurance and Improvement*, creates the expectation that the company will establish and communicate safety-related performance indicators throughout the organization.[24]

Reliance on injury rates. Interviews with BP corporate-level managers make clear that BP relied principally on injury rates to monitor process safety performance at the U.S. refineries before the Texas City accident. As shown in Table 54, the performance metrics in three key reports from different levels of the corporation—refining operations, the Refining and Marketing segment, and the BP Group—also demonstrate this focus on injury rates.

Table 54

Tracking Metrics Contained in Key BP Refining and Group-Level Health, Safety, Security and Environmental Reports

2005 Refining HSSE Performance Report	2005 Refining and Marketing Segment HSSE Report	2005 BP Annual HSSE Report for the Environment and Ethics Assurance Committee of the Board of Directors
• Fatalities • Days Away From Work Case Frequency (DAFWCF) • Recordable Injury Frequency • Total Vehicle Accident Rate • Oil Spills > One Barrel • Energy Intensity Index • Greenhouse Gas Emissions • Real Sustainable Reductions	• Workforce Fatalities • Third-Party Fatalities • Third-Party Fatalities with Material Influence • DAFWCF • Recordable Injury Frequency • Action-Item Closure • Spills > One Barrel • Severe Spills • Total Vehicle Accident Rate • Serious Vehicle Accident Rate • Health Map Completion	• Fatalities • DAFWCF • Recordable Injury Frequency • Uncontrolled Releases • Greenhouse Gas Emissions • HSSE Fines and Penalties

The annual HSSE performance report that highlights the activities, milestones, and performance on HSSE matters within the Refining business tracked eight performance metrics in 2005. Four of these eight metrics indicate injury rates (fatalities, days away from work case frequency, and recordable injury frequency) or driving safety (total vehicle accident rate). The other four metrics indicate environmental performance.

The Refining and Marketing segment also prepares an annual HSSE report that is distributed to the Chief Executive, Refining and Marketing. This report is based in part on the information contained in the refining HSSE report discussed in the preceding paragraph. The 2005 Refining and Marketing Segment HSSE Report, prepared in February 2006, tracked 11 metrics. The majority of these 11 indicators are injury rate metrics or driving safety metrics. The only indicators relevant to process safety are action item closure and spills of oil greater than one barrel.[25]

Finally, BP prepares a Group HSSE report for the EEAC that discusses integrity management, management systems, and various actions taken in response to incidents. However, as shown in Table 54, in the report for 2005 (dated July 12, 2006) BP principally tracked injury rates and environmental metrics, not process safety indicators.

Even following the Texas City accident, BP continued to emphasize its personal injury rates. For example, in June 2005, BP prepared a "Safety Position" paper containing what BP referred to as "Key Messages or 'Safety Story.'" The paper discussed the historical performance of the BP Group and BP's U.S. refineries in fatality accident rate, days away from work case frequency, and recordable injury frequency. Although the report discussed the history of fatalities in BP's U.S. refinery operations, it did not address any historical process safety metrics or indicators.

BP's reliance on occupational illness and injury rates such as days away from work case frequency and recordable injury frequency significantly limited BP's perception of process risk within the U.S. refineries. The Panel, however, does not believe that BP's undue reliance on injury rates to the detriment of process safety is unique in the refining or process industries. Because OSHA only requires the tracking and recording of injury rates, the overreliance on this data is not surprising. However, injury rates do not adequately measure the risk of major accidents:

> [Occupational illness and injury-rate] data are largely a measure of the number of routine industrial injuries; explosions and fires, precisely because they are rare, do not contribute to [occupational illness and injury] figures in the normal course of events. [Occupational illness and injury] data are thus a measure of how well a company is managing the minor hazards which result in routine injuries; they tell us nothing about how well major hazards are being managed.[26]

As discussed later in this Report, BP knew that injury data were not effective in assessing process risk because of three incidents that occurred at BP's petrochemical complex in Grangemouth, Scotland in 2000.

For the reasons discussed above, injury rates should not be used as the sole or primary measure of process safety management system performance.[30] In addition, as noted in the ANSI Z10 standard, "[w]hen injury indicators are the only measure, there may be significant pressure for organizations to 'manage the numbers' rather than improve or manage the process."[28]

Overreliance on occupational illness and injury rates and not enough focus on process safety-specific indicators also can lead to a false sense of security about process safety incidents because a company typically manages what it measures:

> [F]irms normally attend to what is being measured, at the expense of what is not. Thus a focus on [occupational illness and injury] can lead companies to become complacent about their management of major hazards.[29]

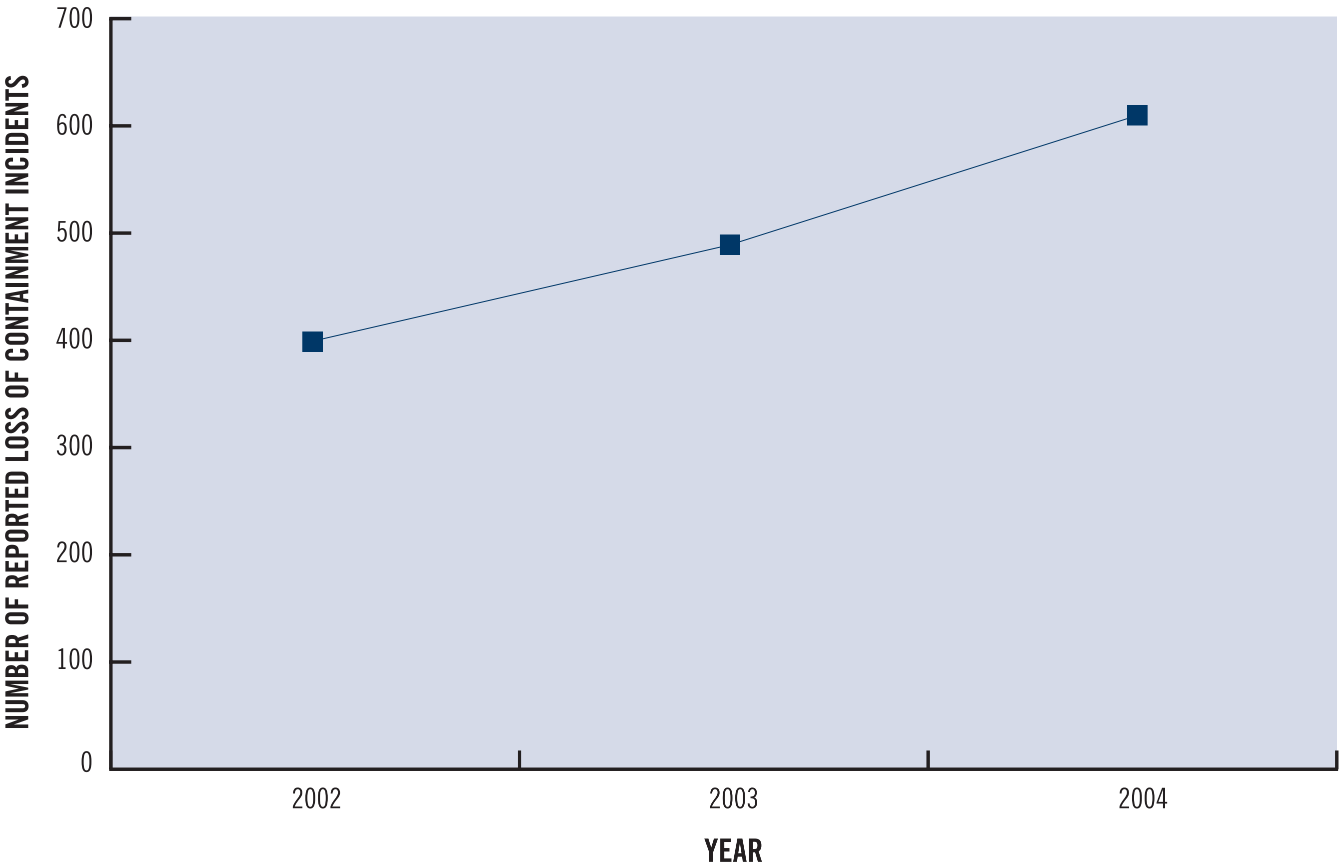
At Texas City, this emphasis on injury rates meant that business plans "focused on projects for reducing personal injuries and enhancing environmental compliance, but contained no plans for the systematic reduction of process risks or improving basic operations."[30]

Tracking of process safety indicators. BP does track some process safety metrics. A mid-2003 report to the EEAC, for example, discussed monitoring process safety indicators. This report, which discussed BP's HSSE performance in 2002, represented the Group HSSE "functional opinion" regarding "BP's process for delivering HSE Assurance." The report provided that a review of BP's major incident announcement and high potential incident databases indicated that plant and operational integrity required continuing attention. To address this key risk, Group HSSE stated that the company would monitor and transparently report segment performance based upon two new metrics: percent overdue planned inspections and the number of loss of containment incidents. The purpose of the metrics was to monitor progress in the overall application of the Group process safety/integrity management standard.

Loss of containment. Loss of containment is an important process safety lagging indicator because a potential for an accident exists when hydrocarbons "get outside the pipe." At the Panel's request, BP provided data showing loss of containment incidents at the U.S. refineries. As shown in Table 55, the number of loss of containment incidents at the Texas City refinery increased each year from 2002 to 2004.[31] In 2002, the refinery experienced 399 loss of containment incidents. That number increased in 2003 to 493. The number of loss of containment incidents at Texas City peaked in 2004 at 607.

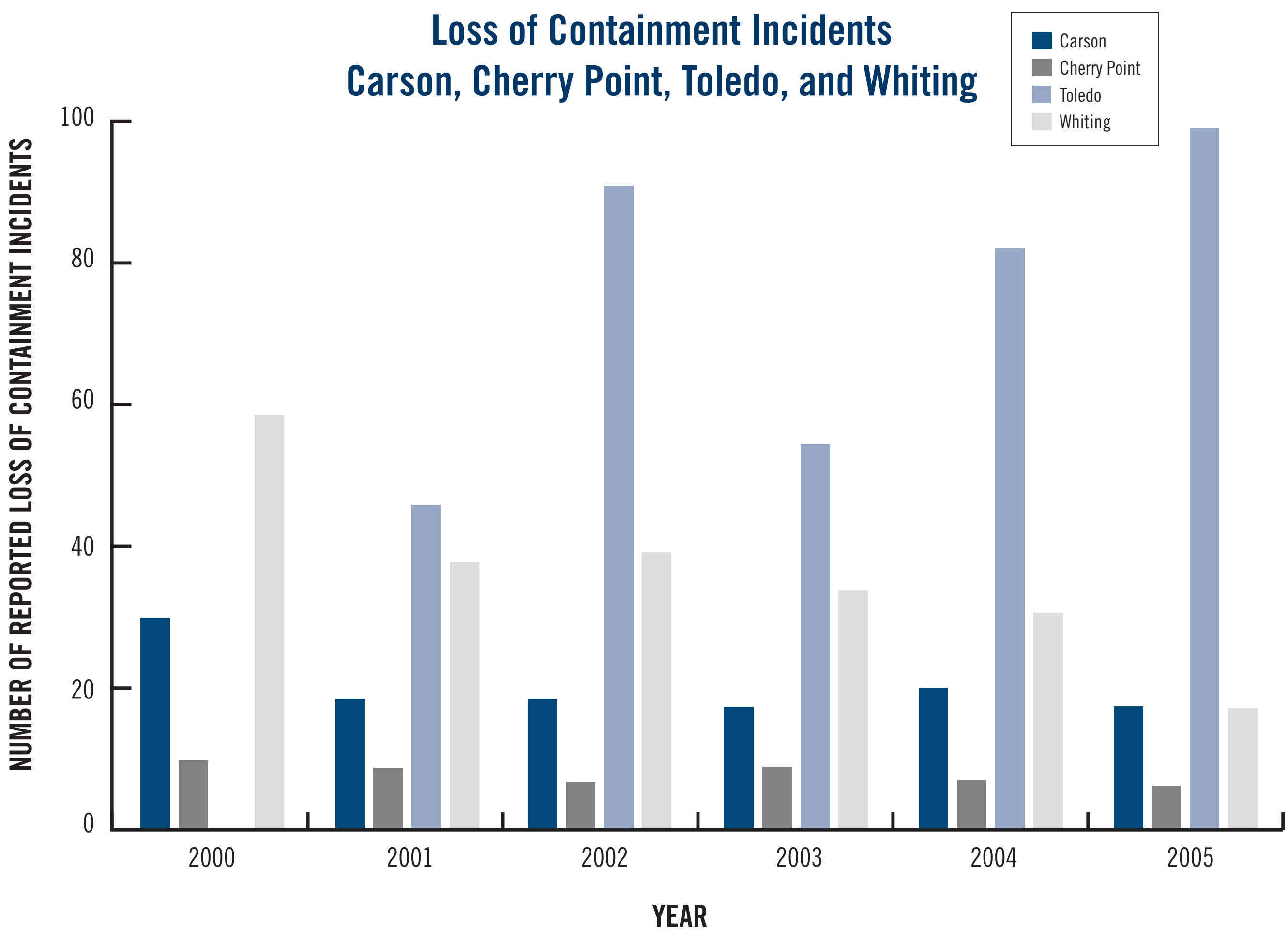
Table 55

Texas City Loss of Containment Incidents



Issues with loss of containment were not limited to Texas City. As shown in Table 56, notwithstanding its small size, the Toledo refinery experienced a large number of loss of containment incidents each year from 2002 through 2005 when compared to the Carson, Cherry Point, and Whiting refineries. In 2005, for example, Toledo had more than five times more loss of containment incidents (99) than the refinery with the next largest amount (Carson with 17). The upward trajectory of the Toledo data for 2003 to 2005 is also troubling.

Table 56



Overdue inspections. BP's U.S. refineries have written inspection and testing programs that include monitoring schedules and impose deadlines for inspections. Because it relates to the future performance of process equipment and safety-critical devices, the number of overdue inspections represents a leading indicator of process safety performance.[32]

The Panel's review indicates that BP's U.S. refineries have experienced deficiencies relating to the timely implementation of mechanical integrity inspection and testing programs for a number of years. As shown in Table 57 below, the company has experienced some improvement in this area, but the number of overdue inspections at some of the refineries remains large.

Table 57

Number of Overdue Inspections by Refinery as Reported by BP[33]

Carson Refinery							
Area of Overdue Inspections	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**As of 7/31/06**
Vessels	N/A[34]	27	11	100	96	45	14
Tanks	N/A	18	21	8	5	0	1
Piping systems	N/A	N/A	28	37	76	363	362
Piping TMLs*	Not tracked						
PSVs‡	956	754	1039	601	254	36	18
Total overdue inspections	**956**	**799**	**1099**	**746**	**431**	**444**	**395**
Cherry Point Refinery							
Area of Overdue Inspections	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**As of 7/31/06**
Vessels	0	0	0	0	0	0	0
Tanks	0	0	0	0	0	0	0
Piping systems	0	0	0	0	0	5	0
Piping TMLs*	Not tracked						
PSVs‡	0	0	0	0	0	5	0
Total overdue inspections	**0**	**0**	**0**	**0**	**0**	**5**	**0**
Texas City Refinery							
Area of Overdue Inspections	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**As of 7/31/06**
Vessels	N/A	N/A	N/A	548	696	7	5
Tanks	1522	N/A	58	9	342	35	34
Piping systems	Not tracked						
Piping TMLs*	N/A	N/A	N/A	519	487	16	67
PSVs‡	N/A	N/A	1191	565	263	75	213[35]
Total overdue inspections	**8050**	**2297**	**2105**	**1641**	**1788**	**133**	**319**

(table continued on next page)

Toledo Refinery							
Area of Overdue Inspections	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**As of 7/31/06**
Vessels	N/A	N/A	N/A	34	0	0	0
Tanks	NA	N/A	N/A	11	0	0	0
Piping systems	Not tracked						
Piping TMLs*	N/A	N/A	N/A	5591	944	1803	1149
PSVs‡	N/A	N/A	N/A	N/A	51	0	0
Total overdue inspections	**N/A**	**N/A**	**N/A**	**5644**	**996**	**1804**	**1149**

Whiting Refinery							
Area of Overdue Inspections	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**As of 6/30/06**
Vessels	N/A	1	0	0	0	0	0
Tanks	N/A	47	3	0	0	0	0
Piping systems	N/A	184	507	442	881	250	70
Piping TMLs*	N/A	N/A	N/A	68164	60030	51870	4060
PSVs‡	N/A	154	109	68	64	55	24
Total overdue inspections[36]	**N/A**	**386**	**619**	**510**	**945**	**305**	**94**

* Thickness measurement locations (TMLs)
‡ Pressure safety valves (PSVs)

In considering this data, the Panel notes that the refineries track piping inspections differently. A piping system at a refinery may include hundreds, even thousands, of individual inspection points. At each of these points, which are referred to as thickness measurement locations (TMLs), BP periodically monitors pipe wall thickness. In tracking overdue inspections, some of the refineries count individual TMLs on a piping system while other refineries count entire piping systems. The Whiting refinery tracks both.

The use of different approaches makes comparison across the refineries difficult. As shown above, for example, the Toledo refinery tracks individual TMLs as opposed to piping systems. At the end of 2005, Toledo reported 1803 overdue inspections for piping TMLs. The Carson refinery, on the other hand, reported 362 overdue piping system inspections. Each of these 362 systems, however, contained many individual overdue TMLs.

The Panel does not suggest that one of these approaches is better than the other. The Panel considers the lack of internal consistency across the sites as a potential concern, however, especially given BP's 2003 decision to use overdue inspections as a process safety metric. The lack of consistency reduces the effectiveness of this process safety indicator.

The Panel's review also identified concerns about the piping data for the Whiting refinery. On three occasions, BP provided inconsistent piping inspection data to the Panel for this refinery. BP ultimately provided corrected data in December 2006, indicating that the number of overdue piping inspections at Whiting was actually less than the number that BP provided to the Panel's technical consultants during the Whiting technical review in March 2006, as well as another number provided to the Panel in August 2006. According to BP, the December 2006 data resulted from an exercise that Whiting undertook to correct errors in the refinery's maintenance database, which had miscounted the number of overdue inspections.

Although the Panel recognizes that the December 2006 data may be more accurate, it remains evident that at various times, the refinery's maintenance database showed large numbers of overdue thickness measurement location inspections. BP's after-the-fact determination that the numbers were better than initially believed is relevant but raises questions about whether BP has effective measurement criteria and systems for monitoring process safety performance.

The Cherry Point refinery data also warrant specific discussion. BP's data for Cherry Point show almost no overdue inspections. Based on the Cherry Point technical review, however, the Panel believes that the data provided do not accurately reflect conditions at Cherry Point. Specifically, the Panel's technical consultants identified several deficiencies regarding the inspection and testing program at the Cherry Point refinery, especially as the program relates to testing intervals and inspection tracking. The report from the Panel's technical consultants attached as Appendix E discusses these matters in more detail. Although the Panel has included the Cherry Point data in the above-table, the Panel questions their validity and comparability to the data for the other refineries.

The number of overdue inspections that BP tracked was not the only indication of problems with respect to this leading indicator. As shown in the following table, every year from 2000 through 2005, a BP audit team identified findings relating to the timeliness of mechanical integrity inspection and testing at one or more BP refineries in the United States: 2000 (Whiting); 2001 (Texas City and Toledo); 2002 (Carson and Cherry Point); 2003 (Whiting); 2004 (Texas City and Toledo); and 2005 (Carson):[37]

Table 58

U.S. Refinery Process Safety Review Findings on Mechanical Integrity Inspection and Testing (2000—2005)

Year	Refinery Process Safety Audit Finding
2000	**Whiting:** Priority 1[38] finding for mechanical integrity testing. More than ten percent of relief valves were out of compliance past due dates.
2001	**Texas City:** Priority 1 findings on mechanical integrity testing: "a large number of the required inspection intervals for relief and vent systems are not in compliance." Similar Priority 1 findings were made with respect to inspection intervals for "a large number" of emergency shut-down systems; critical alarms; trip systems; pump and compressor systems; pressure vessels; storage tanks; and piping systems. **Toledo:** Numerous pressure safety valves (44) were overdue for testing.
2002	**Carson:** 62 pressure vessels and 650 pressure relief valves were past inspection due dates. **Cherry Point:** Several mechanical integrity Priority 1 findings because numerous pressure safety valves (89), tanks (37), and vessels (81) were past due for inspection.
2003	**Whiting:** Priority 1 findings for mechanical integrity, finding that 534 critical alarms components and 100 relief valves were overdue for testing. An unspecified quantity of stationary equipment, including pressure vessels, tanks, furnaces, and piping, also were out of compliance for testing.[39]
2004	**Texas City:** Priority 1 findings on mechanical integrity and inspection due dates. Unspecified quantities of the following types of equipment were overdue for mechanical integrity inspection and testing: on-stream and turnaround critical instruments; rotating equipment; piping, pressure vessels, and storage tanks; and relief valves. **Toledo:** Numerous pressure safety valves (54) and personnel protection monitors (77) were overdue for inspection and testing. Priority 1 findings on mechanical integrity testing deficiencies.
2005	**Carson:** Priority 1 findings because numerous pressure relief valves (134) and pressure vessels (166) were past due for inspection.

The Panel's technical consultants confirmed ongoing challenges for BP with respect to overdue inspections at all five refineries. As shown in Table 59, the technical reviews identified extensive inspection and testing backlogs for fixed equipment, rotating machinery, and instrumentation systems at all five refineries. Sometimes these backlogs reflected inspections that were years past due.

Table 59

Issues Related to Overdue Inspections From Technical Reviews by Panel's Consultants

Refinery	Overdue Inspection Issue
Carson	• Some relief valves were overdue for testing • Some pressure vessels were overdue for inspection • Some piping systems were overdue for inspection • Quarterly preventive maintenance and vibration analysis were overdue on several major machinery items
Cherry Point	• Several vessels and numerous piping inspections were overdue • Documentation of external vessel and piping inspections was incomplete • Relief valve testing frequencies were inadequate
Texas City	• Some pressure vessels, storage tanks, piping, relief valves, rotating equipment, and instruments were overdue for inspection in six operating units evaluated • Numerous heat exchanger tube thickness measurements were not taken
Toledo	• Based upon a review of the past two years of records, nearly all of the rotating equipment had at least one instance of overdue quarterly vibration analysis • Instrument test intervals are based on turnaround schedules and not on an established frequency or on observed equipment condition
Whiting	• 20 percent of more than 250,000 thickness measurement locations were past due for inspection, although many locations were subsequently determined by BP to not be needed or were not safety critical • Some relief valves were past due for inspection • About 50 percent of small rotating machinery (pumps) were overdue for vibration analysis • No established management practice existed to authorize variances in inspection schedules

The Panel recognizes that the percentage of uncorrected deficiencies or overdue items identified during the technical reviews may be small when compared to the total number of items. A facility, for instance, may have hundreds of pressure vessels, thousands of relief valves, and miles of piping. It is important to note, however, that the Panel's technical consultants sampled only a representative number of items and did not attempt to catalog an exhaustive list of deficiencies. The Panel believes that a representative review involving a sampling of items provided an appropriate foundation for conclusions about the effectiveness of BP's overall process safety management system. Thus, the above numbers do not purport to represent the total number of overdue items; a more extensive review might well identify a larger number of overdue items. In addition, even a facility in substantial compliance with requirements related to process safety, measured by percentage of items inspected, may experience a catastrophic process accident. For this reason, the existence of any percentage of piping, pressure vessels, or safety critical equipment (*e.g.*, alarms or pressure relief valves) that are overdue for testing can mean that a particular process hazard is not being managed effectively to reduce process risk to an acceptable level—even if the facility has inspected the vast majority of items in a timely manner.

> Previous concerns about measuring process safety performance

The investigation of three process incidents that occurred at BP's petrochemical complex in Grangemouth, Scotland in 2000 identified concerns with BP's reliance on personal safety metrics and lack of effective process safety leading indicators. As part of its investigation into these incidents, the UK HSE found that the "BP Group & Complex Management did not detect and intervene early enough on deteriorating performance[.]"[40] Specifically, the agency concluded that BP did not "adequately measure the major accident potential" because of "[i]nadequate performance measurement[,]. . . incorrect assumptions about performance based on lost time accident frequencies [(days away from work case frequencies),] and a lack of key performance indicators."[41]

In its dialogue with the UK HSE after the incident, BP acknowledged the importance of key performance indicators:

> One of the key learnings to come from the Grangemouth incidents is for the annual assurance process to take a closer look at the precursor indicators of potential major incidents at a location. The use of occupational safety indicators such as "Days Away From Work Case Frequency" (DAFWCF) can obscure other factors, and provide a false sense of security if it indicates an overall improving trend . . . .

The Grangemouth incident was not the only time that BP acknowledged concerns about its HSSE measuring and monitoring programs. During BP Internal Audit's review of the 2003 gHSEr audits, the auditors found "[p]oor monitoring processes[.]" Specifically, the auditors found an "[i]nadequate process to allow leadership to derive confidence that the processes on which they rely operate effectively—limited monitoring of basic processes (for compliance and robustness), poor [management information,]" and "[p]rocesses not sufficiently integrated to ensure visibility and complete coverage[.]" BP's internal review of its 2004 gHSEr audits found related concerns: "It is apparent that a number of [Business Units] are still unaware that they have to monitor their own HSE management system."

Limited use of leading indicators. In the same 2003 EEAC report in which BP proposed tracking loss of containment and overdue inspections, BP Group HSSE noted the limited use of leading indicators within the company generally: "All Segments routinely monitor HSSE performance, typically by recording and measuring lagging or output indicators." The report states that only "several Segments (notably [Exploration and Production] and Petrochemicals) are using input or leading indicators to monitor performance . . . ." The Panel notes that in the report, BP Group HSSE did not propose a comprehensive set of leading indicators or attribute any urgency to developing such a set.

An Internal Audit report in 2004 reached the same conclusion with respect to the Refining and Marketing segment:

> Performance monitoring, while improving, is overbalanced in favor of output measures, resulting in reactive as opposed to preventative [sic] interventions. The reactive pace and timing of management interventions puts the segment at risk of missing certain targets and may act to driving [sic] reporting underground.

In response to this finding, management for the segment agreed that "relying exclusively on output measures (lagging indicators) is not appropriate."

According to BP's investigation report of the Texas City incident, the Texas City refinery had "numerous measures for tracking various types of operational, environmental[,] and safety performance, but no clear focus on the leading indicators for the potential catastrophic or major incidents."[42] Similar concerns were expressed in the report to the EEAC for 2004, which was written after the Texas City incident. In discussing a 2004 review that Internal Audit conducted of the HSSE function, the report noted a gap:

> **Monitoring of decentralised functional activity to deliver the Functional Plan**—the HSSE [Management Information ("MI")] systems are established but there is limited transparency of how the wider organisation is delivering against the plan. . . . [T]here is a heavy focus by BP senior management on lagging indicators (*e.g.*, fatalities, [days away from work

case frequency], [green house gas]) to the detriment of leading indicators (*e.g.*, [advanced safety auditing], training, safety audits).

The Panel believes that relying exclusively or predominantly on lagging indicators to assess process safety performance is ill-advised. The Panel acknowledges, however, that such reliance may not be unusual in the refining or other process industries. The Panel understands that many organizations rely heavily on failure data to monitor performance.[43] As the Group Chief Executive noted, based upon BP's system and its track record in output metrics commonly used in the industry, BP believed it had a robust safety performance measurement system. BP's reliance on lagging, after-the-fact indicators of process safety performance rather than leading, predictive measures, however, impaired BP's ability to measure, monitor, and detect deteriorating or degraded process safety conditions and performance. This failure to use a set of effective performance metrics that includes leading indicators increased the likelihood that the organization would identify the need for improvements or additional control of risk only after something had gone wrong.[44]

Visibility of process safety indicators. Although BP tracked some metrics relevant to process safety (*e.g.*, loss of containment and overdue inspections) at its five U.S. refineries before the Texas City incident, the Panel does not believe that BP used these metrics to drive performance. BP did not include these metrics in performance contracts, for example. The company's focus on injury rates hindered an appreciation of the importance of these process safety metrics. As mentioned above, Group HSSE informed the EEAC in 2003 that it would monitor the company's performance on loss of containment and overdue inspections. Group HSSE's annual report to the EEAC the following year, however, did not include any information on these metrics. In discussing personal safety, the report cited only injury rates (days away from work case frequency and recordable injury frequency). In the context of plant and equipment integrity, the report only included information on the number of integrity-related major incidents and high potential incidents in 2002 and 2003.

The manner in which data were collected and reported up the line may have made it harder for executive management to appreciate relevant trends at individual refineries. Refining and segment level management appear to have aggregated much of this data as it was reported up, thereby reducing its effectiveness as a performance indicator.

Even within BP's refining operations, it does not appear that people appreciated the significance of the loss of containment and overdue inspection data. BP's investigation report on the Texas City accident, for example, concluded that "[t]here was no obvious priority or management focus on [key performance indicators] for process safety."[45] Specifically, the refinery had "limited visibility" on process safety performance metrics such as loss of containment incidents, spills, hydrocarbon fires, and process excursions/upsets.[46] The trend of the few leading indicators available to the company also did not have sufficient visibility within the organization: "[w]hile a few leading indicators were measured within the [Texas City] HSSE function, site management was not focused on trend analysis of measures that were much more likely to deliver an accurate sense of process safety performance at the site."[47]

The Panel believes that this Texas City assessment also fairly describes BP management's use of process safety indicators. BP tracked some process safety metrics such as loss of containment and overdue inspections. Apparently, however, BP did not understand or accept what this data indicated about the risk of a major accident or the overall performance of BP's corporate process safety management system. Instead, improving trends in BP's occupational illness and injury rates contributed to a false sense of confidence. Before the Texas City accident, BP did not have a sense of urgency about process safety. This lack of urgency appears to have resulted to a large extent because the company was not effectively monitoring its process safety performance.

> BP's efforts to develop process safety indicators

The process safety performance metrics that BP uses are evolving. BP now monitors at the corporate level several leading and lagging process safety metrics as indicated in the table below:

Table 60

BP Group Integrity Management Metrics[48]

Leading Indicators	Lagging Indicators
Number of overdue inspections and tests	Number of uncontrolled releases
Completion of Major Accident Risk assessments	Number of integrity management-related major incidents
Closure of Major Accident Risk Group recommendations	Number of integrity management-related high potential incidents

These metrics do not appear to be an exhaustive list of potential metrics that BP's U.S. refineries may use. The Panel understands, for example, that Texas City is considering several process safety indicators, including overdue process safety action items, overdue management of change reviews, overdue incident investigations, overdue inspection work requests, temporary repairs, and critical alarm compliance.

The Panel is aware that neither the refining industry specifically nor process industries generally have developed and implemented consensus process safety performance indicators that include leading indicators. The Panel believes, however, that sufficient guidance exists in the literature and that BP possesses the technical expertise to develop such indicators for its five U.S. refineries. The lack of a consensus set of process safety indicators should not prevent BP from developing its own internal metrics. A lack of industry consensus on process safety metrics should not give BP reason to delay designing a set of leading and lagging indicators for use in its refineries. The Panel believes that the lack of such metrics represents a serious gap in BP's corporate safety management system.

The Panel understands that BP is working with external experts to review process safety performance indicators across the company and across the industry. Some of these efforts to develop indicators are under the auspices of industry-wide groups, including the CCPS and the American Chemistry Council.

Additionally, BP has revised its biannual "People Assurance Survey" of employees in an effort to obtain more process safety-related information from the survey. BP has added several new questions to the 2006 survey intended to measure forward-looking aspects of safety culture and safety performance at BP sites.

Interviews with BP management indicate that following the Texas City accident, the EEAC has also become more active and involved in monitoring process safety. The EEAC monitors BP's performance against management's targets on a company-wide basis as to each of the metrics in Table 60, as well as to management's targets for fatalities, days away from work case frequency, recordable injury frequency, and severe vehicle accident rate. From 2000 through 2004, BP's Group Vice-President, HSSE typically met twice a year with the EEAC to review the annual HSSE report. Since the creation of the Safety and Operations function following the Texas City accident, the Senior Group Vice-President, Safety and Operations has attended nearly every meeting of the EEAC to report on a variety of topics. In addition, in 2006 the EEAC began monitoring the six process safety metrics shown in Table 60.

Notwithstanding these efforts, the Panel notes that BP will need to do much more in the area of developing and implementing a set of process safety performance metrics. BP may need to change systems at individual refineries to readily produce meaningful process safety management information that site management can use to track significant barometers of process safety performance. At the Texas City refinery, the largest and most complex of BP's refineries, the operations manager reported to the Panel that she had developed her own list of process safety metrics in 2005 to be tracked across the refinery. She described for the Panel how difficult it has been to gather the data on these metrics and how, in the absence of a robust management information system, she and her staff make phone calls or send e-mail to superintendents of individual units to obtain the desired information.

Finding:

> ***BP's safety management system for its five U.S. refineries does not effectively measure and monitor process safety performance.***

BP'S INVESTIGATION AND ROOT CAUSE ANALYSIS PROCEDURES

> Importance of incident investigations

The investigation of incidents represents an important method of evaluating the performance of safety management systems. In this context, the term "incidents" includes events that do not result in injury or major damage and are often referred to as "near misses."[49]

By analyzing incidents to identify underlying deficiencies in the safety management system, an organization can correct those deficiencies and also take steps to prevent the recurrence of incidents.[50] An organization also can take steps to broadly communicate the lessons learned from incident investigations so that all parts of the organization can learn from the investigations and assess whether corrective actions are warranted.[51]

In the United States, employers who are subject to OSHA's process safety management standard must investigate each incident that resulted in, or could reasonably have resulted in, a catastrophic release of a highly hazardous chemical into the workplace.[52] The process safety management standard requires that incident investigations begin as "promptly as possible, but no later than 48 hours following the incident."[53] The employer must also promptly address and then document the resolution of incident report findings and recommendations.[54]

> BP's incident investigation policy

BP's internal standards recognize the importance of incident investigations. Element 12 of gHSEr, *Incidents, Analysis, and Prevention*, includes the following requirements: "[i]ncidents will be reported, investigated, and analysed to prevent recurrence and improve our performance. Our investigations will focus on root causes and/or system failures. Corrective actions and preventive measures will be utilized to reduce future injuries and losses."[55] Like most companies, BP includes near misses in its definition of incidents.[56] Expectation 12.5 of gHSEr provides that lessons learned from incident investigations will be shared and acted upon throughout BP.[57]

The new BP Group standard for integrity management also addresses incident investigations.[58] Element 9, *Incident Investigation and Learning*, provides that, "[e]ach BP Operation shall investigate all significant [integrity management] incidents." The types of events included in this element are major incident announcements, high potential incidents, uncontrolled releases, and other equipment failures. The integrity management standard requires the incident investigation team to employ root cause analysis principles "to determine the possible cause(s) and identify and recommend actions to prevent a recurrence." Additionally, this requirement includes the expectation that the process will be well documented and the findings will be promptly addressed. Every action item associated with these findings should be tracked until closure.

The rigor with which BP investigates an incident depends upon its actual or potential severity. BP's internal standards provide that "[d]etailed investigations should be carried out for all major incidents *(injury or damage)* and any minor incident or near-miss with a high potential of being a major one. Less serious incidents should be investigated with a degree of rigor appropriate to the potential for loss or injury."[59] Special notification requirements, including notification to the Group Chief Executive and the Chief Executives of business segments, apply to major incidents.[60]

> BP's methods of root cause analysis

BP considers root or system causes to be the "most basic causes that can reasonably be identified, that management has the control to fix, and for which effective corrective actions for preventing recurrence can be generated." BP recognizes that incidents typically have more than one cause. As BP notes in its incident investigation guidelines,

> It is very unusual for an incident to have one single cause. Normally incidents result from a chain or combination of actions or errors, some going quite far back in time. This is why it is essential to have a systematic and thorough investigation, following a consistent methodology, so that the chain of causes can be tracked right back to its origins.[61]

The Panel is concerned, however, that BP's investigations may miss systemic causes by considering only causes in a direct, linear chain of causation as discussed above.

BP utilizes several tools in conducting root cause analysis, including methods known as the Five Whys and the Comprehensive List of Causes. The Panel's review, however, raises questions regarding the adequacy and thoroughness of BP investigations into incidents and near misses, especially as BP's investigations relate to root cause analysis and the identification of multiple causes.

As an initial matter, the Panel believes that BP's exclusion of causes outside of management's control in its definition of root cause[62]—if not carefully applied—can result in inadequate consideration being given to systemic and management system causal factors. The Panel recognizes that in creating the exclusion, BP intends to focus the root cause analysis process on failures that are correctable by management. However, if the exclusion is interpreted too broadly, such an interpretation may result in underlying management deficiencies not being identified. For example, the reference to "management" in this context should be read expansively to cover all levels of management. The root cause analysis should exclude causes only if they are truly outside the control of BP—not just outside the control of refinery-level management. In the situation in which true root causes are not identified, proposed corrective action likely will address immediate or superficial causes, but not the true root cause. In such cases, corrective action may be ineffective to prevent future incidents arising from the same root causes.

> The "Five Whys"

For minor incident root cause analysis, BP uses an approach called the "Five Whys." Under this approach, the investigation team questions "why" the incident happened or "why" the unfavorable conditions existed. Specifically, the team selects an event associated with the incident, asks why this event occurred, and identifies multiple subevents or conditions that gave rise to the event. For each of these subevents or conditions, the team again asks why it occurred. The team records the subevents or conditions as an event tree. The team then repeats this process five times to identify the root cause. One advantage of this approach is that it requires minimal effort and expense to train investigation team members.

BP acknowledges several limitations to this approach, however, including that results are not "reproducible/consistent" and that system causes may not be identified. The "Five Whys" process can lead to a very narrow and superficial incident analysis and may not identify the best corrective actions—especially if the investigation team is not properly trained.

Although BP documents discussing the use of this method state that it should only be used for minor incidents, it does not appear that BP has consistently defined what is minor. Sometimes seemingly minor events may be precursors for major accidents, and the identification and elimination of the causal factors of a seemingly minor event may prevent a major accident and therefore provide a valuable learning opportunity. For this reason, the Panel believes that it is important to ensure a thorough assessment of the root causes of even minor incidents.

The Panel also identified some deficiencies in the guidance that BP provided on root cause analysis. In discussing the Five Whys, for example, the process description and example from the Cherry Point safety and health manual's section on incident investigation suggests that there will be only one root cause and only one linear path to an event. The Panel believes that rarely only one root cause or path exists and that this guidance may lead the investigation team to omit important systemic causes. Other BP documents provide insufficient guidance for conducting root cause analyses. A 2003 version of the procedures for incident investigation at the Texas City refinery includes only two very general sentences on root cause analysis (essentially saying that it should be performed) although great detail is provided about the gathering and recording of data during the investigation.

> Comprehensive list of causes

For most of its incident investigations, BP uses a list of causal factors to analyze root causes. BP refers to this method as the Comprehensive List of Causes (CLC). Unlike the "Five Whys," the CLC approach promotes identification of multiple causes.

Analysis using the CLC begins with an incident investigation that the incident investigation team conducts. In its investigation, the team gathers evidence about the incident, creates a timeline of events, and drafts a list of critical factors. BP considers critical factors to be those key factors that precipitated the incident.

BP's CLC is divided into two major categories: "immediate causes" and "system causes." Immediate causes are subdivided into unsafe actions and unsafe conditions. System causes are subdivided into personal factors and job factors. Each of the four quadrants contains a detailed list of causes. BP individually defines the causes within the subcategories in an effort to enable the incident investigation team to differentiate among causes and to properly match critical factors with causes.

The incident investigation team works through the entire CLC in a systematic manner for each critical factor, beginning with immediate causes. BP's instructions for the CLC approach provide that the investigation team should identify all potential causes before proceeding with the next critical factor. The team also provides a reason for each cause. However, it does not appear that BP provides an analytical process for performing this identification.

After identifying all of the specific causes of an incident, the incident investigation team prepares a proposal for corrective action. The proposal should contain a description of the corrective actions for each cause identified during the CLC process. BP's instructions note that the corrective action plans are to be shared throughout the BP system to prevent similar occurrences at other sites.

To enhance the root cause analysis, BP uses a worksheet that provides root cause investigators with an additional list of human factors to be used in conjunction with the CLC. The human error analysis worksheet contains a guide to analyzing human behaviors, beginning with a determination of whether the identified behavior leading to a cause was intentional or unintentional and leading to the identification of external and internal influences and other conditions under which personnel are likely to make mistakes.

A major concern associated with a checklist approach like the CLC is that users likely will not identify any factors other than those on the list. In the Panel's experience, investigations typically use a checklist as a complete list of potential causes instead of a starting point for discussion of the deeper root causes and usually will not identify factors that are not on the list. Labeling the list as "comprehensive" likely exacerbates this problem. The Panel also believes that BP's list of systemic factors related to engineering problems (*e.g.*, "inadequate technical design") appears somewhat superficial. While inadequate technical design is a valid factor, BP should use it to invite more extensive inquiry: What is the design inadequacy? Why was it present? Why was it not discovered prior to the incident under investigation?

Furthermore, many of the listed systemic factors do not represent systemic issues. Fatigue, for instance, is included as a systemic cause. Although BP identifies some subcategories under fatigue, such as whether fatigue was due to workload, lack of rest, or sensory overload, the Panel does not believe that these types of subcategories represent true systemic causes. For example, a system cause may be that management requires too much overtime because they have not hired enough workers or that limits have not been placed on work hours or that required rest periods have not been enforced. Workload, lack of rest, and sensory overload may be the *immediate causes* of worker error, but not the *system causes.* Although human factors are not split into systemic and immediate causes in the human error analysis, the majority of the factors overlap with the CLC and are analyzed in light of their CLC category.

Finally, the Panel notes that BP uses the CLC for both personal safety accidents and process safety accidents. As a result, the checklist CLC approach may tend to bias the analysis toward looking at human error as opposed to engineering and management issues. In the Panel's opinion, the causal factors involved in occupational or personal safety incidents and process safety incidents typically are very different. The use of personal safety incident hypotheticals as the only examples in some of the BP training materials that the Panel reviewed may inadvertently reinforce this bias. The human error analysis, which focuses investigators' efforts on personal safety aspects of incidents rather than all aspects of an incident, may introduce additional bias in the analysis toward finding behavioral root causes.

> The thoroughness of BP's investigations

Several of the technical reviews that the Panel's consultants conducted and a process safety audit that a third-party consultant conducted at Texas City in 2006 confirm the Panel's concerns about the effectiveness of BP's incident and near miss investigations. Based upon their sampling of incident and near miss investigations, the Panel's technical consultants found several instances of deficiencies in BP's near miss investigation system. At the Carson refinery, the technical consultants identified closed incident investigation reports that did not specify the root causes or contributing factors. The review at the Cherry Point refinery found several instances among the sampled investigation reports in which the potential consequences of near misses had been underestimated, resulting in the events receiving a lower classification and, consequently, a less rigorous investigation. The technical consultants observed that the incident type/scope language in the Toledo refinery incident investigation procedure did not explicitly address the need to investigate near miss type events for process safety management compliance purposes.

The 2006 third-party audit of process safety management at the Texas City refinery also reveals deficiencies in incident investigation, especially in root cause analysis. For example, approximately 15 percent of the incident reports that the third-party auditor reviewed list poor judgment as a system cause with no further analysis. Because "many of the causes in the investigation reports involved human errors," the auditor recommended that BP consider further review "to determine whether the investigators should be drilling down deeper (*e.g.*, by asking "Why?" several more times) in order to reach management systems root causes." The auditor also found that no procedure or formal training was provided on what constituted an acceptable or "good" recommendation.

Similarly, although mixed responses were given to the process safety culture survey, more than 20 percent of several groups of workers at BP's U.S. refineries expressed a lack of confidence that process safety issues were investigated thoroughly. Table 61 shows that of the identified groups, a lack of confidence was primarily evident in negative responses from Texas City operators (27 percent), maintenance craft technicians (26 percent), HSSE employees (26 percent), and engineering professionals (22 percent); Toledo operators (36 percent), contractors (33 percent), and HSSE employees (21 percent); and Whiting contractors (25 percent). Other groups at Texas City, Toledo, and Whiting responded more positively but, as shown below, in certain instances they still conveyed somewhat heightened levels of doubt regarding the thoroughness of investigations. Respondents at Carson and Cherry Point, however, provided generally positive responses, as reflected by the fact that all six employee groups shown in the table below had negative response rates of less than 20 percent. Responses from operations management were particularly positive. In that regard, their negative response rates ranged from only two percent at Carson to 11 percent at Texas City.

Table 61

Percentage of Disagree/Tend to Disagree Responses to Survey Item:
"I am confident that process safety issues are: [t]horoughly investigated."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	12	3	27	36	13
Maintenance/Craft Technicians	19	11	26	19‡	18
Full-Time HSSE Employees	8	12	26	21‡	10
Engineering Professionals	8	4	22	11	8
Operations Management	2	2	11	5	7
Maintenance Management	9‡	13‡	16	*	0
Contractors	11	20	18	33	25

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Please read Section I for a discussion of considerations and limitations relating to survey data and the Panel's method of analyzing that data. The analysis of survey data contained in this section is qualified by, and should be read in conjunction with, the discussion of those considerations and limitations in Section I. Some of the survey data provided in Table 61 correlate with views expressed during the hourly interviews. A number of hourly employees at Texas City and Toledo, for example, expressed the belief that management is more interested in assigning blame than identifying the root cause of an incident. In contrast to the generally positive survey results for Carson, however, some hourly Carson employees expressed concern that incident investigations do not dig deep enough and are primarily blame assessments.

> Whiting rupture disk

As described more fully in Appendix D, during the Panel's process safety technical review at the Whiting refinery in March 2006, the Panel's consultants discovered pressure between several rupture disks and pressure relief valves on a fractionator tower. Quarterly operator logs for the previous two years indicated seven out of eight rupture disk/relief valves reported higher than intended pressure. This condition had the potential to make the pressure relief system for the unit ineffective.

The Panel's consultants immediately alerted BP to the rupture disk situation, and BP promptly took corrective measures. In addition, BP categorized the event as a HiPo, or high-potential-for-harm incident, and started a root cause investigation. BP then provided the Panel with a report summarizing BP's internal investigation.

In its report, BP identifies the following root causes of this near miss:

- Failure to recognize the significance of and act upon the potential hazard created by not properly maintaining the rupture disk system as designed or completing the planned upgrades to eliminate the rupture disks. This issue has been ongoing seven years. Individual decisions to defer modifications of the relief system were reinforced by a rupture disk system that was perceived to provide adequate safety protection and not an immediate risk to personnel . . . . The rupture disk protection was difficult to maintain, even though this did not appear to compromise the relief valves (relief valves always operated properly when required).
- Failure to follow documented protocol to write work orders and/or replace the rupture disks when operator inspections revealed the rupture disk assemblies were leaking.

Concerned that BP's investigation into this near miss might suffer from some of the limitations of BP's methods for investigating incidents and near misses, the Panel instructed its technical consultants to return to the Whiting refinery to look into the situation further.

Based upon their subsequent review, the Panel's consultants generally agreed with BP's factual findings regarding the Whiting rupture disk near miss. The consultants, however, identified more systemic root causes for the near miss, including inadequate training/qualification of personnel, inadequate review against technical standards, inadequate operational discipline and attention to detail, inadequate management of change reviews, and lack of a site-based management review system.

Based upon its consultants' additional review and analysis, the Panel believes that BP's investigation into this near miss was not sufficient to identify its true root causes. In effect, BP's investigation stopped prematurely and did not assess the underlying systemic issues that contributed to this situation. For example, with respect to BP's first root cause, the failure to act upon the potential hazard created by not properly maintaining the rupture disk system or completing planned upgrades to eliminate the rupture disks, one should ask, why did employees fail to recognize the significance of the hazard? Was it due to a lack of training? Was it due to a lack of understanding? Similarly, why did employees not follow the work order protocols? Was it a lack of training? Was a management system in place to track the work orders? BP's investigation never reached these issues. Because BP's investigation did not go deep enough, these questions remained unanswered. BP's investigation also left unidentified and unresolved deficiencies that might contribute to other, potentially larger issues.

BP appeared to acknowledge the limitations of its investigation. The cover letter to BP's investigation report observes that while "[t]here are aspects of the findings that also touch on cultural and behavioral issues. [It was] beyond the scope of this incident investigation to define actions to address such aspects. . . ." Such a limited approach appears inconsistent with the rationale for incident investigations as stated in the BP Group process safety/integrity management standard:

> An incident or near miss is an indication that the management system for process safety/integrity management is inadequate, is not being followed, or has failed. Thorough incident investigations, with complete follow-up and closure of action items are critical to achieving an injury and incident free workplace. Investigations are an opportunity to identify and control factors that may contribute to related incidents, strengthen safety systems and communicate lessons learned.

BP's apparent decision to limit its investigation is troubling. An investigation into the root causes of an incident or near miss provides an opportunity to address issues that, if not addressed, could later contribute to an accident. BP's focus on what are more properly considered symptoms as opposed to root causes represents a potential missed opportunity to address more fundamental issues that may manifest themselves in the future in a similar, or even different, manner than the rupture disk situation. The underlying causal factors relating to the rupture disk situation could contribute to another incident in the future that has nothing to do with pressurized rupture disks under relief valves.

Other external reviews of BP's process for determining root causes have reached similar conclusions. In 2004, BP retained a consultant to perform behavioral safety culture assessments at Carson, Cherry Point, Toledo, and Whiting. A consistent theme of those interviewed during the assessments was that BP's root cause analysis does not drill down behind the major classifications to find all the contributing behavioral causes and systems causes. The consultant concluded that this failure to drill down may result in treating symptoms, the failure to uncover threads between incidents, the failure to arrive at permanent solutions, the perpetuation of unsafe actions and conditions, and a repeated analysis of the same problems.

Based on discussions with the Panel, BP now appears to acknowledge deficiencies in its processes for root cause analysis. Interviews with corporate-level managers indicate that BP's root cause process did not go to the depth necessary to understand underlying cultural issues and that the Panel's repeated focus on the Whiting rupture disk issue has allowed BP to see this point more clearly.

> BP's efforts to share lessons from incidents and improve the effectiveness of its incident investigations

BP employs different methods at the corporate, Refining and Marketing segment, and refinery levels to distribute information regarding incidents and lessons learned. At the corporate level, each major incident announcement and high potential incident investigation results in a "learning summary." BP's communication process requires distribution of these summaries by email and entry of the summaries into Tr@ction. The company reviews major incident announcements and high potential incidents to determine whether the company should revise or develop new Group standards, engineering technical practices, or other types of Group guidance. A serious incident also may require the development of a specific intervention across the Refining operations to implement lessons learned from the incident. The Global Refining leadership team determines which incidents require such an intervention.

At the Refining and Marketing segment level, a designated team reviews the major incident announcement and high potential incident investigation learning summaries to identify lessons that specifically relate to the Refining and Marketing segment. This review also includes incident reports from other BP business and other companies. Each quarter, the review forms the basis of the *Quarterly Safety Bulletin*, which is distributed to the Refining process safety community of practice, Refining advisors, and several HSSE employees throughout BP. All BP employees have access to the *Quarterly Safety Bulletin* through the BP intranet. At the refinery level, a designated team of individuals at each site reviews all major incident announcements and high potential incident investigation reports and identifies which learnings are applicable to that site.

The Panel also understands that BP is in the process of improving aspects of its incident investigation process. During 2006, for example, BP began a review of its current comprehensive list of causes for possible updating based upon BP's experience with the list as well as current recognized good practices.

BP also is attempting to improve its system for sharing lessons from previous incidents. Although this work is still preliminary, BP has stated its intention to have the new Group Safety and Operations function make specific improvements with respect to the collection and distribution of lessons learned, as well as tracking follow-up actions.

Finding:

BP's investigation system has not instituted effective root cause analysis procedures to identify systemic causal factors.

BP'S REPORTING OF INCIDENTS AND NEAR MISSES

The Panel believes that BP has an incomplete picture of process safety performance, and therefore of process risks, at its U.S. refineries because not all incidents and near misses are being detected and reported. This issue is a serious one because the first step in "a successful incident investigation is to recognize when an incident has occurred so that it can be investigated appropriately."[63] If BP is not aware of an incident or near miss, it has no opportunity to investigate it and prevent its recurrence or the occurrence of another incident having the same root cause.

It is generally believed that for every serious incident involving fatalities, serious injuries, or significant damage to the environment or property, a larger number of incidents result in more limited impacts, and an even greater number of incidents result in no loss or damage.[64]

Near misses in the process safety context can occur in many different forms. Recognized examples include exceeding process operating limits, releases of hydrocarbons or other hazardous substances, and activation of layers of protection such as relief valves, interlocks, or rupture disks, that are built into process equipment.[65]

In the process safety context, the investigation of these near misses is especially important for several reasons. First, there is a greater opportunity to find and fix problems because near misses occur more frequently than actual incidents having serious consequences. Second, despite the absence of serious consequences, near misses are precursors to more serious incidents in that they may involve systemic deficiencies that, if not corrected, could give rise to future incidents. Third, organizations typically find it easier to discuss and consider more openly the causes of near miss incidents because they are usually free of the recriminations that often surround investigations into serious actual incidents. As the CCPS observed, "[i]nvestigating near misses is a high value activity. Learning from near misses is much less expensive than learning from accidents."[66]

Ratios of near misses to major incidents. In response to a request from the Panel, BP provided data on the occurrence of major incidents at its U.S. refineries as reflected by major incident announcements and reported near misses. BP considers major incidents to include fatalities, multiple serious injuries, significant economic losses, specific types of large environmental releases, or significant adverse reactions from regulatory authorities. BP defines a near miss, on the other hand, as "an undesired event, which, under slightly different circumstances, could have resulted in harm to people, damage to property, or loss to process." A table reflecting this data is reproduced below.

Table 62

Number of Reported Near Misses and Major Incident Announcements (MIAs)

Refinery	Items Reported	2000	2001	2002	2003	2004	2005	Annual Average[67]
Carson[68]	Near misses	N/A	37	17	35	72	20	36.2
	MIAs	1	1	1	1	0	2	1
Cherry Point	Near misses	N/A	141	213	332	418	371	295
	MIAs	0	0	0	0	0	1	0.17
Texas City	Near misses	N/A	N/A	701	1292	1801	1256	1262.5
	MIAs	0	1	2	2	5	4	2.33
Toledo	Near misses	7	16	39	32	89	107	48.33
	MIAs	0	1	3	0	0	2	1
Whiting	Near misses	555	430	551	498	472	535	506.83
	MIAs	6	2	2	3	5	0	3

As shown in Table 62, the annual averages of near misses and major incident announcements for a number of the refineries during the six-year period shown above vary widely. The annual averages yield the following ratios of near misses to major incident announcements for the refineries: Carson (36:1); Cherry Point (1770:1); Texas City (541:1); Toledo (48:1); and Whiting (169:1). The wide variation in these ratios suggests a recurring deficit in the number of near misses that are being detected or reported at some of BP's five U.S. refineries.

Although the Cherry Point refinery's ratio of annual average near misses to annual average major incident announcements is higher than the ratios for the other four refineries, even at Cherry Point a previous assessment in 2003 noted the concern "that the number of near hits reported appears low for the size of the facility." The ratios for Carson and Toledo, however, are especially striking. The Panel believes it unlikely that Cherry Point had more than 35 times the near misses than Carson or Toledo. Other information that the Panel considered supports this skepticism. A BP assessment at the Toledo refinery in 2002, for example, found that "leaders do not actively encourage reporting of all incidents and employees noted reluctance or even feel discouraged to report some HSE incidents. No leader mentioned encouragement of incident/near-miss reporting as an important focus to improve HSE performance at the site and our team noted operational incidents/issues not reported."

Ratios of high potential incidents to major incidents. In addition to tracking near misses, BP tracks high potential incidents, which BP defines as an incident or near miss in which "the most serious probable outcome is a Major Incident." Termed "HiPos," these high-potential incidents can be a predictor of the potential for major incidents. The Panel believes that comparing the frequency of high potential incidents to the frequency of major incident announcements further supports concerns regarding the adequacy of near miss and incident reporting.

An examination of the ratio of high potential incidents and major incident announcements reported by BP suggests that high potential incidents may be going unreported or undetected. As seen in Table 63, the ratios of high potential incidents to major incident announcements are markedly lower than the ratios for near misses to major incident announcements. At several of the facilities, no high potential incidents were reported in some years, but one or more major incident announcements occurred in those years. This situation is particularly noticeable at Whiting. From 2000 to 2002, no high potential incidents were reported, but ten major incident announcements occurred: six in 2000, two in 2001, and two in 2002. All of the facility ratios of high potential incidents to major incident announcements, viewed as an annual average, yielded ratios of no more than five to one.

Table 63

Number of High Potential Incidents (HIPOs) and Major Incident Announcements (MIAs)

Refinery	Items Reported	2000	2001	2002	2003	2004	2005	Annual Average
Carson	HIPOs	0	0	0	1	4	6	1.833
	MIAs	1	1	1	1	0	2	1
Cherry Point	HIPOs	0	0	0	0	1	4	0.833
	MIAs	0	0	0	0	0	1	0.167
Texas City	HIPOs	0	0	0	1	2	2	0.833
	MIAs	0	1	2	2	5	4	2.333
Toledo	HIPOs	1	3	4	9	7	5	4.833
	MIAs	0	1	3	0	0	2	1
Whiting	HIPOs	0	0	0	1	4	4	1.5
	MIAs	6	2	2	3	5	0	3

The Panel considers the annual average ratios of high potential incidents to major incidents to be compelling: Carson (1.8:1); Cherry Point (5:1); Texas City (0.4:1); Toledo (4.8:1); and Whiting (0.5:1). The ratios for Texas City and Whiting are actually inverted from what would be reasonably expected in that they reflect reporting of more major incident announcements than high potential incidents. At the other refineries, BP reports fewer high potential incidents when compared to major incident announcements than what the Panel would expect.

Several responses to the process safety culture survey support the Panel's conclusion that BP's systems were not detecting or reporting all minor process-related incidents, accidents, and near misses. As shown in Table 64 below, for example, certain BP employees and contractors tended to believe that in general, workers did not bother to report minor process-related incidents, accidents, or near misses. Responses tended to be most negative at Texas City and Toledo, but responses at Whiting, Carson, and to a lesser extent Cherry Point also reveal potential reporting deficiencies. More than half of maintenance/craft technicians at Carson, Texas City, and Toledo expressed a belief that workers were not reporting everything. More than half of contractors across all refineries, and at least one-third of HSSE employees at Texas City, Toledo, and Whiting, responded in the same manner. Even respondents in certain management groups tended to opine that workers did not report minor process-related incidents, accidents, and near misses. In that regard, negative response rates were particularly high for maintenance management at Carson (50 percent) and Texas City (38 percent). As indicated previously, respondents from Cherry Point provide mixed signals regarding the reporting of minor process-related incidents, accidents, and near misses. Forty percent of maintenance/craft technicians and 56 percent of contractors responded negatively. In sharp contrast, however, less than ten percent of HSSE employees, engineering professionals, operations management, and maintenance management responded negatively.

Table 64

Percentage of Agree/Tend to Agree Responses to Survey Item:
"In general, workers don't bother to report minor process-related incidents, accidents, and near misses."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	35	18	47	44	37
Maintenance/Craft Technicians	57	40	56	69‡	32
Full-Time HSSE Employees	22	8	36	39‡	33
Engineering Professionals	19	7	31	23	27
Operations Management	20	3	29	26	17
Maintenance Management	50‡	0‡	38	*	9
Contractors	60	56	61	61	60

* Survey data are not available because of the small number (fewer than 15) of potential respondents.
‡ Fewer than 25 respondents were in this group.

Information from the hourly interviews also supports this data. Hourly employees interviewed at Texas City, Toledo, and Whiting indicated their belief that some incidents, accidents, and near misses were not reported. Some hourly employees interviewed at Carson also expressed skepticism about whether all near misses were reported.

Reasons incidents and near misses are going unreported or undetected. Numerous reasons exist to explain why incidents and near misses may go unreported or undetected. A lack of process safety awareness may be an important factor. If an operator or supervisor does not have a sufficient awareness of a particular hazard, such as understanding why an operating limit or other administrative control exists in a process unit, then that person may fail to see how close he or she came to a process safety incident when the process exceeds the operating limits. In other words, a person does not see a near miss because he or she was not adequately trained to recognize the underlying hazard.

As discussed elsewhere in this report, the Panel believes that the general awareness of process hazards at BP's U.S. refineries is deficient. The Panel believes that this lack of awareness likely contributes to BP's insensitivity to near misses and high potential incidents.

During BP's investigation into the Texas City accident, for example, several minor fires occurred at the Texas City refinery.[69] The BP investigators observed that "employees generally appeared unconcerned, as fires were considered commonplace and a 'fact of life' in the refinery."[70] Because the employees did not consider the fires to be a major concern, there was a lack of formal reporting and investigation.[71] Any underlying problems, therefore, went undetected and uncorrected.

A Toledo email shows a similar complacency about the significance of incidents:

> There apparently was a very small fire at Coker III. The fire was due to vapors coming out of the coke drum overhead line low point drain (the "flange drain"). I'm not sure if the plug was not installed in this drain before the hot vapor drum pre-heat started, or if the plug was installed but not fully seated, allowing vapors to escape to atmosphere. Either way, I believe that this was a minimal impact, non-event type of fire . . . one that we have seen many times over the years on numerous flanges and connections on our Cokers. I do not know if a Traction was entered for this event or not.

The absence of a trusting environment among employees, managers, and contractors also inhibits incident and near miss reporting. As discussed in Section VI.A, an employee who is concerned about discipline or other retaliation is unlikely to report an incident or near miss out of fear that the employee will be blamed.

Ineffective reporting tools also may inhibit BP employees from reporting. Although BP has established several reporting systems such as Tr@ction, Near Miss Reports, and Lessons Learned, some hourly workers at Carson, Toledo, and Whiting complained about the difficulty in using Tr@ction and its poor design.[72] In addition, some survey respondents expressed dissatisfaction with the safety reporting system, primarily at Texas City and Toledo. For example, almost one-third of operators at Texas City (32 percent) and more than one-third of operators at Toledo (38 percent) indicated that they were not satisfied with the process safety reporting system at their refineries. More than one-third of the maintenance/craft technicians at Texas City (35 percent) and Toledo (40 percent)[73] expressed similar dissatisfaction, as did 36 percent of HSSE employees at Texas City and 26 percent of HSSE employees at Toledo.[74] These concerns were less prevalent at Carson and Cherry Point, where no more than 15 percent of BP employees in the process safety functional groups and contractors responded negatively.

Finding:

> ***BP's process safety management system likely results in under reporting of incidents and near misses at BP's five U.S. refineries.***

BP'S PROCESS SAFETY AUDIT SYSTEM

> Importance of compliance and site safety management system audits

An audit provides the most formalized means of assessing the performance of a process safety management system. Audits should evaluate the effectiveness of the site's safety management systems as well as assess the site's compliance with regulatory requirements and other applicable standards.[75] As part of such an assessment, the audit team should interview relevant site personnel, review representative records, and review on-site conditions.

In the United States, the OSHA process safety management standard mandates compliance audits against the requirements of the standard every three years.[76] OSHA also requires companies subject to the standard to "promptly determine and document an appropriate response to each of the findings of the compliance audit, and document that deficiencies have been corrected."[77]

> BP's gHSEr and process safety management audit programs

BP's standards recognize the importance of compliance and site safety management system audits. Expectation 13.10 of gHSEr, under Element 13: *Assessment, Assurance and Improvement*, provides an expectation of annual self-assessment against the gHSEr expectations by each business unit, such as a refinery, and external audits at least every three years.[78] In the past, the HSSE and Technology Group for the Refining and Marketing segment managed these external gHSEr audits for BP's U.S. refineries. According to BP, the refineries use the audits to demonstrate compliance with applicable legal requirements as well as BP's HSSE expectations, including effective management of major risks, performance against agreed targets and objectives, and documented action plans for closure of all outstanding items from HSSE self/external assessments.[79]

The BP Group process safety/integrity management standard further emphasizes process safety compliance and system audits.[80] The standard lists refinery plant manager assurance, external regulatory/legislative audit requirements, independent audits, and ongoing local self-assessments of systems and procedures as part of the overall audit and assurance structure used to review the effectiveness of process safety/integrity management. BP Refining also required field verification that compliance audits had been undertaken and regulatory requirements met.

The Refining process safety community of practice coordinates process safety audits at each refinery every three years to meet these requirements and to satisfy OSHA's audit obligation. BP conducted its process safety audits using the BP Refining Process Safety/Integrity Management Audit Protocol that BP issued in January 2003. The audit protocol outlined the areas to be reviewed during an audit and was organized by both gHSEr element and process safety/integrity management standard element. The audit protocol contained specific areas of inquiry that the audit team must cover during the audit. For example, the audit protocol required that the audit team "[i]dentify administrative controls to promptly determine and document a response to each of the audit findings as well as documenting that deficiencies have been corrected."

BP's process safety audit teams historically have spent approximately 30 to 40 percent of their time identifying and understanding the process safety management system at the audited refinery site and approximately 60 to 70 percent of their time checking compliance in the field. The audit teams have spent most of their time during the audit talking with refinery personnel, such as operators, maintenance workers, contractors, pipe fitters, inspectors, and technicians, who have a direct influence on and interaction with refinery processes.

On the last day of the audit, the audit team presents its Priority 1 and Priority 2 findings to refinery management. Priority 1 findings include items that are believed to be out of compliance with legal or internal standards. The site is responsible for correcting Priority 1 findings. Priority 2 findings, which are less serious, are concerned with "moving the sites forward" and include ideas or suggestions to improve the process safety management system.

> The effectiveness of BP's process safety management audit programs

BP considers audits as vital elements of the annual assurance process for HSSE performance. According to a Group executive, BP previously believed that its process safety auditing system was on the leading edge; however, this view has changed since the Texas City incident. BP's own investigation identified specific deficiencies in process safety audit scope:

> The Texas City site has been subject to several audits in recent years, but these audits focused on documented management systems and processes rather than actual practices, such as following operating procedures. The audits also appeared to ignore the history of previous incidents, process excursions, and near-misses. Verification and audit processes were inadequate to provide early warning of process safety risk.[81]

BP now acknowledges that its process safety audit system was inconsistent and did not "flag" the severity of the issues at Texas City. Similarly, BP acknowledges that its process safety audit process was "not clear enough" and "issues were not emerging with enough edge." Based upon its review, the Panel has reached similar conclusions. Specifically, the Panel identified concerns in auditor qualifications, audit scope, reliance on internal auditors, and limited review of audit findings.

Training and qualifications of auditors. According to BP, the process safety advisor for the refining business was responsible for selecting process safety audit team members. In making these selections, the process safety advisor requested recommendations from the process safety community of practice for individuals with specific qualifications and expertise.

BP required at least ten years of experience for audit team members. The Panel notes, however, that this experience requirement appears to be operational or subject matter-related, not audit-related. Although the typical audit team had one or more team members who participated in previous audits, BP did not specifically require prior audit experience or training as an auditor. In addition, BP did not provide formal training on auditing or have an auditor apprentice program.

BP's own internal reviews of gHSEr audits acknowledged concerns about auditor qualifications: "there is no robust process in place in the Group to monitor or ensure minimum competency and/or experience levels for the audit team members." The same review further concluded that "[the Refining strategic performance unit suffers] from a lack of preplanning, with examples of people being drafted onto audits the week before fieldwork. No formal training for auditors is provided."

The Panel believes that the absence of formalized audit training for individuals participating in BP audits, including process safety reviews at the refineries, reduced the overall effectiveness of the BP audit program. Beyond having subject matter expertise, effective auditing requires a combination of prior auditing experience and special audit training.

As discussed above, BP used a classification system to prioritize action based upon whether a finding represented a possible gap in compliance with applicable regulations or BP standards (Priority 1) or a lesser process safety practice weakness reflecting an opportunity for improvement in process safety performance (Priority 2). In the judgment of the Panel's technical consultants, several prior findings that BP's audit teams made during process safety reviews at Carson, Toledo, and Whiting were misclassified as lesser (Priority 2) items instead of as regulatory compliance or BP policy (Priority 1) issues. These potential misclassifications suggest that the competence, experience, or independence of some audit team members may have been insufficient.

Depth and breadth of audits. To conduct an effective process safety audit of a site, the size of the audit team and the length of the audit will vary depending upon the refinery being audited. The duration of an audit clearly affects the breadth and depth of the review. The shorter the audit, the less time there is to talk with employees and review relevant documents. Opening and closing conferences at the beginning and end of the audit further limit the time available for the actual conduct of audit procedures. Short audits are not necessarily inadequate, but they limit the depth of review of representative systems that the auditors can conduct before coming to their conclusions. Conducting a review of fewer systems increases the likelihood that the auditors will miss deficiencies or come away with an inaccurate picture of a management system's performance. In general, BP's process safety audits of the U.S. refineries typically have lasted one work week.

The size and complexity of the refinery being audited affects the duration of the audit and the size of the audit team. The Panel believes it would be very challenging to conduct a thorough review of a refinery's process safety compliance and management systems in one week with the size of the audit teams that BP used. For this reason, although BP's audits may have been sufficient to satisfy the audit obligation in the process safety management standard, the Panel is concerned that some of BP's audits were of insufficient duration to ensure the depth and breadth necessary to provide BP adequate assurance as to its overall process safety performance.

For example, the Panel's technical consultants believe that the factual circumstances and support for several of their findings at the Whiting and Toledo refineries existed during at least one prior BP process safety audit at those refineries but were not identified in the previous audit. This oversight raises questions regarding the level of detail or thoroughness of prior BP audits on those issues.

Based upon its understanding of the audit protocol, the Panel also notes that the principal focus of the audits was on compliance and verifying that required management systems were in place to satisfy the OSHA audit requirement. It does not appear that BP used the audits to ensure that management systems were delivering the desired level of safety performance or to assess a site's performance against industry best practices.

Reliance on internal auditors. BP also relied almost exclusively on internal auditors. Although the auditors were external to the subject site, they almost always were BP employees. The Panel recognizes that benefits can be gleaned from using employees to audit other sites, such as promoting best practices and sharing lessons across facilities. This approach has limitations, however. BP's process safety audit teams generally did not benefit from external experiences or perspectives of audit team members because they relied primarily on a pre-existing, internalized view of "how things are done at BP." Despite the best efforts of the audit teams, the auditors frequently came to an audit with the BP view of process safety and integrity management. The Panel believes that this internalized view likely reduced the effectiveness of the audits because the auditors did not have perspectives beyond their own organization as to process safety performance.

BP now acknowledges the importance of external perspectives. The Chief Executive, Refining and Marketing, for example, believes that the business units should be open to an external review periodically because third-party audits offer a different level of assurance.

Limited review of audit findings and corrective actions. The Panel has also observed what it believes was a fairly limited review of audit findings outside of the audited refinery. Under prior requirements for process safety audits, the audit team presents its findings to the local refinery upon the completion of an audit. The process safety advisor then drafts the process safety audit report. At a later date, typically two to three weeks after completion of the process safety audit, the process safety advisor distributes the final process safety audit report to the refinery manager, the local refinery process safety committee, the local process safety coordinator, and the local HSSE manager. From that point, BP provides little or no guidance about what should happen next. In practice, the refinery manager has had great latitude in how to manage the audited site's response to audit findings. It appears that little, if any, process safety audit information was provided to executive management, although executive management certainly could have requested that information. For example, the Chief Executive, Refining and

Marketing was apparently told either that a site was in compliance or that certain things needed attention. This executive sometimes would receive a summary report of audit findings a few times per year or have discussions with BP's Internal Audit group regarding any audits they conducted.

Even within BP Refining, review of audit reports was limited. Refining Technology had functional responsibility for coordinating and performing the audits. The current Vice-President HSSE and Technology, however, did not receive or review process safety audit reports for BP's five U.S. refineries.

During the typical audit, a combination of site management and the audit team would then begin to consider corrective actions. Facility management was responsible for promptly determining a response to each of the assessment findings and for documenting the correction of any deficiencies. The audit team, however, sought to ensure that the actions would actually address the findings.

Each site also determined the timeline for closure of audit action items. BP's general expectation was that all Priority 1[82] actions should be verified as closed by the time of the next process safety audit. The site also specified when an action item was complete.

The Panel's review indicates that audit action items were sometimes shown to be closed when in fact the action items were not complete because the underlying systemic cause of deficiency remained uncorrected. For example, after reviewing the previous process safety audits from each refinery, the Panel's technical consultants found that Cherry Point, Texas City, Toledo, and Whiting each had several types of recurrent findings, such as equipment deficiencies, overdue inspections, and action item completion. Because the same finding occurred in two or more consecutive process safety audits, the technical consultants concluded that the corrective action taken to address the finding was ineffective. The Panel also identified instances in which it appeared that audit action items were not actually complete when the items were reported as closed.

The Panel believes that these deficiencies likely occurred because no one independent from the refinery reviewed the closure actions. An after-the-fact review occurred as part of the next triennial audit when the audit team assessed the closure of previous findings. The Panel believes that this practice was insufficient.

> BP's current efforts to improve its audit program

The Panel recognizes that BP is in the process of changing how it conducts audits of safety and operations management systems, including process safety audits. Auditing responsibilities for BP's U.S. refineries, including process safety audits, that previously resided in the Refining and Marketing segment now reside in the newly created Group Safety and Operations function.

BP has provided the Panel an overview of how process safety auditing will take place at BP's five U.S. refineries under the new auditing function. To undertake its new auditing responsibilities, Safety and Operations has created an independent auditing group that will review both compliance with internal policies and procedures as well as legal compliance. All Safety and Operations auditors will receive external training and roughly half will be hired from outside BP. Safety and Operations will audit all large sites every three years for compliance with the Group control of work standard, the Group integrity management standard, gHSEr, process safety, and legal compliance. BP has indicated that the Safety and Operations audit process will operate independently from line management, including the decision regarding which sites to audit. The Panel understands that the Safety and Operations function will make decisions about which site will be audited in a risk- and performance-based manner.

Interviews with members of the Safety and Operations function indicate that the auditing group's role will consist of two steps. First, the group proposes to audit the completeness of the management systems being used at the sites and whether the sites have the right tools to manage the facilities and evaluate compliance. Second, the group proposes to conduct deep sampling to ensure that what is in the system is what is being done. The auditing process will be used both to help build management controls and processes and to verify that they are being followed. BP has advised that the audits will be less system-based and more compliance-based, meaning that the audits will focus less on whether paperwork is in place and more on whether procedures are being followed.

BP proposes that the entire audit process will take approximately 60 days, including the audit team leader's first visit to the site, development of the audit focus, and development of the audit protocol. The audit team contemplates three to four days of pre-work, followed by ten days of actual audit fieldwork.

BP contemplates that in these audits, the audit leaders and the refinery managers will agree on a time frame for resolving audit findings and for taking corrective action, which will be shared with senior refining line management above the refinery level and with segment leadership.

BP also has plans for independent verification. Safety and Operations proposes to track and verify closure of action items resulting from its audits. If action items are not closed in a timely manner, they will be brought to the attention of senior refining line management above the refinery level, the Chief Executive for the Refining and Marketing segment, as well as the Group Chief Executive.

BP has also indicated that its internal audit group will review the Safety and Operations audit process once a year. As part of this effort, BP Internal Audit will review the level of rigor in the auditing process as well as the locations Safety and Operations is auditing.

In mid-2006, BP identified improvement of audit finding closure as an element of six new expectations that apply to operational leadership.[83] Under this new element, sites must (1) focus on closure of agreed action items from audits, regulatory inspections, and major accident investigations; (2) address all outstanding action item backlogs; (3) provide assurance that closed action items have been resolved in a rigorous way that would be confirmed through external scrutiny; and (4) develop reasonable timelines for addressing all new action items.

The Panel recognizes that BP is in the process of making significant changes to its audit program after the Texas City incident. If BP effectively implements and then sustains these changes, the Panel believes that they will greatly enhance BP's process safety audit system.

Finding:

BP has not implemented an effective process safety audit system for its five U.S. refineries.

CORRECTION OF IDENTIFIED DEFICIENCIES

> Importance of corrective and preventive actions

The Panel believes that an effective process safety management system necessarily requires the prompt correction of identified deficiencies and inadequately controlled hazards. As noted in the voluntary ANSI Z10 standard:[84]

> An organization needs to address all identified system deficiencies and inadequately controlled hazards through the corrective and preventive action process, regardless of how those deficiencies and hazards were identified. This ensures that corrective and preventive actions are undertaken in a systematic fashion, whereby the most serious hazards are addressed in an expedited fashion and all actions are followed through to completion.[85]

In the United States, OSHA's process safety management standard requires the correction of specified deficiencies. The provisions related to process hazard analysis, for instance, require an employer subject to the standard to "establish a system to promptly address the team's findings and recommendations; assure that the recommendations are resolved in a timely manner . . . [and] complete actions as soon as possible . . . ."[86] Similar requirements exist for deficiencies identified during incident investigations and compliance audits.[87]

As noted above, an organization identifies the need to take corrective and preventive action in different ways, including hazard assessments, audits, routine inspections, and investigations into incidents and near misses. After a company identifies a deficiency, it should develop a plan to correct it, establish a deadline for doing so, implement the plan, and then track the plan to closure. Actions not implemented by their deadlines should be considered overdue.

> BP's processes for closing out action items

BP's internal standards recognize the importance of correcting deficiencies as well as learning and sharing lessons from previous incidents. The company's entire process safety management system is based upon a Plan-Perform-Measure-and-Improve cycle.[88] The gHSEr element regarding *Assessment, Assurance and Improvement*, for example, provides for the closure of actions items: "Findings from learning processes (*e.g., audits, incident investigations, near misses, HAZOPs, etc.*) are prioritized, tracked and used to systematically improve the HSE management system."[89] gHSEr Element 12: *Incidents Analysis and Prevention* requires incidents to be "reported, investigated and analysed to prevent recurrence and improve our performance. . . . Corrective actions and preventive measures will be utilized to reduce future injuries and losses."[90] The BP standard also provides that preventive actions from incident investigations will be "documented and closed-out."[91]

The BP Group process safety/integrity management standard provides additional support for the importance of corrective and preventive actions. Element 1.0, *Hazard Evaluation*, provides that "[t]he output of the risk assessment and process hazard analyses should include identification of specific hazards and the accepted recommendations from these studies shall be implemented in a timely manner to minimise the risk or eliminate the hazard." The process safety/integrity management standard also provides that "[t]horough incident investigations, with complete follow-up and closure of action items, are critical to achieving an injury and incident free workplace."

Although BP expends significant effort to identify deficiencies and to correct many identified deficiencies, which BP often does promptly, the Panel's review found an apparent inability to address repeat audit findings at BP's U.S. refineries by correcting true root causes. This problem is especially apparent in overdue mechanical integrity inspection and testing. BP would often identify overdue items and then make a concerted effort to close them out. Because the fundamental cause of the problem remained unaddressed, however, the list of overdue items would begin to grow again and be observed in the next round of audits.

Refining line management above the refinery level was aware of the company's poor record on closing out action items. For three years in a row, the company's annual gHSEr assessments identified BP's failure to timely close out action items as a repeat finding. In addition, the status of open Priority 1 action items was reported to the Global Refining leadership. Prior to the Texas City incident, personnel at the BP Refining level began tracking the status and closure of action items.

BP's own process safety audits and gHSEr assessments highlighted what the Panel considers to be a continuing and significant deficiency within the company. There is no shortage of assessments, reviews, and audits within BP, and company internal auditors have examined the performance and management systems of many of BP's business units and segments. The follow through after the review, however, has fallen short repeatedly. This failure to follow through compromises the effectiveness of even the best audit program or incident investigation:

> The ultimate objective of incident investigation is preventing recurrence of a specific incident scenario or related similar incidents. Considerable effort and resources are expended in determining an incident's root causes and identifying suggested preventive measures. Despite this effort, *the potential for a repeat occurrence remains unchanged until recommendations are implemented.* The value of the investigation is entirely dependent on the effectiveness of follow-up activities.[92]

For these reasons, the Panel observes that BP seemingly has been unable to close out its own repeat finding that the company does not effectively correct the deficiencies that it identifies.

> Repeat findings in BP's process safety audits

As OSHA requires, BP audits its process safety compliance at each of the U.S. refineries at least once every three years.[93] The Panel recognizes that BP appears to have promptly corrected many of the deficiencies or uncontrolled hazards identified by these reviews.

BP has sometimes failed, however, to address corrective and preventive actions recommended during hazard assessments, audits, inspections, and incident investigations. The Panel's review of the reports summarizing BP's prior process safety audits, described in more detail below, confirms this view. As Browne now acknowledges, some of the prior process safety audits identified the same issues again and again: "There was a stubbornness around getting things done."

Carson audit reports. The Panel reviewed process safety audit reports for the Carson refinery dated July 2002 and December 2005.

The 2002 audit report indicates that the audit team could not verify whether previous recommendations were closed because the site did not use an action item tracking system for process safety audit corrective actions. The audit team also found that the site did not resolve overdue action items identified during hazard assessments. At the time of the review, for example, the site had more than 60 open action items that were more than three years old. In addition, 62 pressure vessels and 650 pressure relief valves were past inspection due dates. Previous recommendations resulting from incident investigations were also overdue. The auditors noted that up-to-date information on the status of these recommendations was difficult to obtain.

The 2005 audit reveals similar issues. With respect to process hazard assessments, the report notes that "[t]here are around 200 Revalidation HAZOP action items open and [three] overdue. However, some open items are more than eight years old." The audit team issued a repeat finding from the 2002 audit because one unit at the facility used a different categorization of operating procedures. The audit team also issued repeat Priority 1 findings because numerous pressure relief valves (134) and pressure vessels (166) were past due for inspection. The Priority 1 findings on these issues made in 2005 are virtually identical to the Priority 1 findings on these same issues made in 2002.

Cherry Point audit reports. The Panel reviewed process safety audit reports for the Cherry Point refinery dated July 2002 and December 2005.

The 2002 audit report found that "[a] considerable number of [process hazard analyses], incident investigation, and compliance audit findings, and recommendations [were] still open and [had] passed the targeted completion date established by the Cherry Point refinery." The audit team also issued several mechanical integrity Priority 1 findings because numerous pressure safety valves (89), tanks (37), and vessels (81) were past due for inspection. The 2002 audit raised the question of whether action items were being closed out even though the recommendations were not implemented: "At the time of this audit all recommendations from the previous audit were marked as complete. However, two recommendations, [Finding] No. 1790 (HAZOP documentation) and [Finding] No. 1792 (Contractor approval), were cited again during this audit under the PHA and Contractor elements, respectively."

In 2005, the audit report notes that three Priority 1 recommendations from the 2002 audit remained open. The 2005 audit report again raised the issue of premature closure of action items. The audit report notes, for instance, that the refinery had not tested the fire water systems in the reformer and hydrocracker units: "This is a repeat of finding 2914 from the 2002 [Process Safety] Compliance Audit. That finding was closed with *intent* of compliance—not actual compliance." Similarly, the auditors note that two findings from 2002 relating to additional fire water flow tests and car-seal checks were closed merely with affirmative statements by the refinery's inspection department that it would conduct the tests and maintain records to demonstrate compliance. The audit team, however, could find no records showing that the required tests and checks had been or were being performed. For this reason, the 2005 audit team made the same Priority 1 findings for these issues as in the 2002 review.

Texas City audit reports. The Panel reviewed process safety audit reports for the Texas City refinery dated January 1998, March 2001, and May 2004.[94]

The 1998 report included a finding that 44 percent of the action items from hazard assessments had not been completed according to schedule. Six of eight hazard assessments also were past their deadline for revalidation.

The 2001 report includes a similar finding: "9% of [the] total PHA recommendations made since the program was started remain open . . . . Of these open items, 15% were found to be past their due dates. Some of these open items date from 1993 PHA's." The audit report also includes Priority 1 findings regarding mechanical integrity testing: a "large number of the required inspection intervals for relief and vent systems are not in compliance." Similar Priority 1 findings were made with respect to inspection intervals for "a large number" of emergency shut-down systems, critical alarms, trip systems, pump and compressor systems, pressure vessels, storage tanks, and piping systems. The auditors also found that the "incident investigation target completion dates for a number of action items are past the completion dates."

The 2004 report also includes Priority 1 findings regarding mechanical integrity and inspection due dates. The audit report notes that unspecified quantities of the following types of equipment were overdue for mechanical integrity inspection and testing: on-stream and turnaround critical instruments; rotating equipment; piping, pressure vessels, and storage tanks; and relief valves. The audit team also issued a Priority 1 finding because the site had not acted upon "a significant number of inspection findings/recommendations . . . ." A "significant number of 'Safety' recommendations" also were overdue, resulting in another Priority 1 finding.

Toledo audit reports. The Panel reviewed process safety audit reports for the Toledo refinery dated May 2001 and June 2004.

The 2001 audit report identifies concerns regarding mechanical integrity. Numerous pressure safety valves (44) were overdue for testing.

The audit team found similar problems in 2004. Numerous pressure safety valves (54) and personnel protection monitors (77) were overdue for inspection and testing. For these reasons, the auditors again issued Priority 1 findings regarding mechanical integrity testing concerns. The 2004 report also identifies that action items from process hazard assessments "[had] not been resolved in a timely manner." Seven of these action items were ten years old. Finally, the 2004 report contains other repeat findings from the 2001 audit, including findings related to operator awareness of process safety information, version control over operating procedures, sign offs for start-up and shut-down procedures that BP's Group process safety/integrity management standard required, and inconsistencies in the site's safe work permit program.

Whiting audit reports. The Panel reviewed process safety audit reports dated March 2001 and July 2003 for the Whiting refinery. The 2001 audit report found, as a Priority 1 finding for mechanical integrity testing, that more than "10 [percent] of relief valves were out of compliance past due dates." The audit team also concluded that although a positive material identification program was in place, it was "lacking in follow up of corrective action items." In the absence of such a system for closing action items, the issues were left unresolved.

The 2003 audit again included Priority 1 findings for mechanical integrity. 534 critical alarm components and 100 relief valves were overdue for testing. An unspecified quantity of stationary equipment, including pressure vessels, tanks, furnaces, and piping, also were out of compliance for testing.[95]

> Other indications of deficiencies in timely closure of action items

The process safety audits against the OSHA process safety management standard and against BP's own internal standards are not the only BP assessments indicating deficiencies in the timely closure of action items. Under gHSEr Expectation 13.10, BP indicates that auditing a business unit's performance against gHSEr expectations will provide assurance regarding the effective implementation of its HSSE policies and expectations.[96] This assurance takes the form of annual self-assessments coupled with external audits at least every three years.[97] The Panel's review of three years of repeat findings from gHSEr assessments indicates that BP's efforts to improve its performance in correcting identified deficiencies has fallen short of BP's expectations under gHSEr and the BP Group process safety/integrity management standard.

In a report dated March 2004, BP's Internal Audit function evaluated the findings of the gHSEr audits that BP's segments, including the Refining and Marketing segment, conducted in 2003.[98] The report observes that the "[p]rocesses for closing action items generated from audits and other activities [were] not robust[.]" It also notes that there was a "[p]oor prioritization of actions . . ." and that "[a]ccountabilities for actions [were] not assigned[.]" Internal Audit further noted a "[l]ack of [l]eadership focus on this issue . . ." and that an "output of this is the backlog of maintenance actions[.]" The report acknowledges that information on incidents was circulated but observed that some entities "do not have robust processes for assessing the implications of these [reports] and initiating actions to manage their risks of a similar occurrence[.]" The report concluded that there were "poor processes for lessons learnt."

The next year, BP's Internal Audit function evaluated the findings of the gHSEr audits that BP conducted in 2004 and reached essentially the same conclusion. In a report dated August 2005, BP's Internal Audit team made the following finding:

> There is little evidence of a formalised action tracking system with robust monitoring of action completion. Asset leadership are not engaged on ensuring action close out as there appears to be little consequence for failure to close actions. This reduces the effectiveness and credibility of the [gHSEr] audit programme as assets question the effort expended in undertaking the audit to produce findings and no one is apparently concerned as to whether subsequent actions are completed. Independent [gHSEr] audit are viewed in some quarters as a 'check-box audit.'

The same concern arose again during the review of the 2005 gHSEr audits. As it did during the 2003 and 2004 reviews, BP found "[i]nadequate tracking and closure of items and insufficient sharing within segments of [gHSEr] findings and lessons learned."

Although the reviews referenced above included business units other than those in the Refining and Marketing segment, the Panel's review indicates that leaders within the segment and within Refining were aware that deficiencies regarding the closure of action items existed within their organizations. In 2004, for example, BP's review of the safety management systems solely within the Refining and Marketing segment[99] identified concerns regarding action item closure. This report went to the Chief Executive, Refining and Marketing, refining line management above the refineries, and corporate-level managers with functional oversight of safety performance.

A key objective of the 2004 Refining and Marketing audit was to assess the effectiveness of "[p]erformance management processes [including] performance metrics, monitoring activities, and intervention and followup processes." BP's Internal Audit function concluded that the "formulation, documentation, and timely and effective closure of action items resulting from monitoring activities are poor." In addition, multiple systems for tracking action items in use across the segment made "a full assessment of open action item status difficult to calculate and resource." After accepting the finding, management of the Refining and Marketing segment committed to eliminating the "significant backlog of overdue action items" by April 1, 2005, and setting new expectations regarding the closure of action items entered after January 1, 2005.

Although some progress was made, the closure of action items remained a concern during 2005. For example, BP refining had 2,378 open action items at mid-year 2005. Almost 32 percent of these open items were past their target dates for completion.

BP's review of the management systems at the Texas City refinery also suggests that deficiencies in action item closure persisted into 2005. The Stanley Report found a "[r]epeated failure to complete recommended actions from audits, peer reviews, and past incident investigations."[100] The team that conducted the review, for example, identified a backlog of unclosed action items in the tracking databases relating to various aspects of process safety management, including those stemming from incident investigation.[101] Some of the action items from incident investigations extended back over a period of more than 12 months.[102]

The Panel's technical reviews found that during the past few years all five refineries had significant numbers of action items that were not completed within a reasonable period of time, as well as backlogs of overdue action items—some as long as many months or years overdue. The Panel considers BP's tolerance of repeat findings and the chronic failure to correct deficiencies identified by audits, incident investigations, and hazard assessments as a serious systemic deficiency.

Carson. For example, at the time of the Carson refinery technical review in May 2006, about half of process hazard analysis, or PHA, action items at Carson from 2001-2004 remained open. In addition, action items from facility siting and human factors checklists used in PHAs were not consistently tracked and implemented. More than one-third of the resolutions/corrective actions from four sampled initial incident reviews were not documented. The Panel's technical consultants also noted that compliance audit action items were being closed out upon the development of a plan as opposed to when the refinery implemented the plan. These issues are similar to those BP had observed in its process safety audit report for Carson, dated December 2005.

Cherry Point. The Panel's technical review at Cherry Point identified overdue mechanical integrity inspection and testing for several vessels and numerous piping inspections. The Panel's technical consultants also made findings regarding follow-up and tracking from incident investigations. Again, BP made similar findings in previous reviews when auditors expressed concern about mechanical integrity inspection and testing and action item closure.

Toledo. In Toledo, the Panel's technical consultants found that action items from hazard assessments were not implemented in a timely manner. The consultants also concluded that the refinery did not always correct compliance audit deficiencies. Significant repeat/chronic findings were observed in the testing of emergency shut-down systems, critical alarms, and interlock tests; pressure relief valve testing; and safe work permits. BP's June 2004 process safety audit report for Toledo also found similar issues.

The issues that the Panel's technical consultants observed in Toledo are similar to those that OSHA observed during its inspection of the Toledo refinery in October 2005 and that were the subject of a "Citation and Notification of Penalty," which OSHA issued to BP in April 2006.[103] In the citation, OSHA alleged that the Toledo refinery

- "does not have a system to timely resolve and complete as soon as possible actions recommended by the process hazard analysis ("PHA") team. . ."[104]
- "does not ensure that appropriate responses to the findings of . . . compliance audit[s] . . . are promptly determined and documented, and . . . does not document that the deficiencies are corrected. . ."[105]
- "does not [have] a system to promptly address and resolve incident report findings and recommendations, and to document their resolution and the actions taken to correct the problems identified. . ."[106]

OSHA also found that the Toledo refinery did not properly inspect its pressure piping systems[107] and failed to correct deficiencies in dump valves and monitors.[108] OSHA noted that BP previously identified the monitors as having operating deficiencies, but had not repaired or replaced the monitors in a timely manner.[109] OSHA further alleged concerns regarding operating procedures.[110] Again, the Panel notes that BP made similar findings in its 2004 process safety audit at the Toledo refinery.

Whiting. The Panel also observed problems regarding the timely resolution of deficiencies at Whiting. Action items from hazard assessments, for example, were not implemented in a timely manner. Some safety action items were more than a year past due. Almost 20 percent of the measurements required to detect thinning pipe or vessels were overdue (although BP subsequently determined that many locations were not needed or were not critical). Some pressure relief valves were overdue for testing, and 738 inspection work order requests were past due for closure. In addition, findings and recommendations from some of the site's incident investigations were not tracked to closure. The BP process safety audit report for Whiting, dated July 2003, found similar problems.

In addition, issues that the Panel's consultants identified at the Whiting refinery are similar to those identified at the Toledo refinery and are consistent with issues contained in a recent occupational safety citation. In November 2006, Indiana OSHA cited the Whiting refinery for several occupational safety violations including alleged failures to conduct required equipment inspections and alleged failures to adequately address findings of past process safety audits.[111] Indiana OSHA identified inspections that allegedly "did not follow recognized and generally accepted engineering practices"[112] and issued two separate citations alleging the refinery's failure to complete inspections according to the required schedule in four different areas within the refinery.[113] The citation also alleged that three findings from the refinery's 2003 process safety management audit had not yet been addressed, despite tracking data indicating the contrary.[114]

Texas City. A third-party review of process safety issues at the Texas City refinery in 2006 also revealed deficiencies in the timely completion of corrective actions. For example, based upon a review of recommendations from four OSHA process safety management incident investigation reports from 2004 through 2006, the third-party auditor concluded that recommendations were not being resolved promptly. The auditor also observed that recommendations from PHAs were not always resolved in a timely manner. Eight of 29 operating units had open PHA safety action items that were more than two years old, and six of those had open items that were more than three years old. Similarly, the auditor found that deficiencies identified during inspection, testing, and preventive maintenance had not been corrected. The oldest deficiency was first identified in 1998.

BP's own investigation into the ISOM unit identified concerns with corrective actions. According to the Mogford Report, "[a]ction items did not appear to be tracked and effectively closed, especially those of nonspecific and cultural aspects."[115]

> BP's response to the Whiting rupture disk HiPo

As described more fully in Appendix E, the Panel's technical consultants found higher than intended pressure in spaces between rupture disks and relief valves on a fractionator tower in a fluidized catalytic cracking unit during their March 2006 technical review at the Whiting refinery. The Panel's technical consultants immediately notified BP of the situation. Among other actions that BP took in response to this problem was the issuance of a companywide HiPo announcement describing the situation that caused BP's other U.S. refineries to evaluate their rupture disk/relief valve installations.

It appears, however, that BP's actions in response to the HiPo did not always identify or correct other rupture disk problems. The Panel's technical consultants, for example, identified a situation in June 2006 at Texas City where the refinery missed an opportunity to identify and correct a deficiency directly related to the Whiting rupture disk HiPo. For a more detailed discussion of this deficiency, see Section VI.B and the technical consultants' report attached at Appendix E.

Indiana OSHA subsequently identified a similar issue at the Whiting refinery. As described above, in November 2006, Indiana OSHA cited the Whiting refinery for several alleged occupational safety violations. In addition to the allegations listed above, Indiana OSHA cited the Whiting refinery for the following allegations addressing rupture disks in the alkylation unit at the Whiting refinery:

(1) AL-338 rupture disk, the pressure gauge was on the top of the tower and was located so that the pressure gauge could not be read.

(2) On two rupture disks, AL-339 and AL-340, the gauges indicated greater than atmospheric pressure and were not functioning properly.

(3) AL-342 rupture disk, the gauge indicated greater than atmospheric pressure and the rupture disk was compromised (blown).[116]

These allegations from Indiana OSHA came just weeks after the Whiting refinery conducted the investigation of its rupture disk systems and associated safety management practices in response to the Panel's initial discovery. BP's swift investigation indicates that, at least initially, BP placed a high priority on addressing newly identified problems with refinery disk rupture systems. Although the Panel has not independently investigated the factual basis for the rupture disk allegations in the OSHA citation, the Panel believes that they indicate that the measures which the Whiting refinery took were ineffective and raise questions about whether BP identified and corrected the true root cause of the initial near miss, as well as the Whiting refinery's operational discipline and ability to prevent the recurrence of process safety issues.

Finding:

BP does not ensure that identified process safety deficiencies at its five U.S. refineries are addressed promptly and tracked to correction.

USING RESULTS OF INCIDENT INVESTIGATIONS

As discussed above, an important component of an effective incident and near miss investigation program is the sharing of lessons learned from investigations throughout the organization. The Panel believes that BP's systems for using and sharing information from incidents and near misses are not effective in a number of respects. For example, BP does not appear to use near miss data to analyze whether the type of system control failure leading to the near miss was of a type anticipated in relevant hazard assessments. Because it does not analyze the data in this way, BP does not take advantage of an opportunity to reduce the likelihood of similar failures.

Additionally, BP sometimes does not effectively share lessons that are learned from near misses. The company's investigation into the Texas City accident found little evidence that the Texas City refinery had implemented BP Group programs to share lessons learned.[117] The Mogford Report also concluded that the Texas City refinery had not learned lessons from the process safety experiences of other refineries.[118] During its recent audit at Texas City, a third party auditor found that the refinery did not properly incorporate information from near miss investigations as part of its review of process hazard analyses or PHAs. For example, the audit team identified near misses that had occurred before the last PHA but were not considered in revalidating the PHA. This point underscores the importance of ensuring not only that information is shared, but also that sites and individuals who receive it must be able to evaluate the information and take actions to manage risks of a similar occurrence.

The Panel, however, does not believe that this issue is limited to Texas City. Some of the responses to the process safety culture survey support this belief. Many BP employees and contractors, for example, disagreed or tended to disagree with a survey item stating that workers were informed about the results of process related incident, accident, and near miss investigations. Specifically, between 23 percent and 33 percent of contractors at all of BP's U.S. refineries except Carson responded in that manner. More than 20 percent of maintenance/craft technicians also responded negatively at Texas City (32 percent), Toledo (44 percent), and Whiting (21 percent). In addition, there were negative responses from 33 percent of HSSE employees at Texas City, 33 percent of engineering professionals at Toledo, 29 percent of operators at Texas City, 27 percent of operators at Toledo, and 21 percent of HSSE employees at Toledo. Responses from Carson and Cherry Point employees in the six groups shown below, however, tended to be more positive, with no more than 16 percent of any group responding negatively to the quoted survey item. Indeed, employees in five of the six groups at each of those two refineries had negative response rates of less than ten percent, indicating a general perception that workers were informed about the results of process related incidents, accidents, and near miss investigations.

Table 65

Percentage of Disagree/Tend to Disagree Responses to Survey Item:
"Workers are informed about the results of process related incident, accident, and near miss investigations."

Category	Carson	Cherry Point	Texas City	Toledo	Whiting
Operators	6	3	29	27	10
Maintenance/Craft Technicians	16	6	32	44‡	21
Full Time HSSE Employees	0	8	33	21‡	8
Engineering Professionals	6	2	24	33	11
Operations Management	2	5	19	9	3
Maintenance Management	0‡	13‡	27	*	3
Contractors	16	24	23	33	30

* Survey data are not available because of the small number (fewer than 15) of potential respondents.

‡ Fewer than 25 respondents were in this group.

> BP's response to other major process safety incidents: lessons from Grangemouth

The Panel believes that BP's responses to other major process safety incidents provide an important insight into BP's effectiveness in correcting identified deficiencies. For this reason, the Panel considered BP's management of process safety at the U.S. refineries against the backdrop of three major process incidents that occurred at BP's petrochemical complex in Grangemouth, Scotland during a two-week period in 2000.[119]

The three incidents involved a power distribution failure (May 29, 2000), a medium pressure steam main rupture (June 7, 2000), and a fire in an operating unit (June 10, 2000).[120] No fatalities or serious injuries occurred, but the UK HSE considered that the absence of injury was only due to "good fortune."[121] The incidents received significant media coverage and caused public concern regarding BP's "operating competence and the ability to manage the site safely."[122]

The UK HSE and the Scottish Environment Protection Agency jointly investigated the incidents under the United Kingdom's Control of Major Accident Hazards regulations. Among their conclusions, the agencies noted that BP Group policies for health and safety management "set high expectations but these were not consistently achieved because of organisational and cultural reasons at the [c]omplex."[123]

BP conducted its own review, individually investigating each incident using the company's root cause investigation procedures. Following these investigations, BP convened a task force to undertake a wider review of all operating units and functions across the complex.[124] The task force's main investigation generated more than 800 prioritized recommendations.[125] A small core team of this task force also developed "key themes that were relevant complex-wide, and potentially had wider organisational implications for the Company."[126]

Based upon its review, the Panel considers the similarities between the lessons from Grangemouth and the events of the Texas City incident to be striking. As shown in the table below, the circumstances may be different, but the underlying issues are very much the same.

Table 66

Comparisons of Selected Findings from Investigations of the Grangemouth and Texas City Incidents

Issue	Grangemouth	Texas City
Leadership and Accountability	"Insufficient management attention and resources [were] given to maintaining and improving technical standards for process operations and enforcing adherence to standards, codes of practice, good engineering practice, company procedures and the HSE guidance."[127]	"Process safety, operations performance, and systematic risk reduction priorities had not been set and consistently reinforced by management."[128]
Understanding of process safety	"There was a need to build awareness and competencies in process safety and integrity management within senior leadership and the organization in order to develop a meaningful value conversation around cost [versus] safety. There was a lack of experience in some areas, and limited refresher training plans."[129]	"[The Texas City Refinery suffers from] an inability to see risks and, hence, toleration of a high level of risk. This is largely due to poor hazard/risk identification skills throughout management and the workforce, exacerbated by a poor understanding of process safety . . . . There was no ongoing training program in process hazards risk awareness and identification for either operators or supervisors/managers."[130]

Issue	Grangemouth	Texas City
Safety focus	"With no formal structure or specific focus on process safety, many of the components of process safety management (PSM) were not formalized at Grangemouth. There was no site governance structure to provide overview and assurance that process safety issues were being handled appropriately. Process safety needed to be elevated to the same level as personal safety."[131]	"The investigation team was not able to identify a clear view of the key process safety priorities for the site or a sense of a vision or future for the long term." "[Texas City culture was] [f]ocused on environment and personal safety, not process safety." "There was little ownership of PSM through the line organization."[132]
Performance measurement	"BP Group and Complex Management did not detect and intervene early enough on deteriorating performance . . . . Inadequate performance measurement and audit systems, poor root cause analysis of incidents, and incorrect assumptions about performance based on lost time accident frequencies (DAFWCF—days away from work case frequencies) and a lack of key performance indicators . . . meant that the company did not adequately measure the major accident hazard potential."[133]	"The safety measures focused primarily on occupational safety measures, such as recordable and lost time injuries. This focus on personal safety had led to the sense that safety was improving at the site. There was no clear focus or visibility on measures around process safety, such as lagging indicators on loss of containment, hydrocarbon fires, and process upsets."[134]
Timely completion of corrective actions	"Over the years a number of maintenance and reliability reviews, task forces and studies had been conducted, but many of the recommendations had not been implemented. There was a maintenance backlog and mechanical integrity testing was not prioritized to ensure that safety critical equipment received timely preventive maintenance."[135]	"Repeated failure to complete recommended actions from audits, peer reviews and past incident investigations."[136] "There is currently a backlog of unclosed action items in the tracking databases related to various aspects of process safety management, including those stemming from incident investigations. Some of the latter extend back over a period of more than twelve months."[137]

The Panel recognizes that BP implemented some corrective actions after the Grangemouth incident. For example, as the UK HSE acknowledged, BP developed a comprehensive strategy and set of priorities aimed at improving the complex's health and safety performance.[138] The incidents also led the company to issue the Group process safety/integrity management standard and to begin the Refining strategic performance unit project to develop what BP now terms process safety minimum expectations.

In the end, however, it appears that BP largely viewed the Grangemouth incident as three separate events. Although BP attempted to identify and communicate broader learnings, it does not appear that the effort was successful. A senior manager, who at the time was at another refinery in the United Kingdom, recalled limitations on the information that was coming out of the investigation and that most of the lessons learned addressed only one of the three incidents. Other managers whom the Panel interviewed offered similar views.

Individual business units may have learned and incorporated lessons from Grangemouth, but the Panel believes that a systematic and sustained effort to implement the lessons learned from the Grangemouth incidents at BP's refineries in the United States was not made. BP did not do enough to confirm the application of lessons learned to sites other than Grangemouth. Perhaps because no fatalities occurred at Grangemouth, the Panel believes that BP eventually focused on other concerns as time passed and the internal and external scrutiny surrounding the incidents faded.

No one knows whether BP could have prevented the Texas City accident had the company made more comprehensive and lasting changes after the Grangemouth incidents in 2000. But the Panel believes that in its response to Grangemouth, BP missed an opportunity to make and sustain company-wide changes that would have resulted in safer workplaces for its employees and contractors.

Finding:

BP does not effectively use the results of its operating experiences, process hazard analyses, audits, near misses, and accident investigations, such as the Grangemouth investigation, to improve process operations at its five U.S. refineries and process safety management systems.

CORPORATE OVERSIGHT

An effective process safety management system requires significant involvement by an organization's leaders. As discussed earlier in this report, a company's leaders must establish performance objectives, develop and implement a system to accomplish them, provide the necessary resources, and then foster a culture in which the system can operate as intended. The final part of the continuous improvement cycle also requires management involvement. At this point in the cycle, the organization must assess the available indicators of the system's performance and evaluate whether the system is functioning as intended. In its 2003 report on best practices in corporate safety and health, the Conference Board cited monitoring performance regularly and providing frequent feedback as one of the core elements of successful safety and health strategies, as expressed in a survey of senior safety executives from a group of major corporations.[139]

According to the ANSI Z10 standard for occupational health and safety management systems, the management review process should include consideration of the following eight inputs:

- progress in the reduction of risk;
- effectiveness of processes to identify, assess, and prioritize risk and system deficiencies;
- effectiveness in addressing underlying causes of risks and system deficiencies;
- input from employees and employee representatives;
- status of corrective and preventive actions and changing circumstances;
- follow-up actions from system audits and previous management reviews;
- the extent to which objectives have been met; and
- the performance of the system relative to expectations, taking into consideration changing circumstances, resource needs, alignment of the business plan, and consistency with policy.[140]

The related commentary to the ANSI Z10 standard provides a useful description of the role of and purpose for management reviews:

> Management reviews are a critical part of the continual improvement of the [safety management system]. The purpose of reviews is for top management, with the participation of [safety management system] leaders and process owners, to do a strategic and critical evaluation of the performance of the [safety management system], and to recommend improvements. This review is not just a presentation or a non-critical review of the system, but should focus on results and opportunities for continual improvement. It is up to the organization to determine appropriate measures of [safety management system] effectiveness. They should also evaluate how well the [safety management system] is integrated with other business management systems, so it supports both health and safety goals and business needs and strategies.
>
> Reviews by top management are required because they have the authority to make the necessary decisions about actions and resources, although it may also be appropriate to include other employee and management levels in the process. To be effective, the review process should ensure that the necessary information is available for top management to evaluate the continuing suitability, adequacy, and effectiveness of the [safety management system]. . . . Reviews should present results (for example a scorecard) to focus top management on the [safety management system] elements most in need [of] their attention . . . .
>
> At the conclusions of the reviews, top management should make decisions, give direction, and commit resources to implement the decisions. The management review should include an assessment of the current [safety management system] to address if the system is encompassing all of the risks to which the organization is exposed. This portion of the review should include a review of major risk exposures and ask the question, "Are there any holes" in the current [safety management system] that could allow a risk that might not be considered within the [safety management system].[141]

> Assessing performance of the process safety management system

gHSEr framework. On paper, BP recognizes the importance of ensuring that its safety management system functions as intended. Element 13 of gHSEr, *Assessment, Assurance and Improvement*, provides that BP "will periodically assess the implementation of and compliance with these Expectations to assure ourselves and stakeholders that management processes are in place and working effectively."[142] Subelement 13.10 establishes the expectation that "[a] process is in place whereby assurance is regularly provided to the Group Chief Executive demonstrating effective implementation of the BP HSE Policy and Expectations."[143]

System for assuring performance. BP's system for assuring process safety performance utilizes a bottom-up reporting system that originates with each business unit, such as a refinery. The exact reporting hierarchy for BP's U.S. refineries has changed as BP's organizational structure for Refining has evolved.[144] Presently, each U.S. refinery manager prepares an annual report regarding HSSE assurance that is submitted to the Group Vice-President, Refining and refining-level support staff. Refining then aggregates information considered to be relevant and submits an annual HSSE assurance report for worldwide refining operations to the Chief Executive, Refining and Marketing and to segment-level support staff. By the time the HSSE performance is aggregated at this level, refinery-specific information is no longer presented separately. Next, the Refining and Marketing segment does the same with relevant HSSE information for the entire segment and submits an annual HSSE assurance report to the Group Chief Executive and Group-level HSSE staff (currently, the Safety and Operations function). A report summarizing the overall Group HSSE performance is then prepared and submitted to the EEAC.

Reports to the EEAC. The reports to the EEAC for 1999 through 2005 indicate that BP management was focusing on process safety matters, including plant and operational integrity issues. The reports discuss major incidents at different facilities, including Grangemouth (2000 report year); Texas City (2001 report year); Grangemouth, Kwinana, Australia, and Nerefco, the Netherlands refineries (2002 report year); and Texas City and El Morgan, Egypt (2003 report year). The reports identify HSSE risks that various levels of the organization confronted and describe management actions proposed to address and mitigate those risks, including

- development of a Group HSSE standard for process safety (2000);
- development of standards for process safety and for addressing major incident risk and development of "8 Golden Rules" (2001);
- Group HSSE monitoring of performance by BP segments in completing high priority action items, sharing and embedding of lessons learned, overdue planned inspections, and number of loss of containment incidents (2002);
- continued implementation of the Group process safety/integrity management standard and development of a "strengthened" process safety/integrity management functional standard intended to refocus resources for managing process safety (2003);
- launch of a global project to enhance HSSE compliance management programs worldwide and development of a U.S. HSSE compliance framework (2004); and
- introduction of a more rigorous and comprehensive management system to integrate operating excellence, integrity management, and engineering technical practices with health, safety, and environmental best practices and standards (2005).

Selected excerpts from the EEAC reports for 2000 through 2003 related to process safety are shown in Table 67.

Table 67

Excerpts from EEAC Reports (2000—2003)

Report Year	Discussion of Incidents and Related Issues	Discussion of Risk	Management Action
2000	There were three serious incidents at the Grangemouth Complex during the summer of 2000	When . . . assurance reports are considered alongside the reported [] (MIA) and [] (HiPo) notifications received in 2000 . . . Process Safety/Integrity Management [is identified as one of three key risks.]	Development of a Group HSE Standard for Process Safety[.]
2001	[T]here were a number of high potential incidents and accidents which occurred at our facilities . . . . At Texas City site, a major site outage related to plant integrity occurred which resulted in a significant loss of revenue.	[P]lant and operational integrity require continuing attention. . . . The potential for a failure in technical, operational or mechanical integrity of process equipment at our plants remains a high risk issue for the company.	At the Group level, Standards for Process Safety and Major Incident Risk have been created. All business units are expected to implement them. . . . In [refining operations], five new process safety standards for refining were developed.
2002	Incidents in 2002 at the Grangemouth, Kwinana and Nerefco refineries resulting in the release of small quantities of hydrogen fluoride point towards the continuing need to actively manage the potential high risk involving our most hazardous materials. . . . None of Segments have reported 100% closure of action items from investigation of their own incidents.	A review of the MIA/HIPO databases indicates that plant and operational integrity requires continuing attention.	Group HSE will monitor and transparently report Segment performance in: completing action items identified as high priority by the Segment; and the sharing and embedding of lessons learned. . . . [P]ercent overdue planned inspections and number of loss of containment incidents.
2003	Recent events, such as the Texas City Refinery fire and the El Morgan, Egypt incident, both of which occurred in Q1 2004, reflect legacy Process Safety/Integrity Management failings. Therefore, additional focus and resources—human and capital, are being put in place to meet the requirements of the Standard, as implementation to date is inconsistent across the Group.	In process facilities, as with the transportation of hydrocarbons, the greatest risks are associated with the release of toxic materials and highly flammable gases or liquids. The potential impact on any population within a community or occupied buildings is our greatest concern.	Following several serious process safety incidents at the Grangemouth Complex, implementation of the Process Safety/Integrity Management Standard was introduced in 2002. Work continued on this in 2003. In order to reflect experience gained over the past two years, a strengthened Process Safety/Integrity Management *Functional* Standard is being developed by Group Technology and is planned for implementation in 2004/5. This is intended to refocus resources to ensure consistency in BP's approach to managing process safety.

The same reports indicate that issues persisted relating to assurance of effective implementation of BP's HSSE policies and expectations. The EEAC reports from 2000 to 2005 highlight the following:

- inappropriate levels of operational review and maintenance, resource shortage for HSSE, and a lack of regional governance for HSSE issues (report year 2000);
- audit and assurance program reports and serious incidents indicate that Group HSSE standards were not fully adopted throughout the organization (2002 report year);
- evidence from routine audit programs and serious incidents demonstrate cases of non-compliance with internal policies, standards, and expectations, suggesting suboptimal use of HSSE management systems is reducing effectiveness and safety. Report also indicates increased emphasis on line management verification of site procedures and processes, and systematic identification and completion of agreed actions (2003 report year);
- consolidated gHSEr audit findings cite to (a) "no material improvement in 2004 on the issue of widespread tolerance of non-compliance with basic HSE rules," (b) concern about reliance on key people rather than on established processes of HSSE management system, and (c) overall organizational HSSE capability continues to be a Group risk and includes HSSE leadership and awareness within the senior levels of the Group (2004 report year); and
- cases of noncompliance with internal standards and controls, inadequate tracking and closure of items, and insufficient sharing within segments of gHSEr findings and lessons learned (2005 report year).

For additional discussion of gHSEr audit reports and deficiencies cited in those reports, see Section VI.B.

The same reports to the EEAC raise several other questions about management's response to continuing issues in safety performance. For example, while the 2002 EEAC report indicates that Group HSSE would monitor overdue inspections and loss of containment incidents, the company's performance against those metrics is not discussed in any of the subsequent reports to the EEAC. Although BP appears to have recognized these metrics as being important indicators of process safety performance, these post-2002 reports to the EEAC do not appear to reflect that BP refining-line management was collecting, reporting, and reviewing this data in a way that allowed BP's executive management to give additional consideration to the risks confronting the company and determine whether those risks warranted further management actions.

It also appears that other information about process safety performance, such as repeat process safety audit findings, was not elevated within the company. Only in 2006, for example, did BP undertake a review of the previous process safety compliance audits for its U.S. refineries to look for indicators of systemic issues.

The information available to the Panel indicates that a substantial gulf appears to have existed between the actual performance of BP's process safety management systems and BP's perception of that performance. The Panel appreciates that it reviews the EEAC and gHSEr reports with 20/20 hindsight; it also acknowledges that BP management continued to act, year after year, to address the continuing HSSE issues including issues under the HSSE management system. This gulf did not occur at any one particular point in time and did not exist only at a particular point within the organization. Instead, the information available to the Panel appears to indicate a more systemic breakdown occurring at multiple levels and in different line and functional positions. Business units were charged with implementing systems to address corporate-level expectations. BP corporate management developed a management framework and high-level expectations, but it did not provide operational detail or objective criteria for implementation at the refineries. To its credit, BP conducted internal audits and other assessments that indicated issues existed with the HSSE management system, and BP took a number of steps in an effort to improve process safety performance.

BP's safety management system was not, however, effective in evaluating whether the actions taken were actually improving the company's process safety performance. The company's lack of process safety performance indicators to measure process safety performance is discussed earlier in this section. For example, during 2002 to 2004—the same time period in which BP was devoting significant resources to develop

Group- and refining-level process safety standards—refinery specific data suggested deteriorating process safety performance. During these same years, the number of loss of containment incidents that the Toledo refinery experienced each year was increasing. Overdue inspections at Whiting also were increasing during this period. Reports coming out of Texas City indicated a deterioration in the condition of plant and process safety capabilities. Unfortunately, BP's executive management either was not receiving this data or did not appreciate the significance of the information that they did receive.

Although Group HSSE stated that it would begin monitoring and reporting loss of containment incidents and overdue inspections in 2003, the EEAC report for 2003 did not discuss either of these indicators. The report included only injury rates and totals for major incidents and high potential incidents:

> The Segments have developed and implemented Risk Management Plans to address the requirements of the Process Safety/Integrity Management Standard. These have resulted in a reduction in the number of integrity related Major Incidents and High Potential Incidents in 2003 (37 and 402) when compared to 2002 (63 and 477 respectively).

This statement from the 2003 report about the reduction in the number of incidents suggests a lack of understanding about these incidents. Because process accidents tend to be infrequent, looking for trends in the number of incidents, particularly on a year-to-year basis, is not an effective or appropriate metric for assessing process safety performance.

During the period that these reports to the EEAC covered, management continued to focus on and to report personal injury rates as an indicator of overall safety performance. The following statistics from the reports illustrate this point:

- HSE performance improved over 1999. Fatalities decreased by 38 percent and days away from work case frequency decreased 17 percent (report year 2000);
- BP's safety performance in 2001 was in the top quartile in its industry. Fatality rate per hours worked decreased, and days away from work case frequency showed a steady improvement since 1997 (report year 2001);
- workforce fatalities decreased 25 percent compared to 2001, while third party fatalities increased 28 percent,[145] and days away from work case frequency decreased 20 percent from 2001 (report year 2002);
- overall safety performance, based on frequency of injuries, improved 16 percent and 6 percent for report years 2003 and 2004, respectively; and
- excluding the Texas City incident, "the performance in BP was consistent with BP's historical improvement trend and comparable with leading levels across the industry" (report year 2005).

> Previous assessments of BP's HSE management systems

Previous assessments of BP's HSE management systems included findings relating to shortcomings in the implementation of the system.

HSE compliance assessment. In 2000, BP retained an external consulting firm to assess BP's HSE compliance management systems. In developing the protocol for the assessment, the consultant considered the compliance management system elements of Plan, Perform, Measure, and Review. The consultant also looked towards applicable regulatory requirements, alignment with gHSEr expectations, ISO 14001 principles,[146] and consistency with industry leading compliance assurance practices.

The focus of the assessment, which largely stressed environmental compliance, was to determine whether "external HSE legal and regulatory requirements [are] effectively embedded into [BP] management systems . . . ." The consultant made the following observations in its 2000 report:

- In BP's HSE Management System (Plan, Perform, Measure, Review); Plan and Perform are most strongly embedded; Measure and Review are the weakest.
- There is only partial implementation of a Compliance Assurance Process through the US Streams.
- Downstream HSE staffing levels appear to be below needed levels. Issues and work needing attention are often delayed and/or sometimes omitted.

In December 2002, executive management requested further review of the compliance process in the United States. This review was "requested to verify the current status of HSSE management systems from a cross section of US facilities."

BP retained the same external consultant in 2003 to again evaluate its compliance management system. BP initiated this second review to test improvements that operating units had made to address the gaps identified in 2000 and because HSE assurance reports in 2002 showed that BP's fines for noncompliance with HSE regulations were rising, with the majority coming from U.S. operations. BP's perception of how it compared with its peer companies was another basis for the review. A document establishing the terms of the review noted that BP's competitors in the energy and chemical industries "have implemented (or are implementing) compliance management . . . systems which are substantially more detailed than BP's."

The review had several key findings, which were reported to the BP Group Chief Executive's Meeting on June 25, 2003. The review concluded that BP was applying sound compliance standards and practices and that levels of compliance assurance were improving. Although the review found improvement since the 2000 assessment, it also found that compliance system gaps between facilities and business groups remained. The review also concluded that "BP—US systems and efforts [were] not as developed as [BP's] competition's systems and efforts."

In addition to these key findings, the review provided results and causal factors for specific aspects of the continuous improvement performance cycle across different parts of BP. The causal factors that the consultant identified were related to BP's overall HSSE management system and were not specific to process safety. Nonetheless, the Panel considers some of the causal factors from the 2003 report to be relevant to the Panel's review:

- Line personnel are not held accountable for compliance with all HSSE legal requirements.
- The full gap in HSSE compliance is not well understood by management.
- A systematic approach is not used to determine, interpret or document compliance requirements.
- Reliance on certain key employees for compliance knowledge.
- Knowledge of HSSE compliance requirements is not viewed as a critical business need.
- Management has not requested results on HSSE legal compliance performance.
- Audits and inspections have been viewed as the preferred method for measuring HSSE legal compliance performance.
- BP culture promotes pushing accountability for HSSE to the business unit, and has not established an effective HSSE legal compliance assurance process.
- BP's culture promotes autonomy in the business units, therefore, not requiring the use of a common action tracking method by all U.S. locations.
- BP's culture is very "action" oriented, and systematic improvements are not stressed when closing out HSSE legal compliance action items.
- Using action items and their root causes as a method for predicting future occurrences is not a strategy that is recognized nor utilized across the Segment.
- Compliance with all HSSE legal requirements has not been emphasized as a minimum expectation.

- Knowledge of performance management practices, including HSSE legal compliance metrics, is limited.
- HSE compliance is not managed as a sequence of related events, *i.e.*, “a process”—it is task oriented, reactionary and people dependent.

The Panel recognizes that BP undertook significant efforts to improve its compliance management systems throughout the company in response to the issues identified in these external assessments. In 2003, for example, BP put together a project team to upgrade its HSSE compliance system and processes.[147] The next year, BP launched a “global project to enhance the HSSE compliance management programmes of BP businesses world-wide . . . [And] integrate the HSSE compliance programme enhancement activities previously underway in the United States and Europe into a single, unified global programme.” While management’s effort is evident, it also appears that management’s effort had little effect on near-term process safety performance. The Panel observes that during this 2000 to 2005 time period, it also appears that BP management did not establish objective, measurable performance indicators for process safety and did not include in BP’s system of cascading performance contracts specific metrics designed to promote a high degree of process safety performance. As discussed elsewhere in this report, BP did not appear to be taking steps to embed process safety effectively in its U.S. refining line management or executive management.

BP’s Review of gHSEr Implementation. As part of its implementation of gHSEr, BP also assessed periodically the performance of its HSSE management system. As the EEAC reports provided to the Panel demonstrate, BP previously identified concerns regarding gHSEr’s implementation:

- “BP Policies, Standards and Procedures represent the boundaries within which BP conducts its business. . . . Evidence from routine audit and assurance programmes and serious incidents demonstrate that there may not have been full adoption and compliance with these and existing Group policies, standards, and procedures.” (2002 Report)
- “BP policies, standards and procedures represent the intended boundaries and controls within which BP conducts its business over and above regulatory requirements. . . . Evidence from routine audit programmes and serious incidents demonstrate that there are cases of non-compliance with these internal policies, standards, and expectations. This suggests that the suboptimal use of HSE Management Systems is reducing effectiveness and efficiency. It will therefore require increased emphasis on line management verification of the established site procedures and processes, as well as a systematic identification and completion of agreed actions.” (2003 Report)
- “The consolidated 2004 audit findings are broadly similar to those of 2003. . . . Tolerance of non-compliance: there has been no material improvement in 2004 on the issue of widespread tolerance of non-compliance with basic HSE rules that was first identified in 2003.” (2004 Report)

As was the case with the operational risks identified in the EEAC Group HSSE reports, each of these reports include management actions to be taken in response to these concerns. The fact that these substantially similar deficiencies in the effectiveness of BP’s HSSE management system continued for three successive years indicates that management’s response was not effective. Changes needed to be made to BP’s safety management system to improve process safety performance. While changes were made, particularly in adoption of new policies and standards, these steps appear to have been largely ineffective in improving process safety performance.

Findings:

BP’s executive management either did not receive refinery-specific information that suggested process safety deficiencies at some of the U.S. refineries or did not effectively respond to the information that they did receive.

Neither BP’s executive management nor its refining line management has ensured the implementation of an integrated, comprehensive, and effective process safety management system for BP’s five U.S. refineries.

BOARD OVERSIGHT

> Panel's review relating to the board

The Panel notes that it has had no direct interaction with the Board of Directors of BP p.l.c. The Panel did receive a presentation relating to the Board and corporate governance from BP's corporate secretary and has also received from BP, in addition to copies of reports to the EEAC, copies of portions of some minutes relating to EEAC meetings. Moreover, in its interviews of executive and corporate management, the Panel has inquired into matters relating to Board oversight of process safety.

As discussed in the previous section of this report, the Panel has reviewed the annual reports provided to the EEAC for 1999 through 2005. These reports informed the EEAC of process safety incidents, risks, and certain problems with the company's HSSE management systems and steps that management proposed to mitigate the known risks and correct identified problems. As discussed above, the steps that management took were not effective to implement an integrated, comprehensive, and effective process safety management system for BP's U.S. refineries. In the absence of an effective management system for process safety, by what means could or should the Board have exercised effective oversight of process safety affecting BP's U.S. refineries?

> Role of the board in BP's governance system

The Panel notes that the Board exercises "judgement in carrying out its work in policy-making, in monitoring executive action and in its active consideration of group strategy."[148] The Board does not manage BP's affairs. The Board delegates this management function to the Group Chief Executive. The delegation is made subject to limitations set forth in the Board's executive limitations policy, which defines the boundaries of executive action. Within those boundaries, the Board monitors and gains assurance that the boundaries of delegated management authority are observed. The EEAC primarily serves this monitoring function for process safety. Two executive limitations relate to safety:

- "The CEO will not cause or permit anything to be done without taking into account the effect on long-term shareholder value of the health, safety and environmental consequences of the actions . . . ."
- "The CEO will not cause or permit employees or other parties doing work for the Group to be subject to undignified, inequitable, unfair, or unsafe treatment or conditions."

> U.K. guidance on the role of the board

The Panel recognizes that the concept of a Board's role on health and safety matters is evolving. The United Kingdom has been at the forefront of evolving concepts about the role of boards of directors in overseeing an organization's health and safety performance.

In 2000, the U.K. Health and Safety Commission issued a strategy statement describing a plan for revitalizing workplace safety. One action point under the strategy was the development of a code of practice on responsibilities of directors for health and safety. In discussing the action point, the Commission observed that "in organisations that are good at managing health and safety, health and safety is a board room issue and a board member takes direct responsibility for the co-ordination of effort."[149]

The Health and Safety Commission subsequently promulgated the *Directors' Responsibilities for Health and Safety* in 2001 as voluntary guidance on health and safety responsibilities for directors. Although this guidance does not establish any legal duties, it proposes the following five action points as best practices:

- The board needs to accept formally and publicly its collective role in providing health and safety leadership in its organisation.

- Each member of the board needs to accept their individual role in providing health and safety leadership for their organisation.
- The board needs to ensure that all board decisions reflect its health and safety intentions, as articulated in the health and safety policy statement.
- The board needs to recognise its role in engaging the active participation of workers in improving health and safety.
- The board needs to ensure that it is kept informed of, and alert to, relevant health and safety risk management issues. The Health and Safety Commission recommends that boards appoint one of their number to be the 'health and safety director.'

A 2006 report prepared on behalf of the UK HSE presents an outline framework for what best practices in occupational health and safety governance should look like.[150] While the report relates specifically to occupational safety governance, the Panel believes the principles discussed are instructive as well for process safety governance. The report notes, in particular, "that directors are still unclear as to their role in Occupational Health and Safety (OHS) leadership and in ensuring that risks to OHS within their business are properly controlled."[151] The Panel believes that the same lack of clarity may also apply to process safety.

The 2006 report notes that there are no specific, positive duties on directors of U.K. companies for governing occupational health and safety matters. The report outlines, however, seven basic principles that the authors of the report believe form the framework of what constitutes best practices for occupational health and safety governance. The Panel recites the principles for possible best practices for process safety governance for companies that conduct businesses that involve process risks. Throughout the text below, the Panel substitutes the term "process safety" for "OHS" (standing for occupational health and safety) as appearing in the 2006 report.

(1) Director competence—All directors should have a clear understanding of the key [process safety] issues for their business and be continually developing their skills and knowledge.

(2) Director roles and responsibilities—All directors should understand their legal responsibilities and their role in governing [process safety] matters for their business. Their roles should be supported by formal individual terms of reference, covering as a minimum setting [process safety] policy and strategy development, setting standards, performance monitoring and internal control. At least one director should have the additional role of overseeing and challenging the [process safety] governance process.

(3) Culture, standards and values—The board of directors should take ownership for key [process safety] issues and be ambassadors for good [process safety] performance within the business, upholding core values and standards. They should set the right tone at the top and establish an open culture across the organization with a high level of communication both internally and externally on [process safety] issues.

(4) Strategic implications—The board should be responsible for driving the [process safety] agenda, understanding the risks and opportunities associated with [process safety] matters and any market pressures which might compromise the values and standards, and ultimately establishing a strategy to respond.

(5) Performance management—The board should set out the key objectives and targets for [process safety] management and create an incentive structure for senior executives which drives good [process safety] performance, balancing both leading and lagging indicators and capturing both tangible and intangible factors. Non-executives should be involved in establishing the appropriate incentive schemes.[152]

(6) Internal controls—The board should ensure that [process safety] risks are managed and controlled adequately and that a framework to ensure compliance with the core standards is established. It is important that the governance structures enable management systems, actions and levels of performance to be challenged. This process should utilize, where possible, existing internal control and audit structures and be reviewed by the Audit Committee.

(7) Organizational structures—The board needs to integrate the [process safety] governance process into the main governance structures within the business, including the activities of the main board and its sub-committees, including risk, remuneration and audit, or the creation of an [process safety] committee.

> Panel conclusion

The Panel notes that the Board has been monitoring process safety performance of BP's U.S. operations, as BP executive and corporate management have presented that performance to the Board. Management has made reports to the Board and proposed various actions to address perceived shortcomings in the implementation of BP's HSSE management system. As to personal safety, management efforts have largely been effective to improve performance. In the area of process safety, however, neither executive management nor refining line management generally implemented an integrated, comprehensive, and effective process safety management system for BP's U.S. refineries.

In the context of reviewing the conduct of the Board, the Panel is guided by its chartered purpose to examine and recommend any needed improvements to corporate safety oversight and leadership. This purpose does not call for an examination of legal compliance but, in the Panel's judgment, calls for excellence. In more practical terms, the Panel wishes to make recommendations to ensure that a tragic process accident like the Texas City explosion does not happen again. It is in this context, and in the context of best practices and not because the Panel believes that BP's Board failed to comply with any applicable, legal duties, that the Panel believes that the Board can and should do more. In particular, the Panel believes that the Board should consider the seven best practice areas cited above as possible guidelines for use in improving its oversight of process safety management affecting BP's U.S. refineries.

The Panel does not believe that BP implemented an integrated, comprehensive, and effective process safety management system for its U.S. refineries. Although BP's executive and refining line management was responsible for ensuring the implementation of such a system, BP's Board did not ensure, as a best practice, that management did so.

Finding:

The Board of Directors of BP p.l.c. has not ensured, as a best practice, that BP's management has implemented an integrated, comprehensive, and effective process safety management system for BP's five U.S. refineries.

ENDNOTES FOR SECTION VI.C.

[1] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. iv; International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 5.

[2] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 17.

[3] *Ibid*.

[4] *Ibid*, p. 22.

[5] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 4.

[6] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 65.

[7] *Ibid*, p. 50.

[8] *See ibid*, pp. 64-65; BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. ii.

[9] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History*, Sec. 4.7 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)); BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 167.

[10] *See* Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 65; BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 168.

[11] *See* Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 4.9 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)); BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 163.

[12] *See* Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 4.5 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)); BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, pp. 3, 13.

[13] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 18. Other well-recognized authorities on safety management systems emphasize the importance of evaluating the management system. *See* International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), pp. 13-14.

[14] International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14.

[15] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006).

[16] CCPS is in the process of forming a team to draft "Guidelines for Measuring Process Safety Progress;" *accessed at* http://www.aiche.org/ccps/activeprojects/Pj192.aspx on December 5, 2006.

[17] International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14.

[18] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006), p. 2.

[19] *Ibid*, p. 47.

[20] *See ibid*, p. 2; International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14; *see also* American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 18.

[21] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006), pp. 2-4.

[22] *Ibid*, p. 2.

[23] *Ibid*.

[24] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 22.

[25] The Panel recognizes that the report discusses major incidents and high potential incidents that may sometimes relate to process safety. In this context, however, it does not appear that they were used as process safety indicators.

[26] Andrew Hopkins, "Lessons from Esso's Gas Plant Explosion at Longford," Occupational Health and Safety Management Systems, Proceedings of the First National Conference, Crown Content, Melbourne, Australia, 2001, p. 46, *as quoted in* Isadore Rosenthal et al., "Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks," *Process Safety Progress*, Vol. 25, No. 2 (June 2006), p. 147.

[27] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 19; *see also* International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 14.

[28] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 19.

[29] Andrew Hopkins, "Lessons from Esso's Gas Plant Explosion at Longford," Occupational Health and Safety Management Systems, Proceedings of the First National Conference, Crown Content, Melbourne, Australia, 2001, p. 46, *as quoted in* Isadore Rosenthal et al., "Predicting and Confirming the Effectiveness of Systems for Managing Low-Probability Chemical Process Risks," *Process Safety Progress*, Vol. 25, No. 2 (June 2006), p. 147.

[30] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 165.

[31] BP also provided 2005 data for Texas City, but this data is of limited utility because Texas City operations in 2005 were atypical because of the ISOM accident and the shutdown necessitated by Hurricane Rita.

[32] OSHA's process safety management standard requires inspections and tests on process equipment. The frequency of the inspections and tests generally must conform to manufacturers' recommendations and good engineering practices. 29 C.F.R. § 1910.119(j)(4) (2006).

[33] Number of overdue inspections means the number of individual inspection points due, not the number of pieces of equipment with overdue inspections. For 2000 through 2005, the data is as of year-end.

[34] Data marked N/A means the data were unavailable.

[35] BP informed the Panel that 210 of these overdue inspections are for equipment that is presently out of service.

[36] Whiting's total overdue inspections include overdue piping system inspections, not overdue piping TML inspections.

[37] The panel reviewed eleven process safety compliance reviews for BP's five U.S. refineries. Only two of these reviews did not contain a finding on mechanical integrity, inspection, and testing.

[38] A Priority 1 finding includes findings believed to be out of compliance with legal or internal standards.

[39] Exact figures were not provided. The report only noted that these types of equipment are 90.6 percent to 99.8 percent compliant.

[40] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 65.

[41] *Ibid*.

[42] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 168.

[43] Health & Safety Executive, *Developing Process Safety Indicators, A Step-By-Step Guide for Chemical and Major Hazard Industries* (London, United Kingdom: HSE Books, 2006), p. 1.

[44] *Ibid*.

[45] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 144.

[46] *Ibid*.

[47] *Ibid*.

[48] The six integrity management metrics are defined in BP's "Group HSSE Reporting Definitions 2006" as follows:

1. **Integrity Related MIAs** are major incidents that also are "integrity management incidents." An integrity management incident is an incident where the root cause would be addressed by the integrity management standard and there is actual or potential harm to people or the environment including:
   - Loss or potential loss of primary containment; or
   - Failure of an engineered system (including mechanical, electrical, structural, lifting, process or process control, and protective systems/devices).
2. **Integrity Related High Potential Incident ("HiPO")** are HiPos that also meet the criteria of an integrity management incident.
3. **MAR Assessments Completed** represent the number of MAR assessments completed expressed as a percentage of the total number of MAR assessments required in the Group, including those that have already been completed.
4. **MAR Group Recommended Closures** represent the percentage of the number of recommendations contained in completed MAR assessments that have been closed over the total number of recommendations contained in completed MAR assessments including all recommendations above and below the Group reporting line.
5. **Number of Overdue Plant Inspections and Tests** represent the number of plant inspections and tests included in each BP Operations Inspection and Test Plan that are overdue.
6. **Uncontrolled Releases** are uncontrolled events where process fluids are released from primary containment and which results in the need for immediate corrective action (*e.g.* shutdown, evacuation, or isolation) to mitigate the effects of loss of containment.

[49] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 19.

[50] *Ibid*, pp. 19-20. Other well-recognized authorities on safety management systems emphasize the importance of incident investigations. *See* International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 15; International Labour Office—Geneva*, Prevention of major industrial accidents: An ILO code of practice* (1991), p. 13.

[51] International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), p. 15; *see also* American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), pp. 19-20.

[52] 29 C.F.R. § 1910.119(m)(1) (2006).

[53] 29 C.F.R. § 1910.119(m)(2) (2006).

[54] 29 C.F.R. § 1910.119(m)(5) (2006).

[55] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 21.

[56] *Ibid*. BP defines a "near miss" or "near hit" as an "undesired event which, under slightly different circumstances, could have resulted in harm to people, damage to property or loss to process." An incident, on the other hand, is an "undesired event that results in harm to people, damage to property or loss to process."

[57] *Ibid*.

[58] The BP Group process safety/integrity management standard also emphasizes the importance of incident investigations. Element 6.0, Incident Investigation, requires that "[a]ll process safety/integrity management incidents and/or significant near misses (HiPo's) will be

investigated to determine the root cause(s) and identify the actions that will prevent a recurrence." The process safety/integrity management standard also observes that incident investigations should be initiated as soon as possible following an incident.

[59] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 40 (emphasis in original).

[60] *Ibid*, p. 35.

[61] *Ibid*, p. 40.

[62] CCPS defines "root cause" as a "fundamental, underlying, system-related reason why an incident occurred that identifies a correctable failure(s) in management systems. There is typically more than one root cause for every process safety incident." Center for Chemical Process Safety, *Guidelines for Investigating Chemical Process Incidents* (New York: American Institute of Chemical Engineers, 2d ed. 2003), p. 179.

[63] *Ibid*, p. 2.

[64] James R. Phimister et al., "Near-Miss Incident Management in the Chemical Process Industry," *Risk Analysis*, Vol. 23, No. 3 (2003), p. 445. Such a concept is apparent from every day experience (*e.g.,* driving). On average, a driver has more close calls (*i.e.,* a near miss or almost a car accident) than actual accidents. One typically would not expect to have more accidents than close calls.

[65] Center for Chemical Process Safety, *Guidelines for Investigating Chemical Process Incidents* (New York: American Institute of Chemical Engineers, 2d ed. 2003), pp. 61-62.

[66] *Ibid*, p. 62.

[67] The annual average represents the average of those years where BP has data for both MIAs and near misses.

[68] According to BP, Carson reports near misses in accordance with the BP near miss reporting definition. BP asserts that the Carson STOMP behavioral-based safety program also reports several hundred "at risk" behaviors or actions.

[69] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 140.

[70] *Ibid*.

[71] *Ibid*.

[72] The Panel interviewed hundreds of hourly workers at BP's U.S. refineries. Several workers commented that they thought Tr@ction was difficult to use and that they did not consult the program as a part of their daily routine. Many workers noted that they just wrote information down and handed it to a supervisor, but did not know if the supervisor actually entered the information into the Tr@ction system.

[73] Fewer than 25 respondents were in this group.

[74] Fewer than 25 respondents were in this group.

[75] *See* American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 20. Other well-recognized authorities on safety management systems similarly define system audits. *See* International Labour Office—Geneva, *Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), pp. 15-16.

[76] 29 C.F.R. § 1910.119(o)(1) (2006).

[77] 9 C.F.R. § 1910.119(o)(4) (2006).

[78] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 22.

[79] *Ibid*, p. 24.

[80] The new BP Group integrity management standard also addresses auditing through self and external assessments. As provided by Element 10, *Performance Management and Learning*, these assessments occur once per year and evaluate the integrity management program, which includes a comparison of BP's annual performance to key performance indicators. Element 10 also creates a performance management system, which includes self and external assessments, for all projects, turnarounds and major maintenance activities. Part of the performance management system includes an Annual Engineering Plan, prepared by all BP strategic performance units, that describes the top five integrity management risks identified during the assessment. Good practices identified during assessments are to be shared among all of BP's operations.

[81] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 139.

[82] When conducting reviews, BP designates a finding as either Priority 1 or Priority 2. BP defines a Priority 1 finding as "a compliance gap and resolution is critical to delivering [the refinery's] PSM and RMP performance targets." Priority 2 findings, on the other hand, "reflect an opportunity and resolution is important to the on-going integrity or continuous improvement of [the refinery's] PSM and RMP processes."

[83] BP's plan requires BP's operational leadership to commit to six expectations. In addition to "audit finding closure," these expectations include completing the "Texas City commitments," conducting and taking action on major accident risk assessments, implementing the new control of work and integrity management Group standards, ensuring complete compliance with relevant laws and regulations, and ensuring competence in matters of safety and operations.

[84] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. iii.

[85] *Ibid*, pp. 20-21. Other well-recognized authorities on safety management systems similarly stress the correction of identified deficiencies. *See* International Labour Office—Geneva*, Guidelines on occupational safety and health management systems, ILO-OSH 2001* (2001), pp. 15-17.

[86] 29 C.F.R. § 1910.119(e)(5) (2006) (emphasis added).

[87] 29 C.F.R. §§ 1910.119(m)(5), (o)(4) (2006).

[88] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 4.

[89] *Ibid*, p. 22 (emphasis in original).

[90] *Ibid*, p. 21.

[91] *Ibid*.

[92] Center for Chemical Process Safety, *Guidelines for Investigating Chemical Process Incidents* (New York: American Institute of Chemical Engineers, 2d ed. 2003), p. 305 (emphasis in original).

[93] 29 C.F.R. § 1910.119(o)(1) (2006).

[94] The 1998 audit occurred when the refinery was still owned by Amoco. It also should be noted that the 2004 review was of the BP South Houston complex, which at the time included not just the Texas City refinery, but also chemical manufacturing facilities in the Texas City and Houston areas.

[95] Exact figures were not provided. The report only notes that these types of equipment are 90.6 percent to 99.8 percent compliant.

[96] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 22.

[97] *Ibid*.

[98] The report includes gHSEr audits conducted across the BP Group, including 13 business units in the Refining and Marketing segment.

[99] The audit was conducted within three of the segment's strategic performance units, including Refining. Included among the visited sites were the Carson and Cherry Point refineries.

[100] BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[101] *Ibid*, p. 13.

[102] *Ibid*.

[103] On May 16, 2006, BP filed a notice of contest challenging the citations.

[104] U.S. Department of Labor, Occupational Safety and Health Administration, *Citation and Notification of Penalty*, April 24, 2006, p. 5.

[105] *Ibid*, p. 8.

[106] *Ibid*, p. 24.

[107] *Ibid*, p. 7.

[108] *Ibid*, pp. 13-23.

[109] *Ibid*, pp. 15-23.

[110] Ibid, pp. 5-6, 12.

[111] Indiana Department of Labor, Indiana Occupational Safety and Health Administration, *Safety Order and Notification of Penalty*, November 15, 2006, pp. 15-17.

[112] *Ibid*, p. 11.

[113] *Ibid*, pp. 10, 15.

[114] *Ibid*, p. 17.

[115] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 139.

[116] Indiana Department of Labor, Indiana Occupational Safety and Health Administration, *Safety Order and Notification of Penalty*, November 15, 2006, p. 14.

[117] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 135.

[118] *Ibid*.

[119] The BP Grangemouth Complex is located approximately 20 miles west of Endinburgh, Scotland. At the time of the incidents, the Complex was regarded as unique within BP because it was the only site involving all three of BP's major businesses: Exploration & Production, Refining & Marketing, and Chemicals.

[120] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, pp. 5-6.

[121] *Ibid*, p. 1.

[122] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 3 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)). The authors are BP employees who participated in the company's investigation into the incidents.

[123] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 64.

[124] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 3 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)).

[125] *Ibid*.

[126] *Ibid*.

[127] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 65.

[128] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. ii.

[129] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 4.7 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)).

[130] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 167.

[131] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 4.9 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)).

[132] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 163.

[133] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, p. 65.

[134] BP p.l.c., John Mogford, "Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report," December 9, 2005, p. 168.

[135] Michael P. Broadribb et al., *Lessons from Grangemouth: A Case History,* Sec. 4.5 (presented at the 19th Annual International Conference of the Center for Chemical Process Safety: Emergency Planning Preparedness, Prevention & Response (Orlando, Florida, June 29 to July 1, 2004)).

[136] BP p.l.c., James W. Stanley, "Process and Operational Audit Report, BP Texas City," June 15, 2005, p. 3.

[137] *Ibid*, p. 13.

[138] Health & Safety Executive, *Major Incident Investigation Report—BP Grangemouth Scotland: A Public Report Prepared by the HSE on Behalf of the Competent Authority*, August 18, 2003, pp. 70-72.

[139] Meredith Armstrong Whiting and Charles J. Bennett, The Conference Board, *Driving Toward '0': Best Practices in Corporate Safety and Health* (Research Report No. R-1334-03-RR) (2003), p. 5.

[140] American Industrial Hygiene Association, *American National Standard for Occupational Health and Safety Management Systems, ANSI/AIHA Z10-2005* (Fairfax, Virginia: American Industrial Hygiene Association, 2005), p. 22.

[141] *Ibid*.

[142] BP p.l.c., "getting HSE right: a guide for BP managers," (December 2002), p. 22.

[143] *Ibid*.

[144] Prior to 2003, HSE information for each refinery was aggregated either in a Downstream HSE Assurance Report (1999-2001) or in a report prepared by the Refining and Marketing segment. With the creation of the Refining strategic performance unit in 2003, BP went to the present assurance system of reporting from refinery to Refining to Refining and Marketing segment to BP Group.

[145] The 2002 EEAC Report stated that this increase was explained by improved reporting.

[146] ISO 14001 is an international standard for environmental management systems.

[147] The Panel recognizes that a major incident or a high potential incident may involve a loss of containment.

[148] BP p.l.c., "Making Energy More: Annual Report and Accounts 2005," (2006), p. 158.

[149] Health and Safety Executive, *Revitalising Health and Safety: Strategy Statement* (London, United Kingdom: Department of the Environment, Transport and the Regions, 2000), p. 26.

[150] Jacqui Boardman and Angus Lyon, Health and Safety Executive, *Defining best practice in corporate occupational health and safety governance*, (Research Report 506) (2006), p. i.

[151] *Ibid*.

[152] The Report further explains, "OHS performance management is multidimensional. No single measure provides an overriding indication of an organisation's success or failure in managing work related risk." As an example, the Report explains the drawbacks of relying solely on lost time accident data as a measure of performance. Instead, the Report cites to an authority for accident prevention suggesting a portfolio of leading indicators (including measures such as culture and integrity and performance of management systems) and lagging indicators (such as incidents, near misses, and financial losses). Of note, the Report cites to the Mogford Report for further support of its position.

VII. PANEL'S RECOMMENDATIONS

The Panel was charged with making recommendations to improve BP's corporate safety culture, corporate oversight of process safety, and process safety management systems. The Panel believes that these recommendations, together with the related commentary below, can help bring about sustainable improvements in process safety performance at all BP U.S. refineries.

The Panel's recommendations are based on findings developed during 2006. Since March 2005, BP has expressed a major commitment to a far better process safety regime, has committed significant resources and personnel to that end, and has undertaken or announced many measures that could impact process safety performance at BP's five U.S. refineries. For a brief listing of the measures that BP has undertaken or announced since March 2005, see "BP Post-Texas City Measures" in Appendix F. In making its findings and recommendations, the Panel is not attempting to deny the beneficial effect on process safety that these measures may have. BP is a large corporation, and the Panel recognizes that it is especially challenging to make dramatic and systemic changes in short time frames. Whether measures already undertaken or announced will be effective, and whether BP will promptly and thoroughly implement the Panel's recommendations, remains to be seen. The ultimate effectiveness and sustainability of BP's intended improvements to its process safety performance can be determined only over time. The Panel believes that BP has much work remaining to improve the process safety performance at its five U.S. refineries. BP should assess its future steps, including actions already planned as of the date of this report, against the Panel's findings and recommendations (and related commentary) contained in this report.

The Panel's recommendations and related commentary contain elements designed to ensure that measures taken will sustain improvement in process safety performance. The Panel believes this emphasis on sustainability is particularly important given BP's failure to fully and comprehensively implement across BP's U.S. refineries the lessons from previous serious accidents, including the process incidents that occurred at BP's facility in Grangemouth, Scotland in 2000. The Panel's recommendations, and the process safety excellence that those recommendations contemplate, should not be abandoned or neglected. They should not become lesser priorities as changes occur in the economic, business, or regulatory climate for the U.S. refining industry; as refinery margins decline from their current high levels; as changes occur at BP, including changes in management; or as mergers and acquisitions take place.

The Panel believes that the investments in BP's refining business and its refining workforce that this report suggests can benefit the company in many ways over time. Such investments should help reduce the economic or opportunity costs associated with a refinery operating at less than full capacity or not operating at all. Other potential benefits of investments in operations and process safety, such as improved workforce morale and increased productivity, may be difficult to measure but are no less important. The Panel believes that as process safety is embedded in all aspects of corporate culture, management systems, and operations relating to BP's U.S. refineries, BP's U.S. refining business will benefit.

The Panel recognizes that the task ahead of BP is significant and will take a concerted and lasting effort. It will not be easy, especially as time passes and the collective recognition of the importance of the task begins to fade. The ultimate effectiveness and sustainability of many measures intended to improve process safety performance can be determined only over time. The Panel believes, however, that the BP refining workforce is ready, willing, and able to participate in a sustained, corporate-wide effort to move BP towards excellence in process safety performance as called for in this report. Over the past twelve months, the Panel interacted with a large number of BP employees, contractors, managers, and executives. The Panel generally came away with favorable impressions of these people. As a group, they appear hardworking and conscientious. Most importantly, they appear sincerely interested in improving BP's management of process safety so as to prevent future incidents like the Texas City tragedy. This was the case at the Carson, Cherry Point, Texas City, Toledo, and Whiting refineries and in BP's corporate offices in Chicago and London.

Finally, the Panel believes that all companies in the refining, chemical, and other process industries should give serious consideration to its recommendations and related commentary. While the Panel made no findings about companies other than BP, the Panel is under no illusion that the deficiencies in process safety culture, management, or corporate oversight identified in the Panel's report are limited to BP. If other refining and chemical companies understand the Panel's recommendations and related commentary and apply them to their own safety cultures, process safety management systems, and corporate oversight mechanisms, the Panel sincerely believes that the safety of the world's refineries, chemical plants, and other process facilities will be improved and lives will be saved.

The commentary below is an integral part of the recommendations, and each commentary should be read in conjunction with the related recommendation.

RECOMMENDATION #1—PROCESS SAFETY LEADERSHIP

The Board of Directors of BP p.l.c, BP's executive management (including its Group Chief Executive), and other members of BP's corporate management must provide effective leadership on and establish appropriate goals for process safety. Those individuals must demonstrate their commitment to process safety by articulating a clear message on the importance of process safety and matching that message both with the policies they adopt and the actions they take.

Commentary

(1) *"Provide effective leadership on and establish appropriate goals"*—Process safety leadership in an organization must start at the top. The Board of Directors of BP p.l.c., its Group Chief Executive, and corporate management as a group must set the process safety "tone at the top" and establish appropriate expectations regarding process safety performance. Those expectations must reflect an unwavering commitment to process safety and infuse into BP's workforce the mindset that process accidents are not acceptable. Those expectations must also be translated into measurable goals designed to move BP toward the achievement of excellence in process safety performance.

(2) *"Demonstrate their commitment to process safety by"*—

(a) *"articulating a clear message on the importance of process safety"*—BP's corporate management should communicate a clear, frequent, and consistent message to its stakeholders on the importance of process safety. This message should

- express BP's process safety performance expectations in terms of verifiable objectives and the means by which the company will achieve them, and
- be reinforced through timely reporting on BP's progress in meeting its objectives.

The company's strategy for delivering this message should emphasize discussion of BP's process safety performance expectations with U.S. refinery line managers, supervisors, and staff. These discussions should occur during frequent visits by executive and corporate management to the U.S. refineries, as well as regular and frequent time in the field by refinery leadership team members.

(b) *"matching that message both with the policies they adopt and the actions they take."*—BP's Board of Directors, its executive management, including its Group Chief Executive, and other members of corporate management should also demonstrate their commitment to process safety through their actions. If senior management evidences its belief in the importance of process safety, consistently communicates that belief to other managers and the workforce, and then provides the appropriate resources to promote process safety excellence, shared beliefs and practices will follow in the rest of the organization. Decisions about corporate level initiatives, operations, financial performance, resource allocation, capital projects, personnel changes, compensation, and other aspects of the U.S. refining operations must visibly and tangibly demonstrate BP's commitment to process safety excellence. In particular, BP should make appropriate adjustments to its performance contract system and other incentive-based compensation plans to better align that system and those plans with the pursuit of process safety excellence. In addition, BP should take steps to promote greater continuity of refinery plant managers and other refinery-level managers having significant process safety leadership roles at the U.S. refineries.

RECOMMENDATION #2—INTEGRATED AND COMPREHENSIVE PROCESS SAFETY MANAGEMENT SYSTEM

BP should establish and implement an integrated and comprehensive management system that systematically and continuously identifies, reduces, and manages process safety risks at its U.S. refineries.

Commentary

(1) *"integrated and comprehensive management system"*—In order to be effective, a management system for process safety must be comprehensive; a weak or fragmented system will not address all of the numerous process safety risks that exist in BP's U.S. refineries. Among other things, this comprehensive management system should

(a) provide guidance on implementation of generally accepted hazard identification procedures, qualitative and quantitative risk analysis and assessment procedures, verifiable process risk tolerance criteria, and expectations on when implementation must be achieved;

(b) utilize an integrated set of leading and lagging performance indicators for process safety as described in Recommendation #7 (and the related commentary);

(c) develop a uniform approach for prioritizing and implementing

- internal and external process safety standards and best practices, and
- external good engineering practices, including, recognized and generally accepted good engineering practices;

(d) utilize an effective management of change process for organizational and personnel changes at all levels;

(e) develop and implement a process to evaluate the extent to which any corporate initiatives adversely impact process safety performance;

(f) ensure completion of identified process safety action items within prescribed and reasonable time periods;

(g) ensure that reports on open process safety action items are delivered to refining line management on a periodic basis. Open action items would include those arising from

- process safety compliance audits or other process safety reviews and assessments,
- gaps identified during implementation of process safety related standards and practices, including BP's 2006 Group Integrity Management Standard and engineering technical practices,
- process hazard analyses,
- near misses, high potential incidents, and other incident investigations,
- management of change reviews, and
- inspections of plant and equipment.

(h) report overdue action items to executive management and to the Board of Directors of BP p.l.c.;

(i) implement a policy regarding area electrical classification that

- is consistent with the intent of API Recommended Practice 500, and
- addresses control of vehicle ignition sources on roadways;

(j) develop an accelerated plan to determine the application of and to implement applicable external standards on safety instrumented systems including ISA-84.01;

(k) develop improved procedures and practices on reporting, investigating, and monitoring of trends relating to, and on learning from, near miss events;

(l) implement a plan to provide safer shelters for personnel situated close to process unit areas;

(m) review overtime policies and practices to ensure that excessive overtime work does not compromise the performance of plant personnel;

(n) revise process hazard analysis procedures to ensure that all significant process safety hazards are addressed including those arising in non-normal operating modes; and

(o) establish a refinery-level monthly management review system that monitors important aspects of process safety management performance and systems on prescribed frequencies, including items (a) through (n) above.

(2) *"that systematically and continuously identifies, reduces, and manages process safety risks"*—The overarching goal of the process safety management system should be systematic and continuous risk reduction. While recognizing the importance and role of process safety system audits, an audit is not a substitute for ensuring that a system exists for appropriate levels of designated managers and employees to monitor critical safety indicators continuously. BP's management system should not rely solely on audits to achieve systematic and continuous identification, reduction, and management of process safety risks.

RECOMMENDATION #3—PROCESS SAFETY KNOWLEDGE AND EXPERTISE

BP should develop and implement a system to ensure that its executive management, its refining line management above the refinery level, and all U.S. refining personnel, including managers, supervisors, workers, and contractors, possess an appropriate level of process safety knowledge and expertise.

Commentary

(1) *"develop and implement . . . "*— BP's effort to develop and implement a system to ensure process safety knowledge and expertise will benefit greatly from the input of various stakeholders, including employee representatives and contractors. Those stakeholders should be involved in developing, reviewing, and implementing such a system. BP should also seek input and advice from external groups with appropriate process safety expertise to help design, develop, and implement this system. Such groups might include, but are not limited to, the Center for Chemical Process Safety (CCPS); American Institute of Chemical Engineers (AIChE); the American Society of Safety Engineers (ASSE); and the American Industrial Hygiene Association (AIHA).

(2) *"a system to ensure . . . an appropriate level of process safety knowledge and expertise"*—Specifically, this system should

(a) define the level of process safety knowledge and expertise required for U.S. refining personnel and contractors and those managers above the refinery level who have managerial oversight of, or who provide staff support for, U.S. refining operations. This group includes

- executive management for refining and all levels of refining line management, including corporate management above the refinery level;
- health, safety, security, and environmental staff personnel for refining operations;
- refining engineering personnel and chemists; and
- other members of the refining workforce, including contract personnel, having some process safety responsibilities. Knowledge and expertise for refinery level managers, supervisory personnel, workers and contractors should include an appropriate level of process knowledge for operating units under their management or supervision or on which they work.

(b) establish, implement, and maintain a process safety training curriculum for line managers; supervisors; health, safety, security, and environmental personnel; engineers; chemists; and operations and maintenance personnel. The training should be completed within the first two years of employment for newly hired personnel, and it should be updated and reinforced annually for experienced personnel;

(c) provide education on an annual basis to all refinery line management on BP's expectations about

- reporting of potential process safety incidents and near misses, and
- sharing of both the reports and actions taken in light of the reports;

(d) on at least an annual basis provide awareness training about reporting of potential process safety incidents and near misses to operations and maintenance personnel;

(e) educate refinery personnel on how to conduct root cause analyses in a manner that thoroughly examines all possible causal factors, including systemic and management causal factors; "determines if root causes of process incidents were identified or should have been identified in the relevant process hazard analysis;" and leads to appropriate recommendations to address the findings;

(f) educate and provide training to enable internal BP process hazard analysis leaders and team members to conduct effective process hazard analyses using the latest recognized and generally accepted practices; and

(g) audit contractors regularly to determine compliance with applicable process safety knowledge and expertise standards.

RECOMMENDATION #4—PROCESS SAFETY CULTURE

BP should involve the relevant stakeholders to develop a positive, trusting, and open process safety culture within each U.S. refinery.

Commentary

(1) *"involve the relevant stakeholders"*—In order to achieve outstanding process safety performance, it is important that BP consult and work with stakeholders at its U.S. refineries in developing and conducting the actions listed in Comment (2) below. BP should ensure that mechanisms exist that effectively promote and facilitate two-way communication between BP managers and all relevant stakeholders. The relevant stakeholders include salaried, hourly, and contract employees; employee representatives; contractors; and where appropriate, members of the community in close proximity to BP's U.S. refineries.

(2) *"develop a positive, trusting, and open process safety culture"*—In order to promote the development of a positive, trusting, and open process safety culture, BP should take the actions listed below. The listed actions are not intended to be an exhaustive list, and BP should consider other opportunities to improve the process safety culture at its U.S. refineries. At a minimum, BP should

(a) share the results of the process safety culture survey conducted on behalf of the Panel with the U.S. refinery workforce on a refinery-by-refinery basis within six months from the date this report is issued;

(b) review the effectiveness of existing refinery-level process safety related policies, practices, and procedures that have a significant potential to affect BP stakeholders and develop and implement new refinery level process safety goals, policies, practices, and procedures that take into account stakeholder interests and input;

(c) review the effectiveness of existing safety committees in promoting process safety and develop and execute a plan to improve such effectiveness. Existing safety committees should be able to assume roles that will have a more significant impact on process safety culture and promote adherence to good process safety practices. This review should involve all relevant stakeholders and include an assessment of each committee's composition and purpose and the extent to which its role overlaps with the role(s) of other committees;

(d) review practices with contractors for the purpose of eliminating inappropriate inconsistencies, as compared with BP employees, for training, discipline, incentives, and communications;

(e) implement changes necessary to achieve and maintain compliance with applicable policies, practices, and procedures;

(f) distinguish more clearly between acceptable and unacceptable employee acts such that the vast majority of unsafe acts or conditions can be reported without fear of punishment. A strong process safety culture facilitates the sharing of information that will reduce safety risks. As a result, BP's refineries should operate in such a way as to permit the reporting of the vast majority of unsafe acts or conditions by employees and contractors without fear of punishment. While unsafe acts that are reckless or particularly egregious may warrant some type of sanctions, the culture of each U.S. refinery should promote sharing of information relevant to safety even when that information indicates that workers have made mistakes;

(g) establish a climate in which

- workers are encouraged to ask challenging questions without fear of reprisal, and

- workers are educated, encouraged, and expected to examine critically all process safety tasks and methods prior to taking them;

(h) involve all relevant stakeholders in

- investigating and preventing accidents, incidents, and near misses,
- reviewing the results of process safety management audits,
- developing recommendations for corrective actions when audit deficiencies are identified, and
- tracking recommendations to completion in a timely manner; and

(i) measure the effectiveness of this effort to improve process safety culture by conducting periodically an anonymous process safety culture survey among the U.S. refineries. The first survey should be conducted approximately one year from the date of this report.

RECOMMENDATION #5—CLEARLY DEFINED EXPECTATIONS AND ACCOUNTABILITY FOR PROCESS SAFETY

BP should clearly define expectations and strengthen accountability for process safety performance at all levels in executive management and in the refining managerial and supervisory reporting line.

Commentary

(1) *"clearly define expectations and strengthen accountability"*—Ultimate accountability and responsibility cannot be delegated and rests at the top of the organization. BP must strengthen accountability and responsibility for process safety performance in executive management and in the U.S. refining managerial and supervisory reporting line. Delegations of authority and related accountabilities must be made with operational clarity and specificity about process safety expectations and performance criteria. Accountability should include

- ensuring that process safety performance goals, objectives, and expectations are included in performance contracts, employees goals and objectives, and discretionary compensation arrangements for line managers, supervisors, and workers in BP's U.S. refineries,
- making a significant portion of total compensation of refining line managers and supervisors contingent on satisfactorily meeting process safety performance indicators and goals in the U.S. refineries,
- making a significant portion of the variable pay plan for non-managerial workers in BP's U.S. refineries contingent on satisfactorily meeting process safety performance objectives, and
- making process safety performance and leadership significant considerations in career advancement and succession planning.

(2) *"for process safety performance"*—Because major process safety incidents occur relatively infrequently, process safety performance cannot be measured effectively by the occurrence of such incidents alone. Accordingly, BP should establish performance expectations that (a) eliminate on a prescribed schedule gaps in process safety practices at the U.S. refineries as compared with applicable internal and external standards and practices, including best practices and other recommended external practices and standards, and (b) include identified process safety performance indicators as described in Recommendation #7 (and the related commentary).

(3) *"at all levels in executive management and in the refining managerial and supervisory reporting line"*—All levels of management and supervision play an important role in process safety performance, from the Group Chief Executive to refinery level supervisors and first level leaders. At each of these levels, process safety accountabilities should be defined in operational terms that are understood—and then enforced. Managers and supervisors must know that a failure to perform according to operationally defined process safety expectations will have consequences.

BP should also ensure that each U.S. refinery plant manager is primarily responsible for the safe operation of the refinery. The first priority for the top line manager at each U.S. refinery must be to operate the refinery safely. Commercial responsibilities should not take priority over safety for this key line manager.

RECOMMENDATION #6—SUPPORT FOR LINE MANAGEMENT

BP should provide more effective and better coordinated process safety support for the U.S. refining line organization.

Commentary

(1) *"more effective . . . process safety support"*—While emphasizing that the refining managerial reporting line has primary responsibility for and ownership of process safety performance, BP should designate and establish a full-time leader for process safety who reports to a refining line manager above the refinery level. This leader should provide strategic guidance on process safety direction for the U.S. refineries and, in doing so, should facilitate consistent process safety implementation across the U.S. refineries. The lead process safety person at each U.S. refinery should have a joint reporting relationship with the refinery manager and with this leader. This leader should have substantial knowledge and experience in process safety management and sufficient positional authority to contribute meaningfully to the most significant decisions, financial or otherwise, made at all levels above BP's U.S. refineries that affect process safety performance at those refineries. This leader should reside in the line organization and report jointly to the line manager indicated above and to the leader of BP's Safety and Operations function.

(2) *"better coordinated process safety support"*—While BP should improve the effectiveness of process safety support by establishing a leader as described above, it should not add more complexity to the complex organization that currently supports process safety performance in BP's five U.S. refineries. In order to support refining line managers effectively, process safety support staff at all levels of the BP organization must be able to communicate directly with appropriate line managers and must have their process safety responsibilities clearly defined in relation to line managers and in relation to other support staff. While refining line managers should have primary responsibility for process safety performance, BP should harmonize the roles and efforts of its existing staff personnel in the line organization and in functional groups (*e.g.*, Safety and Operations, Technology, and HSSE) that support line managers' implementation of process safety. To do this, BP should develop and implement a written plan that describes clearly and succinctly process safety responsibilities and accountabilities for existing staff personnel in the line organization and in functional groups that support process safety. The plan should describe (a) the specific roles and responsibilities of such staff and functional groups in setting process safety performance standards and expectations, acting as subject matter advisors, auditing compliance, and monitoring performance, and (b) how BP will ensure coordination among these staff members and functional groups at the Group, Refining and Marketing, Refining, and U.S. refinery levels.

RECOMMENDATION #7—LEADING AND LAGGING PERFORMANCE INDICATORS FOR PROCESS SAFETY

BP should develop, implement, maintain, and periodically update an integrated set of leading and lagging performance indicators for more effectively monitoring the process safety performance of the U.S. refineries by BP's refining line management, executive management (including the Group Chief Executive), and Board of Directors. In addition, BP should work with the U.S. Chemical Safety and Hazard Investigation Board and with industry, labor organizations, other governmental agencies, and other organizations to develop a consensus set of leading and lagging indicators for process safety performance for use in the refining and chemicals industries.

Commentary

(1) *"develop . . . an integrated set of leading and lagging performance indicators"*—BP should develop an integrated set of leading and lagging indicators to measure how the U.S. refineries are performing in regard to process safety. Performance expectations should be set and periodically reviewed for each of these indicators. The performance indicators should include both leading and lagging indicators. The indicators should be reasonably designed to address and monitor how effectively the most significant process safety risks at the U.S. refineries are being controlled. In developing an integrated set of performance indicators, BP should refer to guidance from and literature prepared by regulatory and other authoritative bodies; public interest and industry organizations, including the U.K. Health and Safety Executive, the CCPS, and the American Chemistry Council; and the USW. BP should also consider the examples of potential leading and lagging indicators provided in such guidance and literature. As indicated in such guidance, BP should implement an integrated set of indicators since no single performance measure addresses all process safety risks. The indicators should also be integrated in a manner that addresses process risks as identified through an evaluation of such risks and ensures feedback on the effectiveness of the leading indicators.

(2) *"implement . . . an integrated set of leading and lagging performance indicators"*—Not having an integrated set of performance indicators represents a substantial gap in a process safety management system. While such indicators should be carefully developed, the prompt implementation of a reasonable set of integrated performance indicators should be treated as a top priority. Prolonged delays in employing a reasonable set of indicators because of an extended search for some perfect set of performance indicators will likely do more harm than good. Accordingly, BP should develop and implement within six months from the date this report is issued a reasonable set of integrated performance indicators. BP should involve its Board, executive management (including the Group Chief Executive), refining line management, and U.S. refinery employee representatives in developing and implementing such performance indicators.

The Panel recommends that the set of performance indicators initially include as a lagging indicator a process incident index that addresses

- all fires,
- all explosions (as defined to include certain physical overpressures),
- hazardous releases, and
- injuries/fatalities relating to a process incident.

The process incident index would have a numerator that takes into account the items listed immediately above and would have a denominator that allows the index to be used to compare performance across refineries of different size and scale and to address worker exposure to process risks. Annex I in this Section VII provides an example of this type of index. This process incident index is intended to be temporary. When a consensus set of leading and lagging indicators becomes available that addresses the elements of this process incident index, BP should adopt such consensus indicators, which would replace this incident index.

(3) *"periodically update"*—The leading and lagging indicators selected should not be considered static. Rather, the effectiveness and value of each performance indicator should be evaluated regularly, and at least every two years. Over time, the effectiveness of the set of indicators should improve, with resulting improvements in process safety performance.

(4) *"monitoring . . . by BP's refining line management, executive management (including the Group Chief Executive), and Board of Directors"*—Because of the potential catastrophic nature of process safety incidents, performance of the U.S. refineries against selected indicators should be reviewed carefully and analyzed for trends within individual refineries and BP's refineries as a group. Performance and information regarding trends should be reported to, and monitored by, BP's executive management (including the Group Chief Executive), and Board of Directors. In order to monitor process safety management effectively, BP should develop minimum performance targets for each chosen indicator, even though BP's ultimate goal may be perfection, and hold line management accountable for meeting at least these minimum targets.

(5) *"work with the U.S. Chemical Safety and Hazard Investigation Board and with industry, labor organizations, other governmental agencies, and other organizations to develop a consensus set of leading and lagging indicators"* —The Panel believes that the development of a consensus set of leading and lagging performance indicators would benefit not only BP, but also both the refining and chemicals industries. As a result, in addition to developing leading and lagging indicators for its own use, the Panel recommends that BP work with other stakeholders to develop a consensus set of leading and lagging indicators. The Health and Safety Executive in the United Kingdom, working in conjunction with British industry, has recently provided valuable guidance in the area of developing process safety performance indicators. In addition, the CCPS has included a discussion of metrics in its soon to be published *Guidelines for Risk Based Process Safety* book and has begun a project relating to the development of process safety metrics. In addition, the USW, public interest organizations, and/or organizations from other industries, such as the Institute of Nuclear Power Operations (INPO) in the nuclear electric generating industry, have expertise and experience in metrics that would be valuable resources. The Panel believes that the CSB should provide leadership in developing a consensus set of leading and lagging indicators for process safety performance for use in the refining and chemicals industries. BP should work with the CSB and with industry, labor organizations, other governmental agencies, and public interest organizations in this process. BP should include in the set of performance indicators that it uses from time to time any such consensus set of leading and lagging indicators.

RECOMMENDATION #8—PROCESS SAFETY AUDITING

BP should establish and implement an effective system to audit the process safety performance at its U.S. refineries.

Commentary

1. *"establish and implement an effective system to audit the process safety performance"*—In order to be effective, the audit system should, among other things,

(a) confirm not only that the appropriate process safety management system is in place, but also that actual refinery operations in the field and throughout the line management chain of command conform to the system;

(b) ensure a cross functional team of qualified and trained auditors, including auditors with substantial expertise in the various elements of process safety management, refining technology, maintenance, and operations;

(c) provide adequate time to conduct thorough audits, taking into consideration the size and complexity of the refinery being audited and the number of auditors involved;

(d) periodically use audit teams independent of BP for the process safety audits for each U.S. refinery;

(e) require (i) consultation between the refinery leadership team and the auditors on proposed remedial measures and appropriate deadlines for the completion of those measures and (ii) notification of executive management and refining line management above the refinery level if and when agreed deadlines are not met, as well as if and when any renegotiated extended deadlines are subsequently not met;

(f) provide for the timely verification of remedial measure completion by personnel independent of the audited refinery; and

(g) upgrade the current audit finding significance ranking system to ensure consistent evaluation and prioritization of the significance of findings.

RECOMMENDATION #9—BOARD MONITORING

BP's Board should monitor the implementation of the recommendations of the Panel (including the related commentary) and the ongoing process safety performance of BP's U.S. refineries. The Board should, for a period of at least five calendar years, engage an independent monitor to report annually to the Board on BP's progress in implementing the Panel's recommendations (including the related commentary). The Board should also report publicly on the progress of such implementation and on BP's ongoing process safety performance.

Commentary

(1) *"monitor the implementation of the recommendations"*—The Panel believes that it is critically important that steps be taken to ensure the sustainability of the Panel's recommendations and the implementation of systemic changes contemplated by the recommendations. The Panel believes that timely implementation of the recommendations can result in long-lasting improvements in process safety performance at BP's U.S. refineries. To this end, BP's Board should monitor the performance by executive, corporate, and refining line management above the refinery level within BP in implementing the recommendations, including the need to hold executive management and refining line managers and supervisors at all levels accountable for process safety performance.

To assist in this monitoring role, the Board should, for a period of at least five (5) calendar years, engage an independent person or persons to act as a special monitor to report annually to the Board on BP's progress in implementing the Panel's recommendations. BP should provide the special monitor with access to required administrative and technical support or services and required resources, including process safety, corporate culture, and refining industry knowledge and expertise. The Board should (a) develop a specific process for ensuring the independence of the special monitor and any experts, and (b) make the resulting report publicly available on an annual basis.

(2) *"monitor . . . the ongoing process safety performance of BP's U.S. refineries"*—Because of the potential catastrophic nature of process safety incidents, BP's Board should monitor the ongoing process safety performance of the U.S. refineries. In order to do this effectively, the Board may determine that it needs additional process safety resources and/or expertise. To this end, the Board should assess what resources it needs to monitor effectively and to be able to challenge the process safety performance as reported to it by BP management.

(3) *"report publicly on the progress of such implementation and on BP's ongoing process safety performance"*—The Panel also believes that sustainability and implementation of its recommendations will be served by having BP report publicly on its progress in implementing the Panel's recommendations and on its process safety performance generally. Accordingly, BP should, on a periodic and at least annual basis, report publicly in reasonable detail on (a) BP's progress in implementing the Panel's recommendations, and (b) the process safety performance in the U.S. refineries using leading and lagging indicators as discussed in Recommendation #7 (and the related commentary). This reporting of information should be at least as prominent as the company's current reporting of its personal safety and environmental performance.

RECOMMENDATION #10—INDUSTRY LEADER

BP should use the lessons learned from the Texas City tragedy and from the Panel's report to transform the company into a recognized industry leader in process safety management.

Commentary

(1) *"transform the company into a recognized industry leader"*—The Panel recognizes that in some areas, notably reduction of greenhouse gases and promotion of alternative forms of energy, BP is seeking a leadership position in the energy sector. The Panel challenges BP to do the same in the area of process safety management. Such leadership can help make not only BP's refineries safer, but also encourage other companies in the refining, chemicals, and other process industries to make their plants safer for workers and the public. BP has shown an ability to respond to challenges by taking leadership positions in the past; the lessons learned from Texas City and the Panel's report provide another important opportunity to do so.

(2) *"in process safety management"*—The Panel believes that in order to become an industry leader in process safety management, BP should take a leading role in existing or new industry organizations to promote process safety. In taking such a leading role, BP should be informed by the efforts of public interest organizations and/or organizations from other industries, such as the INPO in the nuclear electric generating industry. Leadership opportunities for making ongoing changes and improvements in process safety include the following:

(a) improving reviews and inspections of refineries against applicable legal and leading industry practices. While the reviews and inspections would be based on applicable OSHA, EPA, and recognized and generally accepted good engineering practices, the goal should be to go beyond minimum requirements and to achieve excellence;

(b) improving process safety training standards, refinery workforce and management knowledge and expertise, and process safety management audits, management reviews, and inspections; and

(c) sharing within the refining and chemicals industries information about learnings from near miss and accident investigations.

ANNEX I—PROCESS INCIDENT INDEX EXAMPLE

Summary

This example process incident index is provided to help BP understand the Panel's expectations on the content of a lagging index that could be used to measure actual process safety performance and thereby quickly establish a lagging indicator that measures overall process safety performance. BP should evaluate this example and consider modifications as appropriate.

The process incident index would be a lagging indicator that captures overall process safety performance through counts of fires, system overpressures and explosions, chemical releases, and injuries/fatalities. The denominator for the index would use worker hours in the same manner as the OSHA injury index.

The process incident index would be calculated in a manner similar to the OSHA injury index. The annual number of process safety incident counts would be divided by the total hours worked in the facility and then multiplied by 200,000 in order to create a normalized annual index for each 100 workers. (Since an employee works approximately 2,000 hours per year, 200,000 hours represents the approximate annual number of hours that would be worked by 100 employees.)

Example:

Assume:

(1) a plant has 200 employees, each of whom worked 2,000 hours in a calendar year; and

(2) incidents with a total of five counts occurred in the plant that year.

Calculation of the Process Incident Index:

Step 1: Divide the five counts by 400,000 hours worked in the calendar year.

Step 2: Multiply the count by 200,000, producing a Process Incident Index of 2.5 for the year.

Process Incident Index Count Threshold—Definitions and Examples

Definition of "Fire": *Unintentional fires of any magnitude and unintentional electrical arcs.*

Set forth below are examples of items that add to the count total:

- a leak that results in a flame;
- a tangible indication of a fire (*e.g.*, soot on the inside of distillation tower) where no flame was actually seen;
- a fire on a scaffold board in a process unit;
- a fire in a vehicle parked by an operating unit;
- a 120 volt shorted switch;

- a ground fault on electrical heat tracing;
- a phase to ground or phase to phase short on electrical power distribution;
- a fault in a motor control center; and
- a fault in a electrical switch gear.

The following items are examples of items that do *not* add to the count total:

- a fire in a trash can in an office building (not in the process);
- a fire from residue in heat exchanger in a shop (not in the process);
- a fire in a laboratory (not in the process);
- smoldering rags in a pump house (no flame);
- a fire in a vehicle in a parking lot outside the refinery fence; and
- catalyst destroyed by overheating (no flame).

Definition of "Explosion": *Explosions of any kind, including detonations, deflagrations, and physical overpressures that result in any physical damage.*

The following items are examples of explosions or overpressures that add to the count total:

- a "puff" during a furnace startup that results in damage to the refractory or bends the walls; and
- a failure of a pressure control system on a tank that results in an overpressure that bulges a tank.

The following are examples of items that do *not* add to the count total:

- an overpressure that results in the activation of a relief valve;
- an overpressure that results in the burst of a rupture disk; and
- a "puff" during a furnace startup that results in no damage to the furnace.

Definition of "Hazardous Release": Any non-permitted environmental release that meets the following criteria:

- an episodic release of 500 pounds of a flammable material; or
- a release of a substance subject to the notification requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or the Emergency Planning and Community Right-to-Know Act (EPCRA) because it exceeds the reportable quantity but without regard to whether the refinery must notify the applicable governmental authority of the release.

Definition of "Injury/Fatality": The definition would include both on site and off site occurrences:

- on site—"Injury/Fatality" includes each serious injury or fatality to an employee or contractor that results from a release of energy or material from a process.
- off site—"Injury/Fatality" also includes each injury to a member of the public that is seen by a physician or a fatality to a member of the public as a result of a release of energy or material from a process.

A serious injury includes any injury that is required to be reported on the OSHA 300 log. For purposes of determining the count for the numerator in the Process Incident Index, a fatality would have a multiplier of 10 to reflect the seriousness of the event. See example calculation below.

The following are examples of items that add to the count total:

- an OSHA 300 log injury that results from a splash while an operator is catching a sample;

- a fatality that results from a mechanic falling from an elevated work surface when the fall was caused by a sudden release of steam; and
- an OSHA 300 log injury to a responder to an incident that is a release of material or energy from a process.

The following are examples of items that do *not* add to the count total:

- an OSHA 300 log injury that results from a splash while a lab technician is running a unit sample (not in the process);
- a small cut to an operator in the unit that does not result in an OSHA 300 log injury;
- a broken leg that occurred in an operating unit when an operator slipped and fell on ice;
- an OSHA 300 log injury that results from a wrench falling from an elevated work surface in an operating unit; and
- a fatality that results from a mechanic falling from an elevated work surface in an operating unit when the fall was caused by a slip.

Example Calculation

Assumptions:

- In a calendar year a plant with 400 employees (800,000 hours worked) had 10 fires.
- One of the fires resulted in a serious injury and a fatality.
- One of the fires resulted from a release of 2,000 pounds of flammable material.
- A hot condensate release resulted in two injuries.
- There were also 8 releases that were reportable under CERCLA.
- No members of the public were directly impacted by the incidents.

10 counts—from the 10 fires
3 counts—from the injuries
10 counts—from the single fatality
1 count—from the release of more than 500 pounds of flammable material
8 counts—from the 8 CERCLA reportable releases.

32 total process incident index counts

Process Incident Index Calculation:

32 counts, divided by 800,000 hours worked, multiplied times 200,000 = 8.0

APPENDIX A
BP U.S. REFINERIES INDEPENDENT SAFETY REVIEW PANEL CHARTER

In response to the Urgent Recommendation of the U.S. Chemical Safety and Hazard Investigation Board (CSB) (copy attached as Appendix 1), the Group Chief Executive of BP p.l.c., acting under delegated authority of the Board of Directors of that company, hereby commissions an independent panel, to be named the BP U.S. Refineries Independent Safety Review Panel (Independent Panel). The purpose of the Independent Panel is to make a thorough, independent and credible assessment of the effectiveness of BP Products North America Inc.'s (BP Products) corporate oversight of safety management systems at its refineries[1] and its corporate safety culture. The commissioning of this review and independent assessment reflects BP p.l.c.'s ongoing commitment to the safe operation of all its United States refining facilities.

I. Purposes

The Independent Panel's written report will examine and recommend any needed improvements to:

- Corporate safety oversight, including the safe management of refineries obtained through mergers and acquisitions.
- Corporate safety culture, including the degree to which:
  - Corporate officials exercise appropriate leadership to promote adherence to safety management systems;
  - Process safety is effectively incorporated into management decision-making at all levels;
  - Employees at all levels are empowered to promote improved process safety; and
  - Process safety programs receive adequate resources and are appropriately positioned within organizational structures.
- Corporate and site safety management systems, specifically:
  - Near miss reporting and investigation programs;
  - Mechanical integrity programs;
  - Hazard analysis programs, management-of-change programs, and up to date operating procedures for processes with catastrophic potential; and
  - Siting policies for occupied structures near hazardous operating units.
- The Independent Panel should avoid duplicating the efforts of the CSB to determine the specific root causes of the incident at Texas City on March 23, 2005. The Independent Panel should not seek to affix blame or apportion responsibility for any past event.
- Any ambiguities in interpretation of this Charter will be resolved in a manner consistent with the purposes and objectives of the CSB Recommendation.

II. Independent Panel Membership

- The Independent Panel will have at least seven (7) members.
- Members will be appointed by the Group Chief Executive of BP p.l.c. based on their competence and ability to add substance to the deliberations of the Independent Panel.
- Members will be appointed so as to have a diverse makeup, including an external chairperson, labor representatives, and outside safety experts, such as experts in process safety, experts in corporate culture, organizational behavior and human factors and experts from other high risk sectors such as aviation, space exploration, nuclear energy and the undersea navy.
- Each Member must also be, and remain during the term of his or her service, independent and free from any material relationship that, in the opinion of the Group Chief Executive of BP p.l.c., would interfere with the exercise of his or her independent judgment or would appear to a reasonable observer to do so. Such material conflicts of interest will be avoided in the selection of Independent Panel Members through the normal vetting process conducted by BP p.l.c. and its counsel. Independent Panel Members will be required to disclose to BP p.l.c. and to the Independent Panel the nature of any relationship with BP p.l.c. or a BP p.l.c. subsidiary or other relevant entities. Upon its formation, the Independent Panel shall make public a summary of any known material conflicts of interest involving its Members and an explanation of how those conflicts have been resolved.
- Any Independent Panel vacancies will be filled, and any additions to membership will be made, by the Group Chief Executive of BP p.l.c., after consultation with the Chair of the Independent Panel, and will be consistent with the considerations above. The CSB will be notified of any vacancies and subsequent appointments to the Independent Panel.
- Only the Independent Panel acting by a majority vote is authorized to remove a sitting member of the Independent Panel for good cause.

III. Structure and Operations

- The Chair of the Independent Panel will be James A. Baker, III.
- The Independent Panel will establish and make public its own operating rules and will meet where and as provided by such rules, by resolution or act of the Independent Panel or by call of the Independent Panel Chair.
- A majority of the members of the Independent Panel, one of whom must be the Chair, will constitute a quorum.
- The Independent Panel will act by majority vote of the members.
- The Independent Panel will meet as often as required in order to accomplish its purposes under this Charter, and is not precluded from meeting in public or in private, as it deems appropriate.
- The liaison with the Independent Panel will be a designated representative of BP p.l.c. who is not employed by or an officer of BP Products. The liaison shall be readily available to the Independent Panel, and shall facilitate communications among the Independent Panel, BP p.l.c. and the CSB.
- The Independent Panel will establish arrangements to provide for its staffing and other administrative needs.

IV. Independent Panel Written Report

- The Independent Panel will be solely responsible for the final content of its written report and will furnish to the Group Chief Executive of BP p.l.c. progress reports and the final report.
- The final report will be delivered to BP p.l.c. through its Group Chief Executive for review and subsequent delivery to the CSB, BP p.l.c.'s workforce, and the public. While BP p.l.c. may comment on the Independent Panel's report and may seek correction of any factual inaccuracies, the report will remain under the sole control of the Independent Panel.
- The Independent Panel will use best efforts to complete its final report within 12 months from its establishment.
- To the extent the Independent Panel makes recommendations to the Group Chief Executive of BP p.l.c. prior to completing its final report, the Group Chief Executive will promptly make them available to the BP workforce and the public.

V. Resources and Authority of the Independent Panel

- BP Products will provide the Independent Panel with all necessary funding, resources and authority in order to conduct the thorough, independent and credible inquiry contemplated by the CSB recommendation.
- The Independent Panel will use its best efforts to provide for the reasonable management of all costs and expenses that it incurs.
- The Independent Panel will have full and broad access to relevant documents, information, facilities and personnel, other than material that is subject to a good faith claim of attorney-client privilege or attorney work-product protection. The information to which the Independent Panel will have access will include the substantial amounts of information already gathered by the BP p.l.c., including the information already gathered by BP p.l.c. during the course of its own investigation of the March 23, 2005, explosion at Texas City. The Independent Panel and its members and staff will use BP p.l.c. information obtained in the course of Independent Panel work solely for the purpose of the Independent Panel's work as commissioned in this Charter. BP p.l.c. will provide the Independent Panel with access to administrative and technical support or services that the Independent Panel requires, and the Independent Panel will have the authority to retain any staff, outside counsel, experts, consultants and advisors that it deems necessary and appropriate to carry out its duties and responsibilities. It will be the responsibility of the Independent Panel to ensure that all such staff, outside counsel, experts, consultants and advisors do not have conflicts that prevent their rendering independent advice and counsel.

---

[1] BP p.l.c. conducts its U.S. refinery operations through BP Products at five different locations: Texas City, Texas; Carson, California; Whiting, Indiana; Cherry Point, Washington; and Toledo, Ohio.

APPENDIX B
U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD URGENT RECOMMENDATION

Whereas:

1. On March 23,2005, the BP Texas City refinery experienced a severe chemical accident involving a raffinate splitter tower and associated blowdown system that resulted in 15 deaths, about 170 injuries, and significant economic losses, and was one of the most serious U.S. workplace disasters of the past two decades;

2. Key alarms and a level transmitter failed to operate properly and to warn operators of unsafe and abnormal conditions within the tower and the blowdown drum;

3. The startup of the raffinate splitter was authorized on March 23 despite known problems with the tower level transmitter and the high-level alarms on both the tower and the blowdown drum; for example, a work order dated March 10 and signed by management officials, acknowledged that the level transmitter needed repairs but indicated that these repairs would be deferred until after startup;

4. The majority of 17 startups of the raffinate splitter tower from April 2000 to March 2005 exhibited abnormally high internal pressures and liquid levels—including several occasions where pressure-relief valves likely opened—but the abnormal startups were not investigated as near-misses and the adequacy of the tower's design, instrumentation, and process controls were not re-evaluated;

5. Written startup procedures for the raffinate splitter were incomplete and directed operators to use the so-called "3-lb." vent system to control tower pressure, even though the pressure-control valve did not function in pre-startup equipment checks and also failed to operate effectively during post-accident testing;

6. The Texas City refinery missed opportunities before and after its acquisition by BP North America to connect the tower pressure-relief valves to a safety flare system, as noted in BP's own May 2005 interim investigation report;[1]

7. Most of the fatalities and many of the serious injuries occurred in or around trailers that were susceptible to blast damage and were located within 150 feet of the blowdown drum and vent stack;

8. The Texas City refinery had a facility siting policy and performed a management-of-change analysis prior to positioning the trailers, but trailers were nonetheless placed in close proximity to the isomerization unit, which had experienced various hydrocarbon releases, fires, and other process safety incidents over the previous two decades;

9. The Texas City refinery experienced two fatal safety incidents in 2004 as well as a serious furnace fire that resulted in a community order to shelter;

10. Subsequent to the March 23 incident, the Texas City refinery experienced a major process-related hydrogen fire on July 28, 2005, that had the potential to cause additional deaths and injuries and resulted in a Level 3 community alert;[2]

---

[1] The BP interim report states: "Blowdown stacks have been recognized as potentially hazardous for this type of service, and the industry has moved towards closed relief systems to flare .... Opportunities to tie the Splitter relief lines into a flare system were not taken when it could have been efficiently done in 1995 or 2002 ...."

[2] Level 3 is the second highest emergency classification under Texas City procedures. It applies when "an incident has occurred, the situation is not under control, and protective action may be necessary for the surrounding or offsite area."

11. On August 10, 2005, the Texas City refinery experienced another Level 3 incident involving the Gas Oil Hydrotreater that resulted in a community order to shelter;

12. All three incidents in 2005 raise the issue of the adequacy of mechanical integrity programs at the Texas City refinery;

13. In April 2005 the US. Occupational Safety and Health Administration listed the BP Texas City refinery as a subject facility under its Enhanced Enforcement Program for Employers Who Are Indifferent to Their Obligations Under the OSH Act;

14. The U.K. Health and Safety Executive (HSE) investigated and reported on three incidents at the BP Grangemouth refinery in Scotland in 2000, concluding that "BP Group Policies set high expectations but these were not consistently achieved because of organisational and cultural reasons; BP Group and Complex Management did not detect and intervene early enough on deteriorating performance. . . ."

15. The Board believes that the foregoing circumstances and preliminary findings raise serious concerns about (a) the effectiveness of the safety management system at the BP Texas City refinery; (b) the effectiveness of BP North America's corporate safety oversight of its refining facilities; (c) a corporate safety culture that may have tolerated serious and longstanding deviations from good safety practice;

16. The Board believes that corporations using large quantities of highly hazardous substances must exercise rigorous process safety management and oversight and should instill and maintain a safety culture that prevents catastrophic accidents;

17. Under 42 U.S.C. §7412(r)(6)(C)(ii), the Board is charged with "recommending measures to reduce the likelihood or the consequences of accidental releases and proposing corrective steps to make chemical production, processing, handling and storage as safe and free from risk of injury as is possible. . . .

18. Board procedures authorize the development and issuance of an urgent safety recommendation before a final investigation report is completed if an issue is considered to be an imminent hazard and has the potential to cause serious harm unless it is rectified in a short timeframe.

Accordingly:

Pursuant to its authority under 42 U.S.C. § 7412(r)(6)(C)(i) and (ii), and in the interest of preventing the serious harm that could result if the imminent hazards underlying the series of incidents at BP facilities are not promptly rectified, the Board makes the following urgent safety recommendation to the BP Global Executive Board of Directors:

1. Commission an independent panel to assess and report on the effectiveness of BP North America's corporate oversight of safety management systems at its refineries and its corporate safety culture.[3] Provide the panel with necessary funding, resources, and authority—including full access to relevant data, corporate records, and employee interviews—in order to conduct a thorough, independent, and credible inquiry.

---

[3] Appropriate reference materials for the design of the assessment may include the Final Report of the Columbia Accident Investigation Board (2003), the Conference Board research report "*Driving Toward '0': Best Practices in Corporate Safety and Health*, the ANSI/AIHA Z10-2005 standard *Occupational Health and Safety Management Systems*, the International Labour Organization (ILO) code of practice *Prevention of Major Industrial Accidents* (1991), and the ILO *Guidelines on Occupational Safety and Health Management Systems* (2001).

2. Ensure that, at a minimum, the panel report examines and recommends any needed improvements to:
   - Corporate safety oversight, including the safe management of refineries obtained through mergers and acquisitions;
   - Corporate safety culture, including the degree to which:
     - Corporate officials exercise appropriate leadership to promote adherence to safety management systems;
     - Process safety is effectively incorporated into management decision-making at all levels;
     - Employees at all levels are empowered to promote improved process safety;
     - Process safety programs receive adequate resources and are appropriately positioned within organizational structures;
   - Corporate and site safety management systems, specifically:
     - Near-miss reporting and investigation programs;
     - Mechanical integrity programs;
     - Hazard analysis programs, management-of-change programs, and up-to-date operating procedures for processes with catastrophic potential;
     - Siting policies for occupied structures near hazardous operating units.

3. Ensure that the panel has a diverse makeup, including an external chairperson; employee representatives; and outside safety experts, such as experts in process safety; experts in corporate culture, organizational behavior, and human factors; and experts from other high-risk sectors such as aviation, space exploration, nuclear energy, and the undersea navy.

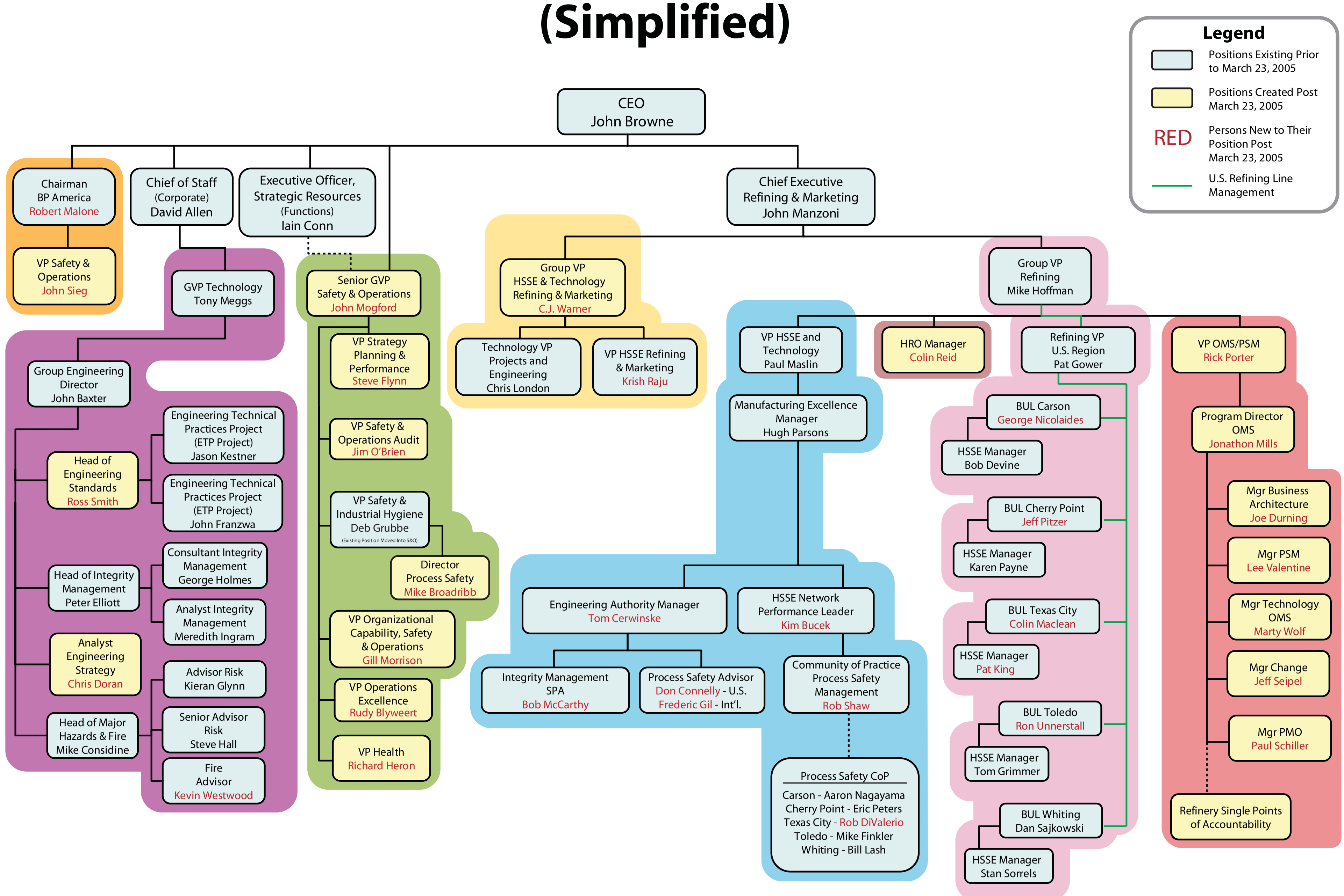
4. Ensure that the report and recommendations of the independent panel, which should be completed within 12 months, are made available to the BP workforce and to the public.

Urgent Recommendation of the U.S. Chemical Safety and Hazard Investigation Board
http://www.csb.gov/news_releases/docs/BPUrgentRecommendation.pdf

APPENDIX C

BP U.S. REFINING ORGANIZATIONAL CHART (SIMPLIFIED)

BP U.S. Refining Organizational Chart (Simplified)



APPENDIX D
WHITING RUPTURE DISK: A CASE STUDY FOR REVIEW OF BP'S PROCESS SAFETY MANAGEMENT SYSTEMS

I. Overview

During the process safety technical review conducted by the Panel's consultants at BP's Whiting refinery in March 2006, the consultants discovered pressure between several rupture disks and pressure relief valves on the fractionator tower of the FCU-500 process unit. Quarterly operator logs for the previous two years for the unit indicated seven out of eight rupture disk/relief valves reported higher than intended pressure. This condition had the potential to make the pressure relief system for the unit ineffective. The Panel believes that the Whiting rupture disk situation, and how BP addressed the situation over time, is indicative of a broader set of systemic issues affecting the overall management of process safety at BP's U.S. refineries.

II. Factual History

The Whiting refinery installed rupture disks on two fluidized catalytic cracking fractionator units (FCU) some time prior to 1993, when the refinery was owned by Amoco, to protect the unit's relief valves. A relief valve is designed to open at a predetermined pressure to protect pressure vessels from pressures that exceed their design limits. It limits the pressure in a system by opening when the system pressure gets too high, allowing material to be released from the pressured system to a safe location, thus reducing the system pressure to a safe level. Rupture disks were installed below the relief valves to protect the valve's internal mechanism from system process fluid. The rupture disk and relief valve system was designed so that when system overpressure occurred, the disk would burst first and then the relief valve would open and then reclose after the system pressure was reduced to a safe level.

Between 1993 and 1998, the Whiting refinery executed numerous work orders to replace failed rupture disks. During this period, Whiting refinery personnel viewed the rupture disk replacement as an economic/reliability problem, not as a safety concern. In connection with a 1998 turnaround involving the two FCU units, the refinery proposed to reengineer the system by replacing the relief valves and eliminating the rupture disks. However, the refinery removed the project from the turnaround, apparently due to budget and schedule pressures.

After BP's acquisition of Amoco in 1999, BP made significant staff reductions and reassignments at the Whiting refinery. As part of these actions, the refinery released the engineer responsible for reengineering the system and did not subsequently reassign or complete the rupture disk upgrade project.

Between 2001 and 2005, the Whiting refinery completed only one work order to replace rupture disks. Each quarterly log sheet dating back to at least April 2004 indicated that the rupture disks had failed.

In early 2005, a review of open work orders conducted by one of the FCU supervisors prompted an inquiry into why the rupture disks were not being replaced. Again, Whiting refinery personnel viewed the situation as an economic/reliability issue, not as a safety issue. The engineering response reinstituted the rupture disk upgrade project.

An engineer involved with earlier efforts to address the rupture disks, who was consulted for recommendations on how to proceed, informed the new engineer assigned to the project that the key hazard presented by the rupture disks was that pressure between rupture disks and relief valves could make the pressure relief system ineffective. However, neither the new project engineer nor others involved in the project adequately understood the hazard. The project engineer and others believed that the hazard was a significant, but not urgent, safety issue.

In August 2005, after completing a management of change review to approve the removal of the rupture disks, the refinery attempted to verify that the rupture disks could be safely isolated from the process. When the valve chosen for the test leaked, the refinery stopped the work.

As a result of the failure to isolate the test valve, the refinery approved a special project to replace the relief valves with corrosion-resistant, soft-seated valves, during an installation scheduled for the second quarter of 2006. Because refinery personnel did not fully understand that the failed rupture disks could disable the pressure relief system, they had no sense of urgency to repair the rupture disks in advance of the scheduled relief valve replacement.

During their review in March 2006, the Panel's technical consultants found the relief valves with the failed rupture disks. The Panel's consultants promptly notified Whiting refinery management of the discovery, and the refinery immediately corrected the condition by removing all the rupture disks on the two FCUs within two days.[1] In addition, because of the serious safety implications of the situation, BP issued a high potential for harm announcement and launched an incident investigation into the root causes.

BP identified the following root causes in its final investigation report (BP Rupture Disk Report):

- "Failure to recognize the significance of and act upon the potential hazard created by not properly maintaining the rupture disk systems designed or completing the planned upgrades to eliminate the rupture disks. This issue has been ongoing for seven years. Individual decisions to defer modifications of the relief system were reinforced by a rupture disk system that was perceived to provide adequate safety protection and not an immediate risk to personnel. . . . The rupture disk protection was difficult to maintain, even though this did not appear to compromise the relief valves (relief valves always operated properly when required)."
- "Failure to follow documented protocol to write work orders and/or replace the rupture disks when operator inspections revealed the rupture disk assemblies were leaking."

In connection with the BP Rupture Disk Report, the Whiting refinery plant manager stated that while the report was complete, both he and the refinery leadership team understood that "[t]here are aspects of the findings that also touch on cultural and behavioural issues. It is beyond the scope of this incident investigation to define actions to address such aspects . . . ."

III. Root Causes that Panel Consultants Identified

While the Panel's consultants generally agreed with BP's factual findings, the Panel's consultants also found that the true root causes were management system breakdowns that the BP internal investigation largely failed either to properly characterize as root causes or to identify in the first place. Based on interviews of key personnel and a review of relevant documents provided by BP, the Panel's consultants identified five root causes: (a) inadequate training/qualification of personnel, (b) inadequate review against technical standards, (c) inadequate operational discipline and attention to detail, (d) inadequate management of change reviews, and (e) lack of an effective management review system.

A. INADEQUATE TRAINING/QUALIFICATION OF PERSONNEL

The Panel's consultants agreed with BP's conclusion that there was a fundamental lack of knowledge about the safety implications of pressure between a rupture disk and a relief valve. Given this lack of knowledge, all the other actions BP personnel took (or failed to take) appeared to be reasonable and logical. However, this lack of knowledge raises the question of why personnel at every level—hourly staff, supervisors and managers—and in every work group—operations, maintenance, engineering, and management—lacked that knowledge. This lack of knowledge points to a breakdown in that portion of the management system that is responsible for ensuring workers have adequate technical knowledge.

B. INADEQUATE REVIEW AGAINST TECHNICAL STANDARDS

Various company standards and the codes referred to in the standards explicitly address the hazard of pressure between rupture disks and relief valves.[2] Over the long history of the rupture disk situation, there were at least two opportunities to consider the rupture disk/relief valve problems during required process hazard analysis revalidations. However, refining personnel overlooked this issue in both cases.

C. INADEQUATE OPERATIONAL DISCIPLINE AND ATTENTION TO DETAIL

Whiting operating staff recorded the quarterly readings of pressure between rupture disks and relief valves. However, they ignored the explicit requirement on the log sheet that a work order be submitted if they recorded non-zero pressures. While BP noted in the BP Rupture Disk Report this breakdown in the work order system, in the opinion of the Panel's consultants, the breakdown was only a symptom, not a root cause. Based on interviews that the Panel's consultants conducted, Whiting operators appeared to believe that it was pointless to write work orders because the repair might only last for a brief time and, as a result, they stopped writing the work orders. Apparently for the same reason, supervisory personnel stopped enforcing the requirement.

D. INADEQUATE MANAGEMENT OF CHANGE REVIEWS

At least two changes occurred during the long period in which the rupture disk situation developed that, if reviewed under a more effective management of change system, should have resulted in appropriate corrective action. First, an effective review of personnel changes that led to the project being "lost" after the 1998 turnaround could reasonably have been expected to result in corrective action. Second, the BP Rupture Disk Report notes that at some point the refinery blocked or plugged vents required between the rupture disks and relief valves, allowing pressure to remain trapped above the rupture disks. Appropriate review of this change also could reasonably have been expected to lead to corrective action.

E. LACK OF AN EFFECTIVE MANAGEMENT REVIEW SYSTEM

The Panel's consultants found no organized system by which a manager or supervisor could identify breakdowns in safety management systems. A periodic review of the relief valve log sheets might have prompted someone to realize there was an ongoing reliability problem (and inquire about the 1998 turnaround project status) and that the work order/repair system had broken down. A management review of the management of change system might have questioned the plugging of the vents or the suspension of the project in 2005 to remove the rupture disks. A management review of the special projects system might have questioned why the refinery did not institute any interim controls until the project to upgrade the rupture disks could be completed (scheduled for the second quarter of 2006), even though the refinery gave the project to upgrade the rupture disks the highest risk ranking in the refinery of all 2006 special projects.

Because BP failed to identify most of the broader systems failures as root causes, BP's proposed corrective actions focused only on rupture disk-specific issues. As a result, in the opinion of the Panel's consultants, the proposed response will do little to prevent future refinery-wide management system breakdowns.

IV. The BP Rupture Disk Report's Proposals for Corrective Actions

While the Panel's consultants concluded that BP's investigation was a good faith effort to identify the root causes of this incident, they also concluded that BP's root cause investigation fell short in two respects. First, the Panel's consultants believe that the items identified as root causes are better classified as "near-root causes" and that the true root causes were the underlying management system failures. Second, BP's investigation failed to pursue some of the factual findings, such as the plugged vents, to their ultimate root causes. As a result, while the Panel's consultants concur with BPs proposed corrective actions, the consultants do not believe the proposed corrective actions will address the underlying root causes.

A. PROPOSED CORRECTIVE ACTION 1.

BP proposed to reevaluate all current applications in which rupture disks protect relief valves across the refinery. The Panel's consultants believe that this proposed corrective action will only address the rupture disks and not the root causes. Whiting refinery recognized the opportunity to upgrade relief valves in 1998, but took no action. In the opinion of the Panel's consultants, this recommendation should be broadened to ensure that opportunities for mitigating process safety risks across the refinery are not "lost" in the system when BP reassigns employees with responsibilities related to operating units (*e.g.*, asset coordinators, project engineers). The undertaking of a "management of organizational change" process when employees leave or are reassigned could address risks associated with such personnel changes. Such a process would involve reviewing all ongoing projects with the specific employee, and then reassigning those projects to others within the organization.

B. PROPOSED CORRECTIVE ACTION 2.

BP proposed to assure that unit rupture disk procedures and checklists are thorough and support safe operations. Again, the Panel's consultants believe that this proposed corrective action does not go far enough in that it will only improve the relief valve checklist. Other checklists should prompt a work order if abnormal readings are noted, and those checklists should be improved in a similar fashion.

C. PROPOSED CORRECTIVE ACTION 3.

BP also proposed to institute training on rupture disk use, design, and maintenance for asset areas that use rupture disks with relief valves. Again, the Panel's consultants believe that this proposed corrective action does not go far enough in that it will only address rupture disks and not broader issues relating to process safety knowledge. Training and education on a broader scope would assist refinery operating personnel to recognize other hazards that exist but that are not obvious, such as not maintaining positive air pressure in buildings in electrically classified areas. The Panel's consultants would recommend a broader training program to assist personnel in recognizing such hazards.

D. PROPOSED CORRECTIVE ACTION 4.

BP proposed an annual audit of the thoroughness/effectiveness of mechanical integrity work processes (rupture disk checklists, relief valve checklists, relief valve testing compliance, critical alarm testing compliance, etc.). Again, the Panel's consultants believe that this proposed corrective action does not go far enough in that it will only address mechanical integrity issues. The Panel's consultants believe that a management review or monitoring process should be implemented to ensure reviews of other elements of OSHA and other process safety standards.

E. OTHER CORRECTIVE ACTIONS

Although not addressed in the BP report, additional corrective actions should be developed, in the opinion of the Panel's consultants, to address the lack of review against technical standards and address the breakdown of the management of change system.

V. Panel Conclusions

The Panel agrees with the conclusions and findings of the Panel's technical consultants relating to the Whiting rupture disk situation, including the general finding that the true root causes point to systemic and management issues beyond the immediate causes cited by BP. These systemic issues included (1) inadequate process safety knowledge and training, (2) failure to follow specified procedures, (3) ineffective management of change reviews, (4) no refinery-level management review system to monitor process safety performance, and (5) inadequate review of practices against both internal and generally accepted external standards.

The Panel believes it is important to note that certain allegations included in the Indiana OSHA citation, discussed earlier in the report, related to rupture disk systems. Specifically, Indiana OSHA found that two rupture disk gauges were not functioning properly and that one rupture disk had failed. Indiana OSHA's discovery came just weeks after the refinery conducted an investigation of rupture disk installations across the refinery in the wake of the discovery of failed rupture disks in the FCUs by the Panel's consultants. BP's swift investigation indicates that, at least initially, BP placed a high priority on addressing newly identified problems with refinery rupture disk systems. Although the Panel has not independently investigated the factual basis for the rupture disk allegations in the citation, the subsequent Indiana OSHA rupture disk discovery raises questions about whether BP identified and corrected the true root cause of the initial near miss, as well as the Whiting refinery's operational discipline and its ability to prevent the recurrence of process safety issues.

---

[1] One rupture disk with the leaking isolation valve was not replaced. Engineering analysis indicated that this rupture disk was not necessary for adequate pressure relief, so it was taken out of service.

[2] *See* American Petroleum Institute, *Sizing, Selection, and Installation of Pressure-Relieving Devises in Refineries, Part I—Sizing and Selection, API Recommended Practice 520* (Washington, D.C.: API Publishing Services, 7th ed. 2000), p. 18 (warning that "rupture disk[s] will not burst if back pressure builds up in a nonvented space between the disk and the pressure relief valve.").

APPENDIX E

TECHNICAL CONSULTANTS' REPORT

ABS Consulting
RISK CONSULTING DIVISION

214-06
GEMS 1544316

Review of Process Safety Management Systems at BP North American Refineries for the BP U.S. Refineries Independent Safety Review Panel

Prepared by:

ABSG Consulting Inc.

in conjunction with

JL McCavit Consulting, LLC

December 2006

ABSG Consulting Inc. • 16855 Northchase Drive • Houston, TX 77060-6008 USA • Tel: 1-281-673-2800 • Fax: 1-281-673-2789
www.absconsulting.com

Disclaimer Notice

ABSG Consulting Inc. (ABS Consulting) and its employees, subcontractors, consultants, and other assigns and JL McCavit Consulting, LLC cannot, individually or collectively, predict what will happen in the future. Both companies have made a reasonable effort, based on the information provided by BP Products North America Inc. (or the BP U.S. Refineries Independent Safety Review Panel), to assess the effectiveness of BP Products North America Inc.'s corporate oversight of safety management systems at its five refineries and its corporate safety culture as provided in the charter of the BP U.S. Refineries Independent Safety Review Panel. However, even if all the assessment findings and observations were addressed, accidents may still occur. Moreover, the actions associated with addressing the findings and observations resulting from this work may subject the refineries' employees or the communities in which the refineries reside to unforeseen or unacceptable hazards. Therefore, all of the assessment team's findings and observations should be reviewed before addressing them to determine if they are in the best interests of BP Products North America Inc., its employees, and contractors and of the communities in which BP Products North America Inc.'s refineries are located. Also, applicable OSHA, EPA, and state regulations are subject to interpretation, and no one can guarantee how they will be interpreted in the future. As a result, neither ABS Consulting nor JL McCavit Consulting, LLC can guarantee that future agency audits will not result in any regulatory citation. Therefore, ABS Consulting and JL McCavit Consulting, LLC accept no liability for any accident or regulatory impact that may occur at any facility assessed by them.

Executive Summary

On March 23, 2005, the BP Texas City refinery experienced an accident that resulted in 15 fatalities and injured over 170 BP employees and contractors. The accident involved a vapor cloud explosion resulting from a release of flammable material from a raffinate splitter tower and the associated blowdown system.

The U.S. Chemical Safety and Hazard Investigation Board (CSB) and other federal, state, and local agencies immediately began an investigation. The CSB subsequently issued to the BP Global Executive Board of Directors an urgent recommendation to commission an independent panel to evaluate the effectiveness of BP Products North America's corporate oversight of safety management systems at its U.S. refineries. BP accepted this recommendation and formed the BP U.S. Refineries Independent Safety Review Panel (Independent Panel) on October 24, 2005.

In January 2006, the Independent Panel retained ABSG Consulting Inc. (ABS Consulting) and JL McCavit Consulting, LLC (collectively, the PSM Review Team) to conduct process safety management (PSM) reviews at all five BP refineries in the United States. This is the final report that the PSM Review Team submitted to the Independent Panel.

This report summarizes the results of the PSM Review Team's assessment of BP's refineries located in Carson, California; Cherry Point, Washington; Texas City, Texas; Toledo, Ohio; and Whiting, Indiana. Four of the refinery reviews were conducted using 2-week visits by five- or six-person teams. The Texas City refinery review differed from the other four refinery reviews. At the Independent Panel's direction, the PSM Review Team relied in part on a 3rd-party audit of PSM systems at Texas City conducted under a Settlement Agreement between BP Products North America, Inc. and the Occupational Safety and Health Administration (OSHA). In all of these reviews, BP personnel gave the PSM Review Team full cooperation in providing access to facilities, records, and people.

The Independent Panel prepared a comprehensive Scope of Work for the process safety reviews, a copy of which is provided as Appendix A. The Scope of Work contemplated a review of the process safety management programs, procedures, actual performance, and process safety culture at the five refineries. In directing the PSM Review Team, the Independent Panel emphasized that the reviews should focus not only on the process safety management systems at each refinery, but also on the actual performance and documentation of performance.

ABS Consulting's project manager, Mr. Steve Arendt, led the Carson and Whiting reviews and participated in the other three refinery reviews. Mr. Walt Frank of ABS Consulting led the Cherry Point and Toledo refinery reviews and participated in the Texas City refinery review. Mr. Jack McCavit, the Independent Panel's technical project manager, led the Texas City refinery review, participated in all of the refinery reviews, and coordinated all reviews with other Independent Panel activities.

Based on the Scope of Work, the PSM Review Team developed a detailed protocol to guide the review. This protocol included conventional OSHA PSM and EPA risk management program (RMP) technical areas as well as additional process safety areas identified by the Independent Panel:

Conventional PSM/RMP Technical Areas

1. Employee participation
2. Process safety information
3. Process hazard analysis
4. Operating procedures
5. Training
6. Contractors
7. Pre-startup safety review
8. Mechanical integrity
9. Safe work practices
10. Management of change
11. Incident investigation
12. Emergency planning and response
13. Compliance audits
14. Trade secrets
15. Risk management program compliance

Additional Process Safety Areas

16. Management leadership, authority, and accountability
17. Process safety measurement
18. Risk-based decision making
19. Conformance with specific industry codes and standards
20. Management of block valves under relief devices
21. Facility siting
22. Other miscellaneous process safety issues

During the reviews, the PSM Review Team developed factual information concerning each refinery's performance in the above-listed technical areas and compared it to the following relevant requirements and guidance:

- OSHA PSM standard (29 CFR 1910.119)
- EPA RMP rule (40 CFR 68)
- BP internal standards, policies, and procedures
- Consensus codes and standards, including appropriate refining industry standards and other recommended and generally accepted good engineering practices
- Guidelines for process safety issued by the Center for Chemical Process Safety and other external organizations

Based on the Scope of Work provided by the Independent Panel, the PSM Review Team reviewed representative aspects of the process safety performance and management systems at the refineries. The PSM Review Team did not attempt to review (1) all units at any particular refinery or (2) all of BP's process safety management programs, procedures, and actual performance against all external guidance, which includes standards, recognized and generally accepted good engineering practices, recommended practices, best practices, and good engineering practices. For this reason, the PSM Review Team did not catalog every potential process safety issue or concern at the refineries. Rather, the PSM Review Team sampled a sufficient number of items to permit the development of a view on the effectiveness of BP's process safety management system.

Based upon its work, the PSM Review Team developed findings for each BP refinery. The team documented a ***finding*** when it found a deficiency that was determined to either (1) broadly exist (i.e., be a systemic problem at an individual refinery) or (2) be of such significance, as a single instance at an individual refinery, that it represented a serious process safety concern. The term serious is used in this report to convey the PSM Review Team's judgment concerning the gravity or significance of the concern; it is not meant to correlate to any legal definition or to have any regulatory connotation.

The PSM Review Team provided the Independent Panel with a preliminary version of its findings for Carson, Cherry Point, Toledo, and Whiting. The Independent Panel subsequently provided the preliminary findings to BP and directed the PSM Review Team to return to the four refineries to clarify for the sites the factual bases of the findings, respond to questions from refinery management, and consider any additional information provided by BP.

Analyzing these findings, additional documents following the refinery visits, and the results of the work at the Texas City refinery, the PSM Review Team then identified 12 "System Findings." A System Finding is a finding identified at multiple refineries that, in the judgment of the PSM Review Team, represents a risk-significant situation with companywide PSM effectiveness implications. The following is a summary of the 12 System Findings relating to BP's five U.S. refineries.

System Finding 1 – Rupture disks under relief valves. BP did not recognize the hazards of pressurized spaces between rupture disks and relief valves and did not evaluate and correct identified deficiencies in a timely fashion. These conditions potentially compromised the effectiveness of the affected pressure vessel relief systems for extended periods of time. (Carson, Texas City, Toledo, and Whiting)

System Finding 2 – Equipment deficiencies. BP did not correct deficiencies in important refinery process equipment in a timely fashion. These deficiencies sometimes existed for years. (Carson, Texas City, and Whiting)

System Finding 3 – Equipment inspections. At all five refineries, BP did not establish appropriate inspection and testing frequencies or meet its internally established frequencies, resulting in extensive backlogs of overdue inspections for important refinery process equipment. Some of these backlogs included hundreds of items overdue for long periods (i.e., years).

System Finding 4 – Facility siting. At all five refineries, BP had some outside operating and maintenance personnel in some refining units occupy permanent buildings that were not designed to withstand overpressures but are located close to refinery processes.

System Finding 5 – Safety shutdown systems. BP has not implemented the industry standard for the design and care of safety instrumented systems (i.e., ISA 84.01) except for two refineries that implemented it on recent projects. Moreover, none of the five refineries had an effective and credible plan to achieve full compliance in a timely fashion.

System Finding 6 – Critical alarms and emergency shutdown devices. BP did not properly bypass or test some important alarms and shutdown devices. (Carson, Cherry Point, Toledo, and Whiting)

System Finding 7 – Action item completion. At all five refineries during the past few years, BP had many process safety-related action items that had not been resolved or implemented in a timely fashion. BP also had many action items that were overdue based on BP's established implementation schedule.

System Finding 8 – Area electrical classification. At all five refineries, BP had instances where the refinery did not meet one or more of industry standards, recommended practices, or good practices with respect to area electrical classification.

System Finding 9 – Compliance audit findings. At all five refineries, BP had deficiencies in process safety audits, including findings that were repeat findings from previous audits or findings that were improperly classified according to importance.
.

System Finding 10 – Fired heaters. BP does not ensure compliance with API's recommended practices regarding the design and operation of fired process heaters, and four of BP's refineries could not otherwise technically establish that the equipment as currently designed meets standards that are at least as stringent. (Carson, Cherry Point, Texas City, and Whiting)

System Finding 11 – Near-miss investigation. All five refineries had one or more deficiencies involving near-miss investigations (i.e., inadequate reporting, improper evaluation and follow-up, or ineffective documentation).

System Finding 12 – Process hazard analyses. BP did not properly evaluate (1) the hazards of its refinery processes with respect to alternate operating modes (e.g., startup and shutdown of major equipment and processes), (2) all the chemical hazards existing in a process (e.g., H_2S), or (3) reasonable worst-case consequences for accident scenarios that were identified. (Carson, Cherry Point, Toledo, and Whiting)

Each of these System Findings represents a significant process safety management weakness within the BP U.S. refining organization. The PSM Review Team recognizes that BP's U.S. refineries have made significant progress in recognizing and correcting their process safety management deficiencies following the Texas City accident. However, the snapshot-in-time technical reviews conducted by the PSM Review Team show that as of the date of those reviews, (1) material deficiencies existed at BP's five U.S. refineries in process safety management and (2) BP had not implemented an effective process safety management system throughout its U.S. refining line organization. In the judgment of the PSM Review Team, there is still much work for BP to do in order to achieve process safety excellence.

Table of Contents

ABS Consulting
RISK CONSULTING DIVISION

List of Tables

1. Introduction

On March 23, 2005, the BP Texas City refinery experienced an explosion and fire that resulted in 15 fatalities and injured over 170 BP employees and contractors. The incident involved a vapor cloud explosion resulting from a release of flammable material from a raffinate splitter tower and the associated blowdown system.[1]

The U.S. Chemical Safety and Hazard Investigation Board (CSB) and other federal, state, and local agencies immediately began an investigation. The CSB subsequently issued to the BP Global Executive Board of Directors an urgent recommendation to commission an independent panel to evaluate the effectiveness of BP Products North America's corporate oversight of safety management systems at its U.S. refineries.[2] BP accepted this recommendation and formed the BP U.S. Refineries Independent Safety Review Panel (Independent Panel) on October 24, 2005.[3]

In January 2006, the Independent Panel retained ABSG Consulting Inc. (ABS Consulting) and JL McCavit Consulting, LLC (collectively, the PSM Review Team) to conduct process safety management (PSM) reviews at BP's refineries in the United States. This is the final report of the PSM Review Team submitted to the Independent Panel.

2. Technical Approach and Project Team

2.1 Technical Areas

The Independent Panel prepared a comprehensive Scope of Work for the process safety reviews to be conducted by the PSM Review Team – a copy of which is provided as Appendix A. The Scope of Work contemplated a review of the process safety management programs, procedures, actual performance, and process safety culture at the five refineries. In directing the PSM Review Team, the Independent Panel emphasized that the reviews should focus not only on the process safety management systems at each refinery, but also on actual performance and documentation of performance.

Based on the Scope of Work, the PSM Review Team developed a detailed protocol to guide the review. This protocol included conventional OSHA PSM and EPA risk management program (RMP) technical areas as well as additional process safety areas identified by the Independent Panel:

Conventional PSM/RMP Technical Areas

1. Employee participation
2. Process safety information
3. Process hazard analysis
4. Operating procedures
5. Training
6. Contractors
7. Pre-startup safety review
8. Mechanical integrity
9. Safe work practices
10. Management of change
11. Incident investigation
12. Emergency planning and response
13. Compliance audits
14. Trade secrets
15. Risk management program compliance

Additional Process Safety Areas

16. Management leadership, authority, and accountability
17. Process safety measurement
18. Risk-based decision making
19. Conformance with specific industry codes and standards
20. Management of block valves under relief devices
21. Facility siting
22. Other miscellaneous process safety issues

The Scope of Work provided by the Independent Panel did not contemplate "wall-to-wall" audits or inspections of BP's five U.S. refineries. The Independent Panel did not view such extensive activities to be necessary to fulfill the Panel's mandate of focusing on the effectiveness of process safety management systems. Instead, the Scope of Work provided by the Independent Panel directed the PSM Review Team to review representative aspects of the process safety performance and management systems at the refineries. The Panel believed that such a representative review would provide an appropriate foundation for conclusions about the effectiveness of BP's process safety management system.

Following these general sampling principles, the depth and breadth of the technical reviews sometimes varied. The PSM Review Team did not attempt to review all units at any particular refinery. In addition, the PSM Review Team reviewed BP's process safety management programs, procedures, and actual performance against selected external guidance, including standards, recognized and generally accepted good engineering practices, recommended practices, best practices, and good engineering practices. Specifically, the PSM Review Team reviewed the adherence by BP's five U.S. refineries with applicable codes and practices relating to (1) safety shutdown systems, (2) area electrical classification, (3) fired heaters, and (4) facility siting.

After the PSM Review Team identified what in its professional judgment represented an area of deficiency based on the sampling of items or a review of existing practice relating to observance of applicable guidance in a particular area, the team members moved on to another aspect of the review. For this reason, the PSM Review Team did not catalog every potential process safety issue or concern at the refineries. Rather, the PSM Review Team sampled a sufficient number of items to develop a view on the effectiveness of BP's process safety management system.

2.2 Relevant Requirements and Guidance

During the reviews, the PSM Review Team developed factual information concerning each refinery's performance in the above-listed technical areas and compared it to the following relevant requirement and guidance:

- OSHA PSM standard (29 CFR 1910.119)[4]
- EPA RMP rule (40 CFR 68)[5]
- BP internal standards, policies, and procedures
- Consensus codes and standards, including appropriate refining industry standards and other recommended and generally accepted good engineering practices
- Guidelines for process safety issued by the Center for Chemical Process Safety[6] and other external organizations

External codes, standards, industry best practices, recommended practices, and other external guidance (collectively, "codes and practices") play an important role in the management of process safety in the United States. Some of these codes and practices have the force of law. OSHA specifically acknowledges the relevance of various industry codes and practices. The OSHA process safety management standard, for example, cites process safety guidance developed by the Center for Chemical Process Safety of the American Institute of Chemical Engineers, the American Chemistry Council, and the American Petroleum Institute. Even where existing codes and practices do not have the force of law, they can provide valuable tools for managing and reducing process risks. Systemic failure to adhere to codes and practices can result in operations being conducted at a higher than necessary risk.

2.3 Review Process

2.3.1 Carson, Cherry Point, Toledo, and Whiting Refineries

The reviews at the Carson, Cherry Point, Toledo, and Whiting refineries occurred during February through June 2006. Each onsite review lasted approximately 2 weeks. During each review, a five- or six-person team evaluated representative process safety systems and practices, consistent with the Scope of Work provided by the Independent Panel, through the following activities:

- Pre-visit conference calls with BP to coordinate visit logistics
- Review of preliminary documentation provided by BP
- Kickoff meeting with refinery leadership, staff, hourly, and employee union representatives (except at Cherry Point where a bargaining unit does not represent employees)
- Presentation by BP of a refinery and PSM program overview
- Orientation tour
- Review of documents
- Walkaround inspections of refinery process areas
- Observations of ongoing work in process areas by BP employees and contractors
- Interviews with BP management, supervision, hourly employees, and contractors
- Daily coordination meetings with refinery personnel to confirm factual information and to review next-day plans
- Closeout meeting with refinery personnel to summarize factual information for findings and other assessment results
- Follow-up visits and conference calls to clarify information

2.3.2 Texas City Refinery

The Texas City refinery review differed from the other reviews. At the Independent Panel's direction, the PSM Review Team relied in part on an audit of PSM systems at Texas City conducted by a 3rd-party consulting firm under a Settlement Agreement between BP Products North America, Inc. and OSHA (the Settlement Agreement Audit).[7]

The PSM Review Team reviewed the work plan for the Settlement Agreement Audit and compared it to the Independent Panel's Scope of Work. Where the Independent Panel's Scope of Work was broader than the work plan for the Settlement Agreement Audit, the PSM Review Team conducted additional field work at the site in June 2006 to address those additional items. Specifically, the PSM Review Team undertook the following activities with respect to Texas City:

- Pre-visit conference calls with BP to coordinate visit logistics
- Review of preliminary documentation provided by BP
- Kickoff meeting with the refinery's Senior Process Safety Consultant
- Presentation by BP of a refinery and PSM program overview
- Orientation tour

- Review of documents
- Walkaround inspections of refinery process areas
- Observations of ongoing work in process areas by BP employees and contractors
- Interviews with BP management, supervision, hourly employees, and contractors
- Coordination meetings with refinery personnel to confirm factual information and to review next-day plans
- Closeout meeting with refinery personnel to summarize factual information and other assessment results
- Follow-up conference calls to clarify information

BP also permitted the PSM Review Team to meet with the Settlement Agreement Audit team, observe its work, and review the resulting report. The PSM Review Team concludes that the Settlement Agreement Audit of the Texas City refinery was thorough and its findings are credible.

2.4 Review Team Members

ABS Consulting's project manager, Mr. Steve Arendt, led the Carson and Whiting reviews and participated in the other three refinery reviews. Mr. Walt Frank of ABS Consulting led the Cherry Point and Toledo refinery reviews and participated in the Texas City refinery review.

Mr. Jack McCavit, the Independent Panel's technical project manager, led the Texas City refinery review, participated in all of the refinery reviews, and coordinated all reviews with other Independent Panel activities. Table 2.1 lists the PSM Review Team members, their process safety technical areas, and the sites where they participated.

Table 2.1 – PSM Review Team, Technical Areas, and Refinery Visit Participation

PSM Technical Areas	J. S. Arendt	W. L. Frank	S. E. Anderson	W. M. Bradshaw	V. E. Brown	J. A. Leonard	D. K. Lorenzo	R. L. Montgomery	L. L. Warren	D. H. Hobbs	J. L. McCavit
Employee participation	✓		✓		✓	✓	✓		✓		
Process safety information			✓	✓		✓	✓	✓	✓	✓	
Process hazard analysis	✓	✓					✓		✓		
Operating procedures	✓				✓						
Training	✓				✓	✓					
Contractors			✓		✓	✓		✓			
Pre-startup safety review	✓	✓				✓			✓		
Mechanical integrity		✓		✓		✓		✓		✓	
Safe work practices			✓	✓	✓	✓		✓		✓	
Management of change	✓	✓				✓	✓		✓		
Incident investigation		✓	✓				✓	✓			
Emergency planning and response			✓			✓					
Compliance audits	✓	✓									
Trade secrets			✓		✓	✓			✓		
Risk management program compliance	✓										
Management leadership, authority, and accountability	✓										✓
Process safety measurement	✓										✓
Risk-based decision making	✓										✓
Conformance with specific industry codes and standards	✓	✓		✓			✓	✓		✓	
Management of block valves under relief devices			✓	✓		✓					✓
Facility siting	✓	✓								✓	
Other miscellaneous process safety issues	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Refinery											
• Carson	L					✓		✓	✓		✓
• Cherry Point	✓	L	✓		✓				✓	✓	✓
• Texas City	✓	✓	✓			✓	✓				L
• Toledo	✓	L	✓	✓			✓				✓
• Whiting	L			✓	✓	✓	✓				✓

L – Refinery Review Leader

3. Discussion of Findings

Based upon its work, the PSM Review Team developed findings for each BP refinery. The team documented a ***finding*** when it found a process safety deficiency that was determined to either (1) broadly exist (i.e., be a systemic problem at an individual refinery) or (2) be of such significance, as a single instance at an individual refinery, that it represented a serious process safety concern. The term serious is used in this report to convey the PSM Review Team's judgment concerning the gravity or significance of the concern; it is not meant to correlate to any legal definition or to have any regulatory connotation.

The PSM Review Team provided the Independent Panel with a preliminary version of its findings for Carson, Cherry Point, Toledo, and Whiting. The Independent Panel subsequently provided the preliminary findings to BP and directed the PSM Review Team to return to those four refineries to (1) clarify for the sites questions about the factual bases of the findings, (2) respond to any questions from refinery management, and (3) consider any additional information provided by BP.

Analyzing these findings, additional documents following the refinery visits, and the results of the work at the Texas City refinery, the PSM Review Team then identified 12 "System Findings." A System Finding is a finding identified at multiple refineries that, in the judgment of the PSM Review Team, represents a risk-significant situation with companywide PSM effectiveness implications. Table 3.1 summarizes the System Findings and cross references them by refinery.

Table 3.1 – Summary of System Findings

Description of System Finding	Carson	Cherry Point	Texas City	Toledo	Whiting
3.1 Rupture disks under relief valves	X		X	X	X
3.2 Equipment deficiencies	X		X		X
3.3 Equipment inspections	X	X	X	X	X
3.4 Facility siting	X	X	X	X	X
3.5 Safety shutdown systems	X	X	X	X	X
3.6 Critical alarms and emergency shutdown devices	X	X		X	X
3.7 Action item completion	X	X	X	X	X
3.8 Area electrical classification	X	X	X	X	X
3.9 Compliance audit findings	X	X	X	X	X
3.10 Fired heaters	X	X	X		X
3.11 Near-miss investigation	X	X	X	X	X
3.12 Process hazard analyses	X	X		X	X

3.1 Rupture Disks Under Relief Valves – Hazard Not Understood or Abated

A rupture disk is a device designed to relieve excessive pressure in a process. When the pressure on one side of the disk exceeds the design limit, which is based on a designated difference in pressures on opposite sides of the disk, the disk bursts or opens, relieving the pressure. Once a rupture disk opens, it cannot reclose.

A relief valve is a pressure relief device that can reclose after opening. While there are different types of relief valve designs, the basic principle is that when the pressure in the equipment exceeds the relief valve's set pressure, the relief valve will open and remain open until the pressure is reduced below the set pressure, after which the relief valve recloses to seal the system.

A common design strategy uses rupture disks in combination with relief valves to prevent damage to the relief valve from exposure to process fluid during normal operation.[8,9] If the system pressure on the process side rises above the rupture disk burst point, the rupture disk will open, exposing the relief valve to the system overpressure. The relief valve will then open to relieve the system pressure. For this design strategy to work properly (i.e., the rupture disk protecting the relief valve until the pressure reaches the disk's bursting point), the rupture disk must not leak or fail prior to the system pressure increase. In a well-designed and maintained system, the space between the rupture disk and the relief valve is normally at atmospheric pressure.

A rupture disk can fail in a number of ways: it can experience a pinhole leak or the rupture disk can prematurely open or burst. If the rupture disk bursts (i.e., fully opens), the relief valve will still operate as intended as long as the process fluid against which it was being protected does not degrade the integrity or operation of the relief valve. On the other hand, if the rupture disk experiences a pinhole leak, the pressure in the space between the rupture disk and the relief valve can equalize with the system pressure. In this situation, the rupture disk will not burst at the system pressure at which it was designed to burst because the rupture disk relies upon the difference in pressures on its opposite sides. If the pressure on both sides is the same due to a small leak, the rupture disk will open only at a pressure much higher than the designed system relief pressure. As a result, the system/vessel may be exposed to a much higher pressure than intended, which is potentially a serious process safety hazard.[10]

For these reasons, it is important to monitor the pressure in the space between the rupture disk and relief valve to determine whether the rupture disk has failed prematurely. It is a recognized good industry practice to continuously monitor and alarm or frequently monitor and log the pressure of the rupture disk/relief valve space. If refinery staff detects a higher-than-intended pressure in the space between the rupture disk and the relief valve, then the situation can be investigated, evaluated, and remedied. While relatively few (less than 1%) of the relief valves in the BP refineries have rupture disks under them, the instances in which vessels have the rupture disk/relief valve combination are nevertheless important because of the potential consequences of a failed pressure relief system. All five refineries had procedures and administrative controls to monitor/log the rupture disk/relief valve space pressures.

As a part of the technical reviews by the PSM Review Team or through reviews conducted by BP after the PSM Review Team visited the Whiting refinery in March 2006, rupture disk/relief valve spaces at Carson, Texas City, Toledo, and Whiting refineries were found to have been pressurized without timely follow-up or corrective action.

A significant example was at the Whiting refinery. At Whiting, the PSM Review Team reviewed quarterly operator logs for the previous 2 years for a single pressure vessel (a fluid catalytic cracking fractionator tower); each such log indicated 7-out-of-8 rupture disks/relief valves reported higher-than-intended pressure in the space between the rupture disk and the relief valve. Despite the elevated pressure in the rupture disk/relief valve space, work orders were not written each quarter to repair the problem as required by BP procedure. Based on refinery records and interviews, the PSM Review Team believes that the refinery operations and maintenance personnel did not understand the hazard/risk significance of a pinhole leak in a disk (i.e., compromising a pressure relief device) even though internal standards clearly defined the issues. As a result, refinery personnel did not correct the problem with appropriate urgency. Instead, they intended to address the problem at a future unit turnaround by changing the metallurgy of the relief valves, thereby eliminating the need for the rupture disks.

After the PSM Review Team found the rupture disk/relief valve issue at Whiting in March 2006, BP followed its High Potential Incident Reporting (HiPo) procedure and alerted the other refineries of the problem.[11] When the PSM Review Team conducted its work at Carson in May 2006 and Toledo in May 2006, both refineries had evaluated all of their rupture disk/relief valve installations in response to the Whiting HiPo. At one or both of the refineries, BP found instances of (1) rupture disk/relief valve spaces with pressure, (2) rupture disk/relief valve spaces with no method of determining if pressure existed, or (3) the pressure of the rupture disk/relief valve space not regularly monitored.

The Texas City refinery did a similar evaluation of rupture disk/relief valve spaces after the Whiting HiPo. Even after Texas City had performed its own evaluation, the PSM Review Team identified a deficiency. On one piece of equipment, pressure gauges indicated that 4 of 11 rupture disk/relief valve spaces had elevated pressure. BP Texas City operations personnel were aware of the condition but had not responded because they believed the pressure gauges were not accurate. When BP Texas City replaced the gauges after the PSM Review Team identified the issue, no elevated pressure was indicated. The refinery allowed the rupture disk/relief valve space to indicate pressure without being certain if the rupture disk/relief valve pressure indication was accurate.

System Finding 1 – Rupture disks under relief valves. BP did not recognize the hazards of pressurized spaces between rupture disks and relief valves and did not evaluate and correct identified deficiencies in a timely fashion. These conditions diminished the effectiveness of the affected pressure vessel relief systems for extended periods of time. (Carson, Texas City, Toledo, and Whiting)

3.2 Equipment Deficiencies – Known Problems Not Corrected in a Timely Manner

Refining process equipment and instrument systems have safe operating envelopes and functional requirements. When process equipment, relief protection, and instrument systems are operating, it is sometimes difficult to know whether the item of equipment or the system is in a degraded condition. For this reason, refineries perform inspections and tests on refining process equipment, control systems, and safety systems to (1) determine their current condition, (2) confirm their continued fitness-for-service, and (3) identify any degraded conditions or incipient failures that warrant correction.

Refineries typically have thousands of equipment items and instruments that undergo regularly scheduled inspections and tests over periods of up to several years. For large vessels or extensive hardware systems (e.g., long piping networks), hundreds of individual inspections may be performed. As a result, a refinery may have hundreds of thousands of individual inspections to be performed during multi-year inspection cycles. When equipment and instrumentation fail or are inspected/tested and determined to be outside of their operating/functional limits, repairs or corrections are required to restore the items. Equipment that operates outside of its design envelope for extended periods increases process risk.

The relevant requirements and guidance for identifying and correcting equipment deficiencies provide that a site should have an effective system to promptly evaluate and appropriately correct deficiencies. Alternatively, the site should impose less-demanding operating conditions on the equipment to ensure the safe operation of the process until the site can correct the deficiency.

The PSM Review Team evaluated the systems for dealing with equipment deficiencies at BP's five U.S. refineries. All the refineries had procedures for identifying and resolving equipment deficiencies, and some refineries had risk-based decision-making approaches for assessing responses to identified deficiencies. All five refineries had management information scorecards for monitoring system performance, and some refineries had deficiency backlog reduction goals as a part of their management/employee performance contracts.

Even though there had been some progress at all refineries in improving the timeliness of correcting equipment deficiencies and reducing backlogs, the PSM Review Team found that a significant percentage of the equipment items sampled at the Carson, Texas City, and Whiting refineries had deficiencies and backlogs on corrective actions.

Carson

- 11 instances where vessel or piping thickness measurements indicated that potentially serious conditions had existed for as long as 3 years
- Seven vessel wall integrity issues that were 3 to 10 years old and four that were older than 10 years

- More than 20 process pipe rack structural integrity or fireproofing issues that were older than 10 years
- Internal inspection reports indicated anomalies for 3 of 11 heaters, vessels, and tanks sampled with no indication whether the anomalies were corrected
- More than 10 work orders for equipment, which BP classified as work to be done on an emergency basis, were awaiting operations approval for more than 2 weeks

Texas City

- 29 vessel or piping thickness measurements were below the safe limits set by codes and practices or BP policy for repair or replacement
- 181 fixed equipment thickness measurement defects were not addressed for as long as 8 years
- 10 rotating equipment items that had vibration levels above the danger setting in the vibration monitoring software
- Seven deficiencies in fire protection systems and equipment

Whiting

- 738 work requests that arose from inspections were past due
- 2,501 (1% of those evaluated by BP) piping thickness measurement calculations indicated potentially unsafe conditions; subsequent to the review by the PSM Review Team, the majority of the items were found by BP either to not be valid or not to be critical

System Finding 2 – Equipment deficiencies. BP did not correct deficiencies in important refinery process equipment in a timely fashion. These deficiencies sometimes existed for years. (Carson, Texas City, and Whiting)

3.3 Equipment Inspections – Past Due or Inappropriate Frequencies

A site should monitor the condition of refinery process equipment, instrumentation, and safety systems to promote sustainable fitness for service. This monitoring typically includes internal and external visual inspections, non-destructive testing, or functional testing. Some of this testing also involves predictive analysis of future performance based on existing readings, such as vibration or oil analysis on rotating equipment done primarily for reliability assurance reasons. While consensus codes and standards developed by various organizations such as the American Petroleum Institute (API) and the American Society of Mechanical Engineers (ASME) generally provide guidance on the frequency of this inspection and testing, a refinery has some flexibility in determining the monitoring frequencies and methods. Based upon the PSM Review Team's experience, most refineries augment the guidance from codes and standards with plant-specific experience to determine inspection and testing frequencies. Some refineries in the United States have begun to adopt risk-based inspection principles to optimize these frequencies.

Once a site specifies the frequencies for its inspection and testing program, the site should reliably execute the program at the designated frequencies to support the safe operation of the refining processes. Not performing inspections and tests in a timely fashion means the refinery is less able to monitor the fitness-for-service condition of its processes. For example, equipment that begins to degrade more quickly than previously predicted or that experiences a hidden failure may go undiagnosed for an extended period, thus increasing the risk of process operation. In addition, not following specified inspection and testing intervals may diminish the overall effectiveness of a site's process safety management systems by sending a signal to the workforce that it is not important to follow established requirements.

All five BP refineries had extensive inspection and testing programs implemented by qualified BP staff and augmented by qualified contractors, as necessary. In addition, all five refineries had inspection scorecards maintained typically by the Inspection, Maintenance, or Reliability functional departments to highlight the status and performance of the inspection and testing program. Nonetheless, the PSM Review Team found extensive inspection and testing backlogs for fixed equipment, rotating machinery, and instrumentation systems at all five refineries. Sometimes these backlogs reflected inspections that were years past due. The following are examples of inspection and testing deficiencies at the refineries:

Carson

- 29 relief valves were overdue for testing
- 29 pressure vessels were overdue for inspection
- 22 piping systems were overdue for inspection
- Quarterly preventive maintenance and vibration analysis were overdue on several major machinery items

Cherry Point

- Several vessels and numerous piping inspections were overdue
- Documentation of external vessel and piping inspections was incomplete
- Relief valve testing frequencies were inadequate, as explained below

At Cherry Point, data from the refinery supplied to the Independent Panel indicated nearly zero overdue inspections for vessels/piping and relief valves. For the reasons discussed below, the PSM Review Team believes that information does not accurately reflect conditions at Cherry Point.

Cherry Point uses a software system (called PCMS) to document relief valve testing intervals. The documented test intervals for many relief valves were initially 2 or 3 years. The refinery subsequently changed, in a single step, most of the relief valve test intervals to 8 years, which is the maximum allowed by BP policy. Cherry Point's inspection and testing procedure does not allow an extension of an inspection schedule to more than double the previous test interval. By extending the scheduled intervals in

PCMS to 8 years, the refinery failed to follow its written inspection and testing procedure.

In practice, the refinery does not rely on the schedules established in PCMS. Cherry Point instead determines relief valve inspection intervals based on turnaround schedules. Refinery personnel use their individual judgment to evaluate the need for inspecting individual relief valves prior to a turnaround and then develop a turnaround inspection work list. Although the individuals making these judgments are very knowledgeable, the PSM Review Team has significant concerns regarding this practice, which has inherent limitations. The team identified several examples where relief valve inspection data repeatedly indicated a failed relief valve, but the inspection schedule was not changed to require inspections on a more frequent basis.

The PSM Review Team believes that this practice makes it more likely that the refinery will fail to inspect a relief valve and not know it. A relief valve could be missed or consciously omitted by the people making the turnaround schedule, and the valve would still not show that it is past due for inspection because it would still satisfy the default 8 year frequency in PCMS.

The PSM Review team does not believe that establishing testing frequencies based on turnaround schedules conforms to BP policies or good engineering practices.

Texas City

- 384 pressure vessels, storage tanks, piping, relief valves, rotating equipment, and instruments were overdue for inspection in six operating units evaluated
- Numerous heat exchanger tube thickness measurements were not taken

Toledo

- Based upon a review of the past 2 years of records, nearly all of the rotating equipment had at least one instance of overdue quarterly vibration analysis
- Instrument test intervals are based on turnaround schedules and not on an established frequency or on observed equipment condition

Whiting

- 20% of over 250,000 thickness measurement locations were past due for inspection, although many locations were subsequently determined by BP to not be needed or were not critical
- 20 relief valves were past due for inspection
- About 50% of small rotating machinery (pumps) were overdue for vibration analysis
- No established management practice existed to authorize variances in inspection schedules

System Finding 3 – Equipment inspections. At all five refineries, BP did not establish appropriate inspection and testing frequencies or meet its internally established frequencies, resulting in extensive backlogs of overdue inspections for important refinery process equipment. Some of these backlogs included hundreds of items overdue for long periods (i.e., years).

3.4 Facility Siting – Occupied Buildings in Hazard Zones

Refineries that process volatile hydrocarbons face the hazard of explosions and fires. The refining and chemical manufacturing industries have experienced major accidents that resulted in damage to occupied buildings near the explosion (e.g., process control rooms, operator shelters, maintenance shops) and injuries and fatalities to occupants. These accidents led OSHA to require consideration of facility siting when assessing process hazards under the PSM standard.

The API subsequently published a facility siting recommended practice (RP 752) providing a methodology for evaluating the hazards associated with process plant buildings.[12] The Center for Chemical Process Safety (CCPS) has also published additional guidance on how to conduct such a facility siting study using recognized consequence models, assumptions, and data.[13] Taken together, these publications propose (1) evaluating the risk to process plant building occupants from potential impacts like fires, explosions, or toxic releases and (2) taking steps to reduce identified risks (e.g., imposing occupancy criteria, strengthening existing buildings, or constructing new buildings that meet certain design criteria).

As a performance-oriented regulation, the PSM standard does not (1) impose a specific methodology for evaluating facility siting, (2) define a level of unacceptable risk, or (3) require a company to take specific steps to mitigate identified risks. OSHA, however, expects companies to follow reasonable and acceptable methodologies in evaluating facility siting. For this reason, many companies subject to the PSM standard rely on API RP 752 or the CCPS facility siting guidelines.

The PSM Review Team evaluated the facility siting practices at all five BP refineries – both for temporary portable buildings and for permanent buildings. The PSM Review Team found that all five refineries met OSHA's requirements for facility siting by conducting facility siting studies (and updating them) in accordance with API RP 752.

In addition, the team noted that since the Texas City accident all five refineries had reevaluated the location of portable trailers in accordance with a new BP Engineering Technical Practice.[14] BP has relocated all of the trailers from the zones representing the highest hazard. BP plans to complete this process for the remaining zones by the end of 2006. The PSM Review Team commends BP for moving expeditiously in response to facility siting issues on temporary buildings identified after the Texas City accident. The PSM Review Team understands that BP is developing a new Engineering Technical Practice on the construction of new permanent buildings.

Notwithstanding BP's prior implementation of recommended practices and the actions taken by BP in response to Texas City, the PSM Review Team identified additional steps that, in the judgment of the PSM Review Team applying good engineering practices, BP should take to further reduce the facility siting risk to personnel. Specifically, the PSM Review Team identified some permanent buildings at all five refineries that are inside hazard zones and were not designed to effectively protect the buildings' occupants in the event of an explosion. In recognition of the hazard associated with potential explosions, the refineries had relocated control rooms into new structures that were either located some distance from the refining process area or designed to be blast-resistant. These control rooms are staffed with process board operators, refinery operation supervision, and engineers.

However, some outside operating and maintenance personnel in some units use offices in the original control rooms that remain in the process areas. Because buildings such as these were not designed to withstand explosions, the PSM Review Team considers it a good practice to restrict their use even by essential operating personnel. The PSM Review Team recognizes that BP has taken steps to secure some buildings and prevent their use, but it appears that these steps are not always effective.

The PSM Review Team did note that the Cherry Point, Texas City, and Toledo refineries were making a substantial effort to replace these process area operator shelters with blast-resistant structures. However, it appeared that it would be several years before this activity would be completed at all five refineries. In the judgment of the PSM Review Team, the pace at which these situations are being corrected is too slow.

System Finding 4 – Facility siting. At all five refineries, BP had some outside operating and maintenance personnel in some refining units occupy permanent buildings that were not designed to withstand overpressures but are located close to refinery processes.

3.5 Safety Shutdown Systems – Nonconformance with ISA 84.01

Refinery process units have important instrumentation systems intended to detect process upsets and then safely shut down equipment prior to reaching unsafe conditions. These systems are usually designed with multiple layers of protection using redundant and highly reliable components. These safety systems typically remain dormant until an authentic process upset occurs, at which time they act to protect the process by putting it into a safe condition. Because these instrumentation systems are dormant, it is difficult to determine at any particular time whether they are fully functional. As a result, it is important to perform functional testing of these safety systems throughout their operational life to ensure dependable operation when they are needed.

Experience has shown that it is important to consider the entire "life cycle" of a safety system – taking care to properly design it, construct it, operate it, and maintain it – all with documented evidence of the design of the system and its associated care. In 1996, The Instrumentation, Systems, and Automation Society (ISA) issued an industry consensus standard to outline the life-cycle care of instrumented safety systems (ANSI/ISA 84.01-96).[15] OSHA considers ISA 84.01 to be a recognized and generally accepted good engineering practice under the performance-based requirements of the PSM standard. ISA published an amended version of this standard in 2004 (ANSI/ISA 84.01-04).[16]

In 2003, BP developed a series of Engineering Technical Practices (ETPs) to provide guidance concerning the application of ISA 84.01.[17] Based on the review by the PSM Review Team, none of BP's five U.S. refineries had a comprehensive plan for conforming to ISA 84.01, and only Toledo and Cherry Point have implemented it for recent projects. It is notable that one refinery (Whiting) did not implement ISA 84.01 for its newest process — a diesel hydrotreating unit scheduled for startup in 2006.

It has been 10 years since ISA 84.01-96 was published. The PSM Review Team believes that BP has not implemented this standard in a timely manner.

Discussion with BP refinery instrumentation subject matter experts indicated that it might be another 10 years before ISA 84.01 would be fully implemented in the BP U.S. refineries. The PSM Review Team believes that it is feasible and reasonable for BP to expedite ISA 84.01 implementation and complete it at a much faster pace.

System Finding 5 – Safety shutdown systems. BP has not implemented the industry standard for the design and care of safety instrumented systems (i.e., ISA 84.01) except for two refineries that implemented it on recent projects. Moreover, none of the five refineries had an effective and credible plan to achieve full compliance in a timely fashion.

3.6 Critical Alarms and Emergency Shutdown Devices – Bypassing Practices and Overdue Tests

Refining processes have instrumented control systems that monitor process parameters; some of these parameters have associated alarms and serve interlock or safety shutdown functions. Operators must sometimes bypass or temporarily render these alarms and emergency shutdown devices (ESDs) inoperative so they can be tested to ensure dependable operation or to repair defective components. Because the process unit typically remains in operation while these alarms or ESDs are temporarily out of service, the ability to monitor the process units during this period for possible process upsets or possible need for shutdown of the process is diminished. To address this temporary condition, a site typically operates the process at a reduced production rate or provides for manual operator intervention via a procedure/administrative control).

The PSM standard addresses these issues as temporary changes under the management of change (MOC) element. In addition, many facilities have a system in place to control the bypassing of critical alarms, interlocks, and ESDs, particularly if done outside of the normal MOC procedure at a facility. In either case, it is important for a site to (1) minimize the bypass time, (2) communicate awareness of the degraded operational safety condition to all who need to know, and (3) keep records documenting the rationale for, and confirming the restoration of, the bypassed components.

Based upon their sampling done at each of the five BP U.S. refineries, the PSM Review Team determined that Carson, Cherry Point, Toledo, and Whiting had insufficient procedures or did not execute established procedures for bypassing critical alarms, interlocks, and ESDs. In addition, numerous instances existed where functional testing of these systems was overdue, increasing the probability that the systems will not operate when called upon.

Carson

- 226 critical alarms and ESDs were overdue for testing
- Bypassing of numerous alarms was not properly documented
- Written procedures did not exist for testing of certain types of interlocks and critical alarms

Cherry Point

- Improper control of bypassing of relief protection on pressure vessels and other safety systems
- Records of proper bypasses were not maintained
- Four instrumented shutdown systems were past due for testing, having been automatically delayed for a deferred turnaround

Toledo

- Procedures for testing critical alarms were inadequate; a written procedure had been developed to support periodic testing for only one of seven critical alarms that were selected randomly by the PSM Review Team for sampling
- Critical analyzer testing procedures did not contain specific pass/fail limits

Whiting

- Several critical alarms were improperly (permanently) bypassed using a temporary change review procedure
- Temporary changes involving critical alarms were not audited per refinery policy
- Numerous critical alarm and interlock testing procedures were inadequate

System Finding 6 – Critical alarms and emergency shutdown devices. BP did not properly bypass or test some important alarms and shutdown devices. (Carson, Cherry Point, Toledo, and Whiting)

3.7 Action Item Completion – Deadlines for Correction Are Often Too Long; Action Items Are Often Past Due

Sites generate process safety action items from a variety of sources — typically a process hazard analysis (PHA), incident investigation, audit, or other safety review. Implementing action items is a critical step in the process of improving process safety.

Not implementing action items or taking too long to complete them limits the value of the analysis activity and potentially increases the risk of process operation. It is common for refineries to have hundreds of active action items.

Under the PSM standard, a site must promptly implement such action items and track the item to completion. Although the time allowed for implementation is generally at a site's reasonable discretion, the site should adhere to the schedule once it is established unless there are compelling technical reasons for not doing so. In addition, a site should consider temporary measures to mitigate the hazard for those action items requiring long implementation times, such as action items where equipment must be procured. In any event, a site should document action item implementation.

The PSM Review Team found that all five refineries over the past few years had (1) significant numbers of action items that were not completed within a reasonable period of time and (2) backlogs of overdue action items – some as long as many months or years overdue.

For example, at the time of the Carson refinery review by the PSM Review Team in May 2006, about half of the PHA action items at Carson from 2001-2004 remained open. In addition, action items from facility siting and human factors checklists used in PHAs were not consistently tracked and implemented. Over one-third of the resolutions/corrective actions from four sampled initial incident reviews were not documented.

At Cherry Point, a review of 2002 and 2005 audit reports and action item follow-up records showed many audit action items that were overdue and, in the judgment of the PSM Review Team, not being completed as soon as possible. Moreover, Refinery Process Safety Committee minutes for the period highlighted a history of action items that were not completed according to schedule or within a reasonable period of time. An intense focus in 2005 reduced the action item backlog to zero.

At Toledo and Whiting, there were many action items during 2001-2005 that did not appear to be implemented as soon as possible (as required by the PSM standard), and some action items were unresolved for more than 1 year. At Whiting, not all incident investigation action items were tracked to completion.

Carson had deficiencies in action item closure documentation in that action items were closed based on the development of a plan to implement, rather than the actual completion of the item implementation.

All five refineries had made reduction of action item backlog a priority through the use of action item metrics or scorecards, and significant progress had been made. Nonetheless, at the time of the refinery visits, significant numbers of overdue action items remained at some refineries.

System Finding 7 – Action item completion. At all five refineries, over the past few years, BP had many process safety-related action items that had not been resolved or implemented in a timely fashion. BP also had many action items that were seriously overdue based on BP's established implementation schedule.

3.8 Area Electrical Classification – Out-of-Date Drawings, Unpressurized Structures and Enclosures with Inadequate Gas Monitoring, and Uncontrolled Ignition Sources

OSHA's PSM standard requires a facility to maintain process safety information for covered processes, including information regarding area electrical classification. One basis for this requirement is that ignition sources in refinery areas where flammable vapor clouds can form represent a hazard that a site should control to reduce the risk of fires and explosions.

Various organizations have published recommended practices, codes, and standards for controlling the design and placement of electrical devices in such areas, including API and the National Fire Protection Association (NFPA). These guidance documents provide guidance about (1) classifying areas according to the potential for formation of flammable vapor clouds, (2) restricting or controlling the types of electrical devices that are allowed in the classified areas, and (3) addressing the design of structures and ventilation systems within classified areas. Refinery buildings and equipment enclosures subject to such standards include control rooms, operator shelters, motor control centers, computer rack rooms, instrument panels, and analyzer boxes.

At all five refineries, the PSM Review Team observed instances where the refinery did not conform to area electrical classification guidance contained in API Recommended Practice 500 or National Fire Protection Association Standard NFPA 496.[18,19] These instances included (1) rooms and enclosures where the ventilation and pressurization systems and seals were out of service or ineffective, (2) inoperative or inadequate flammable gas detection in rooms/enclosures, and (3) outdated electrical area classification drawings that inaccurately depicted classified area restrictions.

The PSM Review Team also observed uncontrolled vehicle access in electrically classified areas. Although API Recommended Practice 500 does not explicitly address vehicle access in such areas, the PSM Review Team considers internal combustion engines in vehicles as potential ignition sources. Some companies develop and implement restrictions on vehicle access to areas in close proximity to process units, including plant roadways, with reference to electrical classification. The PSM Review Team considers this to be a good engineering practice.

System Finding 8 – Area electrical classification. At all five refineries, BP had instances where the refinery did not meet one or more of industry standards, recommended practices, or good practices with respect to area electrical classification.

3.9 Compliance Audit Findings – Repeat Findings, Inadequate Corrective Action, and Improper Assessment of Finding Significance

Process safety management systems should undergo periodic audits (normally at least every 3 years). These audits seek to determine whether the PSM program in place is adequate and is functioning as intended. PSM audits typically use a process very similar to the one that the PSM Review Team used – a thorough evaluation of all relevant PSM elements across a representative sample of refinery process areas. The audit team develops findings regarding PSM procedures and practices based on records review, field and work observations, and interviews. The PSM Review Team found that BP's PSM audit practice was to perform audits of the U.S. refineries using BP employees external to the site to promote auditor independence. The BP auditors typically were PSM subject matter experts or operations personnel from other BP facilities, including other refineries and BP sites.

The typical result of a PSM audit is a list of findings or process safety management deficiencies that a refinery should correct. Audits can generate numerous findings. The PSM standard and good industry practices require that once audit findings have been made, (1) a plan of action should be developed promptly to address each finding and (2) remedial actions be scheduled for completion in a timely fashion and tracked to completion. In the experience of the PSM Review Team, timeliness of audit finding corrective actions is typically measured in weeks or months – not in years.

The PSM Review Team evaluated the available evidence from the previous two PSM audits at each refinery. The PSM Review Team interviewed the leader of the BP audit teams that had conducted the previous audits. The PSM Review Team also had access to the audit reports and the finding resolution and corrective action documentation.

The PSM Review Team observed that each of the five BP refineries had serious weaknesses in its PSM audit and corrective action process. In particular, after reviewing the two previous PSM audits from each refinery, the PSM Review Team found that Cherry Point, Texas City, Toledo, and Whiting each had several types of findings that were chronic in nature, such as equipment deficiencies, overdue inspections, and action item completion. That is, the same finding occurred in two or more sequential PSM audits, indicating that the corrective action taken to address the finding was ineffective.

In addition, the PSM Review Team believes that the factual circumstances and evidence for several of its findings at the Whiting and Toledo refineries existed during at least one prior BP PSM audit but were not identified in the previous audit. This raises questions regarding the level of detail or thoroughness of the audit with respect to those issues (System Findings in Sections 3.1, 3.4, 3.5, 3.8, 3.10, and 3.12). Moreover, the PSM Review Team noted that BP used a finding classification system to prioritize action based upon whether the finding represented a possible gap in compliance with applicable regulations or BP standards (Priority 1, which were reported to BP's Global Refining Leadership) or whether it was a lesser PSM practice weakness reflecting an opportunity for continuous improvement in process safety performance (Priority 2, which were not reported higher in the BP organization and were managed solely at the refinery). In the judgment of the PSM Review Team, several prior findings at Carson, Toledo, and Whiting were incorrectly classified as lesser (Priority 2) items instead of as regulatory compliance or BP policy (Priority 1) issues.

System Finding 9 – Compliance audit findings. At all five refineries, BP had deficiencies in process safety audits, including findings that were repeat findings from previous audits or findings that were, in the judgment of the PSM Review Team, improperly classified according to importance.

3.10 Fired Heaters – Nonconformance with API Standards

Fired heaters are a common energy source for most refining process units. The refining industry has experienced heater fires and explosions that have prompted industry organizations to develop design, operating, and maintenance practices for these units. The American Petroleum Institute (API), for example, has several standards and recommended practices on fired equipment design, operations, testing, and preventive maintenance, including API Recommended Practice 556 covering instrumentation and control system requirements for burner management systems.[20,21]

Legacy BP companies (e.g., Amoco and ARCO) had developed internal standards for fired heaters, but the four legacy refineries (i.e., Carson, Cherry Point, Texas City, and Whiting) have not kept them up to date since being acquired by BP by ensuring those internal standards reflected changes in external standards such as API Recommended Practice 556. BP has developed an Engineering Technical Practice and internal guidelines for fired heaters, and a handbook for furnace and boiler firing.

The PSM Review Team found that the refineries had not implemented the requirements of these internal BP standards. In addition, fired heaters at Carson, Cherry Point, Texas City, and Whiting generally did not comply with API RP 556. Also, the various refinery technical staffs could not otherwise technically establish that the equipment as currently designed meets standards that are at least as stringent as those established by API.

BP is developing its own Process Safety Minimum Expectation (PSME) for fired heaters that is expected to reflect API recommended practices. Refinery personnel also indicated that some recent fired heater installations complied with the anticipated requirements of the new PSME.

System Finding 10 – Fired heaters. BP does not ensure compliance with API's recommended practices regarding the design and operation of fired process heaters, and the refineries could not otherwise technically establish that the equipment as currently designed meets standards that are at least as stringent. (Carson, Cherry Point, Texas City, and Whiting)

3.11 Near-miss Investigation – Inadequate Reporting, Analysis, or Corrective Action

A near miss is an event in which an accident involving property damage, environmental impact or loss of life, or an operational interruption, could have resulted if circumstances had been slightly different. In other words, a near miss provides a valuable opportunity to learn from deficiencies or other management system weaknesses that could help avoid possible future accidents.

The OSHA PSM standard and EPA RMP rule require the investigation of incidents that result in or could reasonably have resulted in a catastrophic release (so called near misses).[22,23] All industry standards and guidance on incident investigation speak to the importance of recognizing, reporting, evaluating, and learning from near-miss events.

All five BP refineries had incident investigation programs and procedures. Typically, a refinery would consider the severity of each reported incident and apply the appropriate level of investigation. Such a "tiered investigation" approach based on severity is typical throughout industry. BP had two documented management practices that addressed near-miss events: (1) the common refinery incident investigation procedures that require the reporting and investigation of near-miss events and (2) the High Potential Incident Reporting (HiPo) procedure.

The HiPo procedure requires BP personnel to report incidents or near misses where the most serious probable outcome is a Major Incident. A Major Incident is defined as an incident involving any of the following:

- A fatality associated with BP operations
- Multiple serious injuries
- Significant adverse reaction from authorities, media, non-governmental organizations, or general public
- Cost of accidental damage exceeding U.S. $500,000
- Oil spill of more than 100 barrels, or less if at a sensitive location (1 barrel = 159 liters = 42 U.S. gallons)
- Release of more than 10 metric tons (22,000 lb) of a classified chemical

These HiPo events and lessons learned are then communicated across BP's refineries so that all facilities can learn and prevent similar future incidents. Under BP's HSE framework management system, reports of HiPo incident are also distributed to, among others, the business group vice president, and the Group vice president of HSE.

Despite these management practices, based on its sampling of incident and near-miss investigations the PSM Review Team found deficiencies in the near-miss investigation system at four of the five refineries. At the Carson refinery, the PSM Review Team identified 9-out-of-10 sampled closed incident investigation reports that did not specify the root causes or contributing factors. At the Cherry Point refinery, the PSM Review Team found several instances among the sampled investigation reports where the potential consequences of near misses had been underestimated, resulting in the events receiving a lower classification and, consequently, less rigorous investigation. Also, at Cherry Point the PSM Review Team found that near-miss investigation recommendations were sometimes not provided, did not address all causal factors, or were not tracked and documented.

The PSM Review Team observed that the incident type/scope language in the Toledo refinery incident investigation procedure did not explicitly address the need to investigate near-miss-type events for PSM compliance purposes. Finally, at the Whiting refinery, the PSM Review Team found that only two PSM incidents had been reported during the past 5 years, confirming interview statements that near-miss events were not being reliably classified as PSM incidents and given the proper level of investigation. The PSM Review Team concluded that BP was systemically missing opportunities to learn from near misses.

System Finding 11 – Near-miss investigation. All five refineries had one or more deficiencies involving near-miss investigations (i.e., inadequate reporting, improper evaluation and follow-up, or ineffective documentation).

3.12 Process Hazard Analyses – Failure to Identify Hazards of Chemicals and Operating Modes

The primary tool for formally understanding risks arising from the refining processes is a process hazard analysis (PHA), which is a qualitative study to evaluate and identify design and operational process safety weaknesses. PHAs should address several technical issues, including an evaluation of the hazards of the process under consideration, including all chemical hazards for all significant process operating modes including startup.[24,25] The results from PHAs provide valuable opportunities for management to take appropriate and timely action to control the identified risks. Under the PSM standard, a site must update or revalidate PHAs at least every 5 years.

All five BP refineries had active PHA programs, and all PHA reports reviewed were completed on schedule. However, based on items sampled at the refineries the PSM Review Team found three important weaknesses in PHA programs at multiple refineries.

At the Toledo and Whiting refineries, the PSM Review Team found that sampled PHAs did not adequately consider the hazards of the process associated with other than normal operation. For example, hazard scenarios involving failures of equipment during startup were not considered, such as startup of a fired heater. The PHAs also did not evaluate hazard scenarios during alternate feed circulation schemes. As a result, (1) the relevant refineries may not have a complete view of the risk involved with operating the process units and (2) safeguards may be less than adequate for the process hazards, equipment failures, or process upsets that may occur during other than normal operation.

At the Carson refinery, 6 of 11 sampled PHAs did not fully consider all process chemical hazards. For example, at the Carson refinery, a unit included a process to remove hydrogen sulfide (H_2S), which occurs through processing crude oil containing sulfur, from water. However, the PHA report for the unit did not address the hazards of H_2S for that process, which are well known within the refining industry.

At the Carson, Cherry Point, and Toledo refineries, the PHAs did not evaluate the reasonable worst-case consequences of the identified hazard scenarios. The OSHA PSM standard and EPA RMP rule require that PHA teams evaluate not only the engineering and administrative controls but also the consequences of failure of those controls.[26] The PSM Review Team found that PHA teams at these three U.S. refineries assumed that some safety systems worked instead of assuming that the engineering and administrative controls providing active safeguards did not work. As a result, these PHAs probably did not adequately evaluate the risk significance of many hazard scenarios.

System Finding 12 – Process hazard analyses. BP did not properly evaluate (1) the hazards of their refinery processes with respect to alternate operating modes (e.g., startup and shutdown of major equipment and processes), (2) all the chemical hazards existing in a process (e.g., H_2S), or (3) reasonable worst-case consequences for accident scenarios that were identified. (Carson, Cherry Point, Toledo, and Whiting)

4. Overall Conclusions

Each of these System Findings represents a significant process safety management weakness within the BP U.S. refining organization. The PSM Review Team recognizes that BP's U.S. refineries have made significant progress in recognizing and correcting their process safety management deficiencies following the Texas City accident. However, the snapshot-in-time technical reviews conducted by the PSM Review Team show that as of the date of those reviews, (1) material deficiencies existed at BP's five U.S. refineries in process safety management and (2) BP had not implemented an effective process safety management system throughout its U.S. refining line organization. In the judgment of the PSM Review Team, there is still much work for BP to do in order to achieve process safety excellence.

Appendix A – Scope of Work for BP Independent Safety Review Panel Process Safety Consultant

The Panel envisions a review procedure that includes one or more visits to each refinery by a team of people who will review the relevant process safety documents (some of this could be done off site ahead of the visit) and interview a cross section of refinery employees, including management, process safety professionals, operating and maintenance supervision, and front line operating and maintenance personnel. While the Panel wants to ensure that the refinery has the appropriate process safety management systems in place, it is equally concerned with ensuring that these are not merely paper systems and understanding how accurately they represent the actual operation of the refinery. ***The Panel believes at this point that its goals can be achieved to a large degree through judicious questioning and review of representative systems and documents rather that attempting a complete audit of all the facilities and documentation at each of the five refineries.***

1. The consultant will work with the Panel and its staff to
    a. review process safety management programs, procedures, actual performance, and process safety culture at all five BP North America refineries, and
    b. compare them to regulations and industry best practices as described by
        i. the OSHA Process Safety Management standard,
        ii. the EPA Risk Management Program requirements,
        iii. appropriate API standards and other recommended practices including recognized and generally accepted good engineering practices, and
        iv. publications such as those of the Center for Chemical Process Safety describing process safety management systems.
2. The review must specifically address all of the elements described in the relevant process safety management standards and other guidelines, and also any specific requirements outlined in BP corporate, BP worldwide refining, or BP North American standards and guidelines. This includes, for example:
    a. Process safety information
    b. Process hazard analysis, including hazard identification and risk management systems
    c. Operating procedures
    d. Training (at all levels, including operators, maintenance personnel, engineers and technical personnel, and managers)

e. Mechanical integrity and maintenance programs, including compliance with standards for safety instrumented systems (ISA S84.01, IEC 61508, 61511)

f. Management of change

g. Capital project process safety reviews, including pre-startup safety reviews

h. Facility siting studies

i. Incident and near miss reporting, investigation, and follow up

j. Emergency response and planning, including training and exercises

k. Process safety performance measurement, auditing, and follow up

l. Systems to monitor follow up on process safety recommendations from all sources, and document and communicate actions taken

3. The focus of the review should be on process safety management systems at each refinery and on actual performance and documentation of performance. Some specific items to be addressed include:

    a. Process safety management organization and responsibility at the refinery

        i. Process safety management expertise and authority

        ii. Line management responsibility, accountability and commitment to process safety management and accountability at all levels of the organization

        iii. Process safety performance measurement

        iv. Management guidance in regard to process risks or potential accident consequences that are unacceptable at the facility

        v. Monitoring system(s) in place to assure line management that process safety management systems are performing appropriately

    b. Spot checks of actual records that document that the process safety management requirements are actually being followed adequately. For example, such spot checks would address:

        i. PHA quality, including follow up on recommendations

        ii. Quality of the estimates of offsite consequences to the public and the environment that are reported to EPA under RMP

        iii. Quality and timeliness of equipment inspection and mechanical integrity actions and reports

        iv. Conformance with reporting requirements in regard to process accidents that are reportable to EPA under the RMP regulation

v. Safety instrumented system design, documentation and maintenance and testing records

vi. Incident reports and near miss reports, including investigations and follow up actions

1. Clear definition of process safety incidents that must be reported
2. Understanding of process safety incident definition
3. Willingness to report process safety incidents
4. Appropriate investigation methodologies
5. Investigation reports focus on causes that can be corrected, not on blame
6. Investigation reports define root causes and identify recommendations that will resolve the root causes
7. Follow up and communication of actions
8. Process safety incident reporting and measurement system
9. Periodic evaluation of all process safety incidents to identify common causes that need additional attention
10. Evaluation of the quality of incident investigations, and training of the investigation facilitators
11. Inclusion in incident reports of specific lessons learned and clear recommendations for preventing similar incidents in the future
12. Evaluation of systems, processes and procedures for sharing between refineries lessons learned as reported in incident reports and near-miss reports

vii. Operating procedures

1. Up to date and accurate
2. Include critical safety parameters and consequences of deviation
3. Actually used

viii. Engineering standards

ix. Management of change

1. Types of change defined, and appropriate review techniques specified
2. Include organizational changes

3. Understanding and recognition of change at the level where changes occur
4. MOCs are written when changes are made that are not replacement in kind
5. Changes are implemented following appropriate authorization
6. Follow up on actions

x. Training – at all levels
   1. Operator training and certification
   2. Refresher training
   3. Management understanding of the process, qualification to make critical process safety decisions

xi. Emergency response measures for coping with on-site and off-site accident impacts

xii. Audits and reviews
   1. Frequency and methodology for process safety audits
   2. Expertise and background of auditors
   3. Criteria for composition of audit teams (*e.g.* BP - Internal to Plant, BP - external to plant, BP - Corporate, 3rd party, etc.)
   4. Status of response to recommendations from audits
   5. Description and findings of BP corporate, 3rd party, or regulatory agency audits

xiii. Status and timeliness of completion of process safety recommendations from any source – PHA studies, incident investigations, management of change reviews, capital project process safety reviews, etc.
   1. Quality and effectiveness of the system for tracking recommendations and ensuring their timely resolution
   2. Documentation and communication of reasons for not taking a specific recommendation, including explanation of why it is not appropriate and/or description of alternative actions taken

xiv. Other systems important to process safety, including
   1. Control of block valves under relief devices
   2. SIS bypass management

Appendix B – PSM Review Team Leader Bios

J. S. (Steve) Arendt (sarendt@absconsulting.com)

Mr. Arendt is a Vice President of ABSG Consulting Inc. – Organizational Performance Assurance Center. He was formerly a co-founder and President of JBF Associates, Inc. He has over 25 years experience in chemical process safety and risk management and has performed hundreds of safety analyses, risk assessments, audits, and accident investigations on a variety of oil, gas, chemical, and related industry processes.

Mr. Arendt is a widely published author, having over 50 articles, guides, and books to his credit on PSM and risk management topics, including:

- ***A Compliance Guide for EPA's Risk Management Program Rule***, API, CMA,1997
- ***Manager's Guide to Quantitative Risk Assessment***, CMA, 1989
- ***Resource Guide to the Process Safety Code of Management Practices***, CMA, 1990
- ***Guidelines for Hazard Evaluation Procedures, Second Edition***, CCPS, 1992
- ***A Manager's Guide to Implementing and Improving MOC Systems***, CMA, 1993
- ***Risk Communication Guide***, Chemical Educational Foundation, 1999

He has recently conducted several industry surveys on PSM "best practices," obtaining information from over 70 companies, which was used in an industry "PSM best practices workshop" sponsored by API. Mr. Arendt's current activities include managing the *API University Global Process Safety and Risk Management Training Initiative*. Mr. Arendt is a member of several safety-related professional societies and is very active with the American Institute of Chemical Engineers and the Center for Chemical Process Safety – for which he is co-authoring two guidelines entitled:

- ***Guidelines for Risk Based Process Safety***
- ***Guidelines for Management of Change***

Since 1989, Mr. Arendt has worked with several industry groups to develop technical positions dealing with OSHA's process safety management regulation (29 CFR 1910.119) and EPA's risk management program rule (40 CFR Part 68). He has been an active participant in these rulemakings, providing testimony at the public hearing for both regulations. Mr. Arendt has served as a moderator for numerous industry workshops on the OSHA PSM and EPA RMP regulations, and is a frequent speaker at conferences involving chemical accident prevention and process safety management activities.

Mr. Arendt was awarded the 2006 Merit Award from the Mary Kay O'Connor Process Safety Center, recognizing significant contributions to the advancement of education, research, and service activities related to process safety concepts and/or technologies.

Mr. Arendt received a Master of Engineering degree from the University of Tennessee in 1977, and is a registered Professional Engineer in the state of Tennessee.

Walter F. Frank

Mr. Frank has more than 33 years of experience in the process industries, with nearly 20 years as a risk, reliability, and safety consultant. Prior to joining ABS Consulting, he spent 24 years with DuPont where he held assignments in the areas of plant technical support, manufacturing supervision, research and development, design, project startup, and process safety consulting.

Mr. Frank provides support to industry and governmental agencies in the areas of consequence assessment, quantitative risk assessment, incident investigation, explosion hazard evaluation and control, the application and enhancement of PSM systems, auditing, regulatory compliance, and safety culture evaluation and growth. Since joining ABS Consulting, he has participated in over 50 PSM audits and program evaluations, most often as the audit team leader, including several 3rd-party "consent decree-type" situations.

Mr. Frank wrote the chapters on auditing and process safety culture for the forthcoming Center for Chemical Process Safety (CCPS) book ***Guidelines for Risk Based Process Safety*** and was the principal author of the CCPS publication ***Revalidating Process Hazard Analyses***. He is a contributing author to the CCPS ***Guidelines for Management of Change***, as well as the process safety chapter for the 8th edition of ***Perry's Chemical Engineers' Handbook***.

Mr. Frank received a B.S. degree in chemical engineering from Rose-Hulman Institute of Technology in 1973. He is a registered Professional Engineer in the state of Delaware and a Fellow of the American Institute of Chemical Engineers. He is also a member of the NFPA and chairs the NFPA Technical Committee on Handling and Conveying of Dusts, Vapors, and Gases.

Jack McCavit

Mr. McCavit is President of JL McCavit Consulting, LLC, a consulting company specializing in process safety management.

Mr. McCavit worked for Celanese Chemical Company for 35 years before retiring in 2005. Through his work at Celanese, Mr. McCavit developed extensive experience in operations management and practical application of process safety management systems.

Most of his career in Celanese was spent in operations and technical management in three different plant sites, including serving as operations manager at the facility in Pampa, Texas. Mr. McCavit led or actively participated in the evolution of process safety management systems in Celanese beginning in 1990. He was directly involved in the development and application of the systems first implemented in response to the promulgation of OSHA 1910.119 in 1992, through efforts to improve efficiency and effectiveness of process safety management systems, to managing continuous improvement cycles for mature systems.

From 2000 until his retirement in 2005, Mr. McCavit provided strategic process safety management direction for Celanese as the manager of process safety. During that time Mr. McCavit participated extensively in the CCPS, an industry alliance of the American Institute of Chemical Engineers, the Mary Kay O'Connor Process Safety Center, and the American Chemistry Council process safety committee. He also participated in numerous process safety management system benchmarking efforts with several other companies to learn practical application methodologies throughout the chemical processing and refining industries.

Mr. McCavit is an active member of CCPS. He serves as chair of the CCPS committee responsible for the development of ***Guidelines for Risk Based Process Safety***, the next generation CCPS process safety management book; as a member of the CCPS committee that writes the ***Process Safety Beacon*,** a monthly publication of process safety messages for manufacturing personnel; and as a member of CCPS committees for the following active projects

- Process Safety Metrics Project
- Risk Tolerance Criteria
- Incidents that Define Process Safety

Mr. McCavit graduated from Texas Tech University with a Bachelor of Science degree in chemical engineering.

Appendix C – References

[1] John Mogford, *Fatal Accident Investigation Report, Isomerization Unit Explosion Final Report*, December 9, 2005

[2] CSB *Urgent recommendation to BP Global Executive Board of Directors*, August 17, 2005, http://www.csb.gov/news_releases/docs/CMerritt%20Statement%208.17.05.pdf

[3] *Charter for BP U.S. Refineries Independent Safety Review Panel*, October 24, 2005, http://www.safetyreviewpanel.com/cmtfiles/panel_charter.php?file_id=83&link_id=39

[4] *Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119)*, U.S. Occupational Safety and Health Administration, February 24, 1992, www.osha.gov

[5] *Accidental Release Prevention Requirements: Risk Management Programs Under Clean Air Act Section 112(r)(7)*, 40 CFR 68, U.S. Environmental Protection Agency, June 20, 1996 Fed. Reg. Vol. 61[31667-31730]

[6] Center for Chemical Process Safety, American Institute of Chemical Engineers, New York, NY, www.aiche.org/ccps/

[7] AcuTech Consulting Group, *Process Safety Management (PSM) Systems Compliance Audit Report for the Texas City Refinery*, June 23, 2006

[8]S*izing, Selection, and Installation of Pressure-Relieving Devices in Refineries. Part I - Sizing and Selection. 5th Edition*, RP 520, American Petroleum Institute, Washington, D.C. (July 1990)

[9] *ASME Boiler & Pressure Vessel Code. Section VIII, Division I*, American Society of Mechanical Engineers, New York, 1995

[10] D. C. Hendershot and A. M. Dowell, III, "No Good Deed Goes Unpunished: Case Studies of Incidents and Potential Incidents Caused by Protective Systems," *Proceedings of the AIChE 31st Annual Loss Prevention Symposium*, Houston, TX, Paper 44c, March 13, 1997

[11] *Getting HSE Right – A Guide for BP Managers*, High Potential Incident Reporting requirements, pg. 42, BP 000349, December 2002

[12] *Management of Hazards Associated with Location of Process Plant Buildings*, RP 752, Second Edition, American Petroleum Institute, Washington DC, November 2003

[13] *Guidelines for Evaluating Process Plant Buildings for External Explosion and Fires*, G-26, ISBN No: 0-8169-0646-7, CCPS, New York, 1996

[14] *Guidance on Practice for Design and Location for Design and Location of Occupied Portable Buildings Within Refineries and Chemical Plants*, BP Group Engineering Technical Practice, RM-GP 04-30, December 1, 2005

[15] ANSI/ISA 84.01-1996, *Application of Safety Instrumented Systems for the Process Industries*, ISBN: 1556175906, The Instrumentation, Systems, and Automation Society, April 1996

[16] ANSI/ISA 84.00.01-2004 Parts 1-3, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector*, ISBN: 1556179197, 1556179200, and 1556179219, The Instrumentation, Systems, and Automation Society, September 2004

[17] *Guidance on Practice for Safety Instrumented System (SIS),* BP Group Engineering Technical Practices, GP 30-75, 76, 80, 81, and 801, 2003

[18] *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*, RP 500, Second Edition, American Petroleum Institute, November 1997

[19] *NFPA 496: Standard for Purged and Pressurized Enclosures for Electrical Equipment, 2003 Edition*, National Fire Protection Association, Quincy, MA, http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=496

[20] *Fired Heaters for General Refinery Services*, Std. 560, 3rd Edition, American Petroleum Institute, Washington DC, May 2001

[21] *Fired Heaters & Steam Generators*, RP 556, First Edition, American Petroleum Institute, May 1997

[22] OSHA Process Safety Management Standard – Incident Investigation Requirements, 29 CFR 1910.119(m)(1)

[23] EPA Risk Management Program Rule Prevention Program - Incident Investigation Requirements, 40 CFR 68.81

[24] OSHA Process Safety Management Standard – Process Hazard Analysis Requirements, 29 CFR 1910.119(e)(3)(i)

[25] *Guidelines for Hazard Evaluation Procedures, 2nd Edition*, CCPS, ISBN: 0-8169-0491-X, New York, April 1992

[26] OSHA Process Safety Management Standard – Process Hazard Analysis Requirements, 29 CFR 1910.119(e)(3)(iii)-(iv)

APPENDIX F
BP POST-TEXAS CITY MEASURES

The Panel recognizes that BP has already undertaken a number of steps to improve or that could affect process safety performance in its five U.S. refineries. This appendix identifies the most significant measures that BP has undertaken since March 2005 that BP specifically identified or that the Panel has noted during its review. The list of measures discussed below is not intended to be exhaustive. For convenience, the Panel has grouped BP's measures according to the three broad areas in which the Panel has made findings in this report: (1) process safety culture, (2) process safety management systems, and (3) performance evaluation, corrective action, and corporate oversight. For additional information relating to measures taken at the Texas City refinery since March 2005, see Michael P. Broadribb, *Lessons from Texas City: A Case History* (prepared for presentation at the 40th Annual Loss Prevention Symposium of the American Institute of Chemical Engineers and the 21st Annual International Conference of the Center for Chemical Process Safety (Orlando, Florida, April 2006)).

A. Process Safety Culture

1. Specific measures at Texas City

Site leadership. Following the Texas City incident, BP installed a new refinery plant manager.

2. Corporate-level measures

Leadership visibility. John Browne, BP's Group Chief Executive, met with the company's top 200 leaders to stress BP's commitment to safety and communicate his expectations regarding safety. Members of the new Safety and Operations organization visited BP's U.S. refineries and gave presentations regarding the importance of process safety and the importance of the Mogford Report recommendations. Additionally, BP senior managers have attended town hall meetings with employees to discuss safety issues. The Chief Executive, Refining and Marketing conducted meetings for all U.S. refining employees, and the President of BP America conducted meetings and sent written communications to BP America employees regarding safety issues.

Learning culture. BP has initiated various efforts to review management systems, safety culture, and process safety performance at its U.S. refineries. These efforts include the Mogford Report (2005), the Stanley Report (2005), HRO assessments (2005), cultural assessments (2005), a reexamination of the company's periodic employee surveys, and learnings through interactions with the Panel.

Review of employee concerns. BP appointed retired United States District Judge Stanley Sporkin to hear and review BP employee concerns.

Support for, or checks on, line management. *New Chairman and President for BP America.* BP has enhanced the role of the Chairman and President of BP America, who will now report directly to the Group Chief Executive. BP named Robert Malone to fill this position.[1] BP has stated that this position now has broad authority to address and correct issues related to safety, operations integrity, compliance, and ethics within all U.S. operations.

In addition, BP has announced that it will form an advisory board to assist and advise BP America in monitoring the operations of BP's U.S. businesses, with a particular focus on compliance, safety, and regulatory affairs.

Engineering authorities. BP is in the process of establishing new engineering authorities at each U.S. refinery and for Refining generally. The engineering authority at each refinery will be the primary decision-maker on the technical aspects of design, operation, and maintenance activities.

Operations network. Refining has redefined the operations network to elevate the profile of operations and to enhance operational performance.

Refining and Marketing Group Vice-President, HSSE and Technology. BP appointed C.J. Warner to the new position of Group Vice-President, HSSE and Technology for Refining and Marketing. Warner reports to John Manzoni, the Chief Executive, Refining and Marketing. (As of April 1, 2007, Ms. Warner will replace Mike Hoffman as the Group Vice-President, Refining.)

Safety and Operations Group. BP named John Mogford to the new position of Senior Group Vice-President, Safety and Operations. The Safety and Operations group consolidated former HSSE functions, and Mogford now reports directly to the Group Chief Executive, John Browne. Safety and Operations continues to build its functional expertise through recruitment.

"Supercharged" process safety community of practice. BP added a second process safety advisor to the process safety community of practice and designated process safety as a "supercharged" community of practice.

Survey for employees. BP has revised its People Assurance Survey to include cultural safety issues.

B. Process Safety Management Systems

1. Specific measures at Texas City

Additional inspectors. BP has added inspectors to the Texas City site, raising the total number to more than 200.

Emergency preparedness procedure update. Emergency preparedness and response procedures at Texas City have been modified to include evacuation drills and workshops on a unit-by-unit basis; development of alarm-sounding procedures and accountabilities emphasizing process unit conditions; establishment of revised worker muster points; and revision of existing communications systems.

Reduction of in-refinery traffic. Through the introduction of a site-wide transit system, vehicle traffic has been reduced at the Texas City refinery.

Siting changes. BP removed more than 200 temporary structures from the Texas City refinery site and relocated approximately 400 affected workers to permanent on-site buildings or off-site locations.[2]

Training and skills development initiatives. The Texas City refinery has begun implementing leadership development and related training, in which the refinery expects to invest 300,000 employee hours per year. The refinery has also enhanced orientation procedures for new hires; training in start-up and distillation processes; and education on safety and environmental compliance, operations, and operator competency.

2. Measures applicable to all U.S. refineries

Facility siting guidance. BP has created an engineering technical practice for facility siting of temporary structures and is developing guidance for siting of permanent buildings.

Maintenance operating model and handbook. Refining has issued the Refining Maintenance Operating Model and Handbook, setting out new refining maintenance expectations.

Major accident risk assessment update. BP has modified its major accident risk guidance by introducing a tool that enables individuals to measure the relative risk of specific individual process units.

Management of change procedures. In 2006, BP began using a management of change process to assess the impact of appointing a new refinery plant manager.

Operations management system development. BP is developing a new Operations Management System to ensure that the safety management system is applied consistently across the refineries. In addition, BP recently created a new Refining Vice-President position to ensure consistent implementation of the company's new Operations Management System and appointed Rick Porter, formerly refinery plant manager of Cherry Point, to this position.

Training and skills development initiatives. *Assessment of skills and capabilities and gap analysis.* The Vice-President of Organization Capability is implementing an assessment aimed at identifying the skills and capabilities needed for different work groups within the BP organization, including U.S. refineries. Training and staff development programs will then be implemented to address any gaps or deficiencies identified.

Engineering expertise. BP Refining is rebuilding its functional engineering expertise, enhancing that function from 35 people in the early 2000s to more than 150.

Training programs. BP is developing a number of training programs for different levels of employees within Refining. BP's Safety and Operations function is developing a set of principles and expectations for board operator training as well as Group-wide training programs, training protocols, and safety standards for leaders, including first level leaders (supervisors), superintendents, and operators. BP's human resources function is developing a Group-wide training program for all managers and supervisors that will include safety issues. BP Refining is developing a training program for operations superintendents that will include treatment of safety issues.

3. Corporate-level measures

Engineering technical practices and Refining process safety minimum expectations. BP continues to develop engineering technical practices and Refining process safety minimum expectations, which serve to standardize BP operating practices. BP is also developing a Group-level engineering technical practice for risk assessment and hazard identification.

Integrity management and control of work Group standards. BP is implementing new Group standards on integrity management and control of work. These Group standards were in development prior to the Texas City incident.

C. Performance Evaluation, Corrective Action, and Corporate Oversight

1. Specific measures at Texas City

Resources for plant, equipment, and systems. BP has undertaken a $1 billion improvement program at Texas City[3] to renovate major units, modernize process control systems on major units, install a new maintenance management system, enhance alarm systems, and remove blowdown stacks in heavier-than-air light hydrocarbon service.

Texas City Program Office. After the Texas City incident, BP established a Texas City Program Office to track and coordinate program initiatives at the Texas City refinery. These initiatives were developed primarily in response to recommendations from the Mogford Report and the Stanley Report.

2. Measures applicable to all U.S. refineries

Auditing. The Safety and Operations organization is creating an enhanced audit function, including additional audit personnel and a number of external hires. BP has listed audit-finding closure as one element of a six-point plan for sustained development. The new audit group is developing enhanced audit protocols to better assess actual operations against applicable standards.

Blowdown stack removal. BP is reviewing blowdown stack use at its five U.S. refineries for identification of stacks to be eliminated because of high potential risks. By mid-2006, 14 blowdown stacks had been removed.

Engineering technical practice for trailer siting. BP has implemented a new engineering technical practice to address trailer siting.

Incident investigation process. BP is working to revise its incident investigation process, including the development of a more rigorous root cause analysis effort and enhanced training in that area.

Leading indicators. BP has begun to report quarterly to the EEAC some process safety metrics and integrity management milestones. These include overdue inspection rates and loss of containment measurements. The company is developing leading indicators to better inform senior company management and refinery managers about process safety performance at the refineries. The Safety and Operations group is leading a project to assess and to develop other appropriate process safety metrics.

Relocations at U.S. refineries. 260 buildings have been moved out of high-risk zones, and 126 buildings have been removed from lower-risk areas within the U.S. refineries. BP has relocated 1,300 people from on-site trailers.

Resources for plant, equipment, and systems. BP has announced that it has earmarked $7 billion over the next four years to upgrade all aspects of safety at its U.S. refineries and to repair and replace infield pipelines in Alaska. The company has also announced $300 million in funding and significant external input for process safety management renewal in Refining.[4]

U.S. Program Office. After the Texas City incident, BP established a U.S. Program Office to track and coordinate program initiatives at the Carson, Cherry Point, Toledo, and Whiting refineries. These initiatives were developed primarily in response to recommendations from the Mogford Report and the HRO assessments conducted at each of those refineries in 2005.

3. Corporate-level measures

Board of Directors oversight. The Board of BP p.l.c. will receive presentations from senior management on process safety matters more frequently than in the past. The Board is also tracking a new set of process safety metrics. In addition, Board members are making visits to operational sites, including U.S. refineries, to increase their awareness of local issues.

Review of Safety and Operations. BP has announced it will conduct a ten-year review of safety operations across the company.

---

[1] BP p.l.c., Press Release, "Robert A. Malone to Lead BP America, Inc.," June 19, 2006.

[2] BP p.l.c., John Mogford, Senior Group Vice-President, Safety & Operations, "The Texas City Refinery Explosion: Lessons Learned," Address at the Center for Chemical Process Safety, 2nd Global Congress on Process Safety, April 24, 2006, p. 5.

[3] BP p.l.c., Press Release, "BP Issues Final Report on Fatal Explosion, Announces $1 Billion Investment at Texas City," December 9, 2005.

[4] "BP to Put Independent Members on New U.S. Board and Pledges Higher Spend to Speed Up U.S. Moves," *accessed at* http://sec.gov/Archives/edgar/data/313807/000119163806001760/bp200607256k2.txt on January 7, 2007.

APPENDIX G

PROCESS SAFETY CULTURE SURVEY

BP U.S. Refineries
Independent Safety Review Panel

2006 Process Safety Culture Survey

INTRODUCTION

Welcome to the BP U.S. Refineries Independent Safety Review Panel 2006 Process Safety Culture Survey

This survey is being administered on behalf of the BP U.S. Refineries Independent Safety Review Panel, an independent panel formed by BP at the urgent recommendation of the U.S. Chemical Safety and Hazard Investigation Board. The survey contains statements that assess process safety in the refinery where you work. Your responses will provide a means of identifying problem areas in the process safety culture at your refinery, as well as areas that work well. Your input will be important to the work of the Independent Panel, whose final report will be available later this year.

Completion of the survey is voluntary. However, your cooperation is appreciated, as it will allow the Independent Panel to complete its task of making a thorough, independent and credible assessment of the effectiveness of BP Products North America Inc.'s corporate oversight of process safety management systems and its corporate process safety culture. The Independent Panel believes that its assessment and the report it will deliver will ultimately lead to a safer work environment for the BP North American refineries. Your opinions and responses are anonymous, and neither the Panel nor BP will attempt to determine your identity. **In order to maintain anonymity, please do not write your name on any part of the survey.**

In order to protect your identity, only statistical summaries of groups of 15 or more respondents will be reported. If you work in a group or department with less than 15 respondents, your results will be aggregated into the next organizational level (e.g., refinery overall) as well as into BP overall results.

As indicated above, the questions in this survey focus on process safety and not on personal safety. Process safety refers to the prevention of unintentional releases of chemicals or energy during the course of refinery processes that can have a serious effect. Process safety involves, for example, the prevention of leaks, spills, equipment malfunction, over-pressures,
over-temperatures, corrosion, metal fatigue and other similar conditions. Process safety programs focus on design and engineering of facilities, maintenance of equipment, effective alarms, effective control points, procedures and training. By comparison, personal safety focuses on injuries such as slips, trips, falls, struck-by incidents and strains. Personal safety programs place a heavy emphasis on hard hats, glasses, slicker suits, goggles, gloves, steel toe shoes and other personal protective equipment. In general, process safety focuses on workplace safety, and personal safety focuses on worker safety. **This survey is about process safety, not personal safety.**

Have you viewed the survey introduction video?

1 Yes

2 No

It is highly recommended that you watch the video prior to completing this survey.

If you responded NO, please take a moment to view the 5-minute video before completing the survey.

OVERVIEW

This survey contains three major sections:

I. About Me

This section asks for information about yourself and your work background. This information is for research purposes only and will not be used to identify you.

II. My Opinions and Comments

This section contains statements that ask for your thoughts on what it is like to work at a BP refinery. There are no right or wrong answers. We simply ask for your opinion, based on your experience. Please review each statement and select the number from 1 to 5 that best expresses your response to the statement. Please note that selecting number 3 in response to a question means either that you do not know or that you do not have an opinion.

Comment sections after each category of questions provide you with an opportunity to express your written thoughts regarding the topic. If you do not have enough space to write your comment after each selection, please feel free to continue commenting on the final page of the survey.

III. Final Comments

There is also an open-ended final comment question at the end of the survey in which you will have an opportunity to add any additional feedback that you might have.

INSTRUCTIONS FOR COMPLETING THE SURVEY

Please observe the following requirements carefully to ensure that your responses are correctly recorded:

- **Use a soft lead pencil or a blue or black pen.**
- Place a heavy "X" in the box which best reflects your answer.
- **Mark only one** opinion for each statement. **Multiple marks cannot be counted**.
- If you want to change an answer, erase completely, or, if you answered in pen, completely black out the wrong answer and put an "X" in the correct box.

MARKING INSTRUCTIONS

CORRECT	INCORRECT
☒	☑ ③ ■

I. ABOUT ME

In this section you are asked to provide some information about yourself and your position within BP. This information is requested because workers from different locations of BP or from different job levels might have varying opinions. The Panel will use the information from this section to break down results in a meaningful way while preserving the anonymity of all respondents.

1. IN WHICH FACILITY DO YOU DO MOST OF YOUR WORK?

- 1 Carson
- 2 Cherry Point
- 3 Texas City
- 4 Toledo
- 5 Whiting

2. WHAT IS YOUR JOB LEVEL?

- 1 Hourly Worker
- 2 Foreman / First Level Supervisor
- 3 Superintendent
- 4 Manager
- 5 Other

3. ARE YOU A MEMBER OF A SAFETY COMMITTEE?

- 1 Yes
- 2 No

4. WHAT TYPE OF WORKER ARE YOU?

- 1 Regular Full-Time BP Employee
- 2 Regular Part-Time BP Employee
- 3 Contractor

5. WHAT IS YOUR CURRENT PRIMARY JOB FUNCTION?

- 01 Administration / Support
- 02 Analytical / Laboratory
- 03 Commercial / Shipping
- 04 Digital & Communications Technology (DCT)
- 05 Drafting / Engineering Design
- 06 Engineering Professional (all disciplines)
- 07 External Affairs / Communications
- 08 Financial Control & Accounting (FC&A)
- 09 HSSE (Health, Safety, Security & Environment) as Full Time (no other functional responsibility)
- 10 Human Resources
- 11 Learning & Development / Training
- 12 Maintenance / Craft Technician (all disciplines)
- 13 Maintenance Management
- 14 Maintenance / TAR Planning
- 15 Materials / Corrosion / Inspection
- 16 Operations-Management
- 17 Operator
- 18 Planning / Strategy / Business Development
- 19 Procurement / Supply Chain Management
- 20 Production Planning / Analysis
- 21 Project Management (Engineering)
- 22 Research and Technology
- 23 Other (specify: ________________)

PLEASE CONTINUE TO NEXT PAGE

6. WHAT IS YOUR HERITAGE COMPANY?

- 01 Amoco
- 02 Aral
- 03 Arco
- 04 BP
- 05 Castrol
- 06 Mobil
- 07 Sohio
- 08 Vastar
- 09 Veba
- 10 I am a contractor
- 11 None of the above

7. HOW LONG HAVE YOU WORKED AT THIS REFINERY?

- 1 Less than a year
- 2 1 year but less than 3 years
- 3 3 years but less than 5 years
- 4 5 years but less than 8 years
- 5 8 years but less than 10 years
- 6 10 years but less than 15 years
- 7 15 years or more

8. HOW LONG HAVE YOU WORKED IN THE REFINING INDUSTRY?

- 1 Less than a year
- 2 1 year but less than 3 years
- 3 3 years but less than 5 years
- 4 5 years but less than 8 years
- 5 8 years but less than 10 years
- 6 10 years but less than 15 years
- 7 15 years or more

THE FOLLOWING CODING QUESTIONS ARE VOLUNTARY. HOWEVER, WE DO ASK FOR YOUR COOPERATION. THE INFORMATION WILL ALLOW US TO COMPARE RESPONSES BY DIFFERENT GROUPS.

9. WHAT IS YOUR GENDER?

- 1 Male
- 2 Female

10. WHAT IS YOUR RACIAL / ETHNIC BACKGROUND?

- 01 American Indian / Alaskan Native / Canadian Aboriginal Descent
- 02 Asian Descent
- 03 Black / African American
- 04 European Descent (White / Caucasian)
- 05 Hispanic / Latino Descent
- 06 Middle Eastern Descent
- 07 Pacific Islander, Aboriginal or Maori Descent
- 08 Multi-Racial (more than one of the above)
- 09 None of the Above
- 10 Decline to Respond

11. WHAT IS YOUR AGE?

- 1 Under 20
- 2 20 - 24
- 3 25 - 29
- 4 30 - 39
- 5 40 - 49
- 6 50 or above

SURVEY TERM DEFINITIONS

Please read through the following definitions of key words that are used throughout the survey. You may come back to this page and reference these definitions at any time.

PLEASE REVIEW THESE DEFINITIONS PRIOR TO COMPLETING THIS SURVEY.

"ACCIDENT" refers to an event or series of events and circumstances that results in one or more undesirable consequences.

"HAZARD" refers to chemicals, materials, operating environments or conditions that have the potential to cause damage to people, property, or the environment.

"NEAR MISS" refers to an event or series of events that could have resulted in one or more undesirable consequences under different circumstances, but actually did not.

"PROCESS" refers to any activity involving, but not limited to, a hazardous chemical (i.e., a substance possessing toxic, reactive, flammable, or explosive properties) or other potentially dangerous material (including steam), including any use, storage, manufacturing, handling, or the on-site movement of such a chemical or material.

"PROCESS SAFETY" refers to the prevention of unintentional releases of chemicals, energy, or other potentially dangerous materials (including steam) during the course of refinery processes that can have a serious effect. Process safety involves, for example, the prevention of leaks, spills, equipment malfunction, over-pressures, over-temperatures, corrosion, metal fatigue and other similar conditions. Process safety programs focus on design and engineering of facilities, maintenance of equipment, effective alarms, effective control points, procedures and training.

"REFINERY MANAGEMENT" refers to all refinery department managers and the business unit leader of your refinery.

"SUPERVISOR" refers to the person to whom you report directly on a daily basis.

"WORK GROUP" refers to the group of people with whom you work on a daily basis.

"WORKER" refers to all refinery personnel, in all departments (including employees and contractors).

II. MY OPINIONS AND COMMENTS

Please review each statement below and select the number from 1 to 5 that best expresses your response to the statement. Please note that selecting number 3 in response to a question means either that you do not know or that you do not have an opinion.

Process Safety Reporting

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
1.	This refinery provides adequate training on hazard identification, control and reporting....	1	2	3	4	5
2.	I have received training on hazard identification, control and reporting in the last 12 months	1	2	3	4	5
3.	I can report hazardous conditions without fear of negative consequences	1	2	3	4	5
4.	In general, workers don't bother to report minor process-related incidents, accidents, or near misses	1	2	3	4	5
5.	I believe a culture exists at this refinery that encourages raising process safety concerns...	1	2	3	4	5
6.	Corrective action is promptly taken when unsafe process safety conditions are brought to management's attention	1	2	3	4	5
7.	I am confident that process safety issues are:					
	a. Thoroughly investigated	1	2	3	4	5
	b. Appropriately resolved	1	2	3	4	5
8.	Workers are informed about the results of process related incident, accident, and near miss investigations	1	2	3	4	5
9.	I am satisfied with the process safety reporting system at this refinery	1	2	3	4	5
10.	I do not hesitate to report actions or conditions that raise a process safety concern, even when a co-worker is involved	1	2	3	4	5

Please provide any comments you have about Process Safety Reporting in the space below.

Safety Values / Commitment to Process Safety

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
11.	My supervisor puts a high priority on process safety through actions and not just empty slogans	1	2	3	4	5
12.	Refinery management puts a high priority on process safety through actions and not just empty slogans	1	2	3	4	5
13.	Operational pressures do not lead to cutting corners where process safety is concerned	1	2	3	4	5
14.	At this refinery, process safety improvement is a long-term commitment that is not compromised by short-term financial goals	1	2	3	4	5
15.	In my opinion, the people at my refinery with specific process safety responsibilities have the:					
	a. Authority to make changes	1	2	3	4	5
	b. Resources to make changes	1	2	3	4	5
16.	In my opinion, process safety programs at my refinery have:					
	a. An adequate number of people responsible for process safety	1	2	3	4	5
	b. Adequate funding	1	2	3	4	5
17.	There is usually sufficient staff in my work group to perform my job safely	1	2	3	4	5
18.	After a process-related incident, accident, or near miss, management is more concerned with correcting the hazard than assigning blame or issuing discipline	1	2	3	4	5
19.	At this refinery, a formal hazard assessment is performed to ensure that changes that affect processes will be safe	1	2	3	4	5
20.	Workers at this refinery feel pressured to work considerable overtime from:					
	a. Co-workers	1	2	3	4	5
	b. Supervisors	1	2	3	4	5
	c. Refinery management	1	2	3	4	5
	d. Their own sense of loyalty to their operating units	1	2	3	4	5

Please provide any comments you have about Safety Values / Commitment to Process Safety in the space below.

Supervisory Involvement and Support

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
21.	In my work group, process safety concerns are secondary to achieving production goals...	1	2	3	4	5
22.	My supervisor sometimes asks me to operate an unsafe process	1	2	3	4	5
23.	My supervisor will support me if I refuse to participate in unsafe work............................	1	2	3	4	5
24.	My supervisor encourages me to identify and report unsafe conditions	1	2	3	4	5
25.	My supervisor makes sure that procedures relating to the following activities are safe before such activities are initiated:					
	a. Operations	1	2	3	4	5
	b. Maintenance..	1	2	3	4	5
26.	Persons with appropriate supervisory authority and expertise participate in hazardous process-related activities, such as startup..	1	2	3	4	5
27.	My supervisor takes action when a worker engages in a poor process safety practice......	1	2	3	4	5
28.	My supervisor takes appropriate action in response to my suggestions for process safety improvements..	1	2	3	4	5

Please provide any comments you have about Supervisory Involvement and Support in the space below.

Procedures and Equipment

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
29.	Interlocks, alarms, and other process safety-related devices are regularly:					
	a. Tested	1	2	3	4	5
	b. Maintained	1	2	3	4	5
30.	Disabled or failed process safety devices are restored to service as soon as possible	1	2	3	4	5
31.	Written operating procedures are:					
	a. Regularly followed	1	2	3	4	5
	b. Kept up to date	1	2	3	4	5
32.	Procedures exist at this refinery that instruct operators to take action as soon as possible if safety critical interlocks, alarms, or other process safety-related devices fail or become unavailable during operation	1	2	3	4	5
33.	Maintenance checklists and procedures are:					
	a. Easy to understand	1	2	3	4	5
	b. Easy to use	1	2	3	4	5
34.	Process equipment is **not** regularly:					
	a. Tested	1	2	3	4	5
	b. Maintained	1	2	3	4	5
35.	In order to ensure process safety at my refinery, inspection and maintenance are made high priorities	1	2	3	4	5

Please provide any comments you have about Procedures and Equipment in the space below.

Worker Professionalism / Empowerment

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
36.	I feel that I can influence the process safety policies implemented at this refinery	1	2	3	4	5
37.	Workers at all levels of my refinery actively participate in:					
	a. Hazard reviews and assessments	1	2	3	4	5
	b. Incident and accident investigations	1	2	3	4	5
38.	When a process safety issue is involved, I can challenge decisions made by the following without fear of negative consequence:					
	a. My supervisor	1	2	3	4	5
	b. Refinery management	1	2	3	4	5
39.	Workers sometimes work around process safety concerns rather than report them	1	2	3	4	5
40.	Creating unapproved shortcuts around process safety is not tolerated at my refinery	1	2	3	4	5
41.	I am informed when potentially dangerous processes are started	1	2	3	4	5
42.	I am responsible for identifying process safety concerns at my refinery	1	2	3	4	5
43.	I feel free to refuse to participate in work activities that are unsafe	1	2	3	4	5
44.	Operators are empowered to take corrective action as soon as possible (including shutting down when appropriate) if safety critical interlocks, alarms, or other process safety-related devices fail or become unavailable during operation	1	2	3	4	5

Please provide any comments you have about Worker Professionalism / Empowerment in the space below.

Process Safety Training

Note: For each statement below, you should select "3" under the response labeled "?" only if you do not know or you do not have an opinion.

		Agree	Tend to Agree	?	Tend to Disagree	Disagree
45.	The training that I have received does not provide me with a clear understanding of the process safety risks at my refinery	1	2	3	4	5
46.	I know how to access appropriate process safety resources if I need them	1	2	3	4	5
47.	The following receive the necessary process safety training to do their job safely:					
	a. New workers	1	2	3	4	5
	b. Experienced workers	1	2	3	4	5
	c. My supervisor	1	2	3	4	5
	d. Contractors	1	2	3	4	5
48.	The process safety training that I have received allows me to recognize when a process should be shut down if safety critical interlocks, alarms or other process-safety devices fail or become unavailable during operation	1	2	3	4	5
49.	The process safety training that workers receive at my refinery is adequate to prevent process-related incidents, accidents and near misses	1	2	3	4	5

Please provide any comments you have about Process Safety Training in the space below.

III. FINAL COMMENTS

Please provide any other comments you might have regarding process safety at your refinery in the space below.

THIS IS THE END OF THE SURVEY. THANK YOU FOR YOUR PARTICIPATION.

PLEASE DO NOT WRITE ON THIS PAGE.

APPENDIX H
GLOSSARY OF SELECTED TERMS

Term	Definition
API	American Petroleum Institute
Atmospheric Distillation	The refining process of separating crude oil components at atmospheric pressure by heating to temperatures of about 600 degrees Fahrenheit to 750 degrees Fahrenheit (depending on the nature of the crude oil and desired products) and subsequent condensing of the fractions by cooling.
Blowdown Drum	Separators or accumulators used to separate liquids and vapors in pressure-relieving and emergency systems.
Blowdown Stack	Venting equipment that can release buildups of dangerous liquid or vapor in an emergency.
CCPS	Center for Chemical Process Safety. CCPS is a not-for-profit, corporate membership organization that identifies and addresses process safety needs within the chemical, pharmaceutical, and petroleum industries.
Critical Alarm	An alarm having no automatic safety backup system and requiring immediate action to be taken by an operator to return the plant to a safe status (e.g., atmospheric combustible or toxic gas detection).
CSB	Chemical Safety and Hazard Investigation Board. the CSB is an independent agency of the United States federal government charged with investigating industrial chemical accidents.
ETP	Engineering Technical Practice
gHSEr	Getting HSE right is BP's Health, Safety and Environmental Management System Framework and sets out expectations for delivery of health, safety, and environmental performance.
Group	"Group" or "BP Group" refers to the entirety of BP's business operations, including businesses included in its Exploration and Production segment; in its Refining and Marketing segment; and in its Gas, Power, and Renewables segment. The term also includes the corporate offices of BP p.l.c. that oversee those operations. The corporate offices of BP provide centralized functions for the Group companies, such as finance; financial control and accounting; internal audit; legal; mergers and acquisitions; and tax.
Gun Drill	A test or evaluation in which a worker is given a hypothetical set of circumstances, and is asked to communicate or demonstrate how he/she would respond in that situation.
High Potential Incident/HIPO	An event that, under different circumstances, might easily have resulted in catastrophic loss.
HRO	"High Reliability Organization." An HRO is an organization that produces product relatively error free over a long period of time.
HSE	Health, Safety, and Environment. This term is used interchangeably with "HSSE" throughout this report.

Term	Definition
HSSE	Health, Safety, Security, and Environment. This term is used interchangeably with “HSE” throughout this report.
Incident	An unusual or unexpected event, which either resulted in, or had the potential to result in, serious injury to personnel, significant damage to property, adverse environmental impact, or a major interruption of process operations.
ISA	The Instrumentation, Systems, and Automation Society is a global, nonprofit organization that sets standards for automation.
Isomerization (ISOM)	A reaction that catalytically converts straight-chain hydrocarbon molecules into branched-chain molecules of substantially higher octane number. The reaction rearranges the carbon skeleton of a molecule without adding or removing anything from the original material.
Leading Indicator	A metric that attempts to measure some variable that is believed to be an indicator or precursor of future safety performance.
Major Incident Announcement	Announcement of a Major Incident. A Major Incident is an incident, including a security incident, involving any one of the following: • A fatality associated with BP operations • Multiple serious injuries • Significant adverse reaction from authorities, media, non-governmental organizations, or the general public • Cost of accidental damage exceeding $500,000 • Oil spill of more than 100 barrels, or less if at a sensitive location • Release of more than ten tonnes of a classified chemical
Management of Change (MOC)	A mechanism to require safety analysis of a proposed change.
MAR	Major Accident Risk. A MAR assessment addresses the risk of major accidents with the potential to cause harm to people and/or the environment and to have a serious adverse impact on the Group’s reputation.
Metric	A “key performance indicator” used by managers to track safety performance; to compare or benchmark safety performance against the performance of other companies or facilities; and to set goals for continuous improvement of safety performance.
Mogford Report	Team composed of BP employees and contractors charged with the task of investigating the circumstances surrounding the Texas City accident to determine the root causes, make recommendations to prevent a recurrence, and identify lessons learned.
NPRA	National Petrochemical and Refiners Association
Process Hazard Analysis (PHA)	An organized effort to identify and evaluate hazards associated with chemical processes and operations to enable their control. This review normally involves the use of qualitative techniques to identify and assess the significance of hazards. Conclusions and appropriate recommendations are developed.

Term	Definition
Process Safety Functional Groups	Nine employee groups whose job functions likely involve some degree of on-site exposure to process safety hazards and process safety practices.
PS/IM Standard	Process Safety/Integrity Management Standard
PSM	Process Safety Management
Relief Valve	Spring-loaded valve activated by static pressure upstream of the valve. The valve opens normally in proportion to the pressure increase over opening pressure. A relief valve is normally used with incompressible fluids and, unlike a rupture disk, a relief valve is a pressure relief device that can reclose after opening.
Rupture Disk	A device designed to relieve excessive pressure in a process. When the pressure on one side of the disk exceeds the design limit, which is based on a designated difference in pressures on opposite sides of the disk, the disk bursts or opens, relieving the pressure. Once a rupture disk opens, it cannot reclose.
Stanley Report	Team commissioned by BP, which included BP and external experts, that conducted a process and operational audit review of the Texas City refinery shortly after the March 23, 2005 accident
Turnaround (TAR)	A planned complete shutdown of an entire process or section of a refinery, or of an entire refinery, to perform major maintenance, overhaul, and repair operations and to inspect, test, and replace process materials and equipment.
United Kingdom Health and Safety Executive (UK HSE)	A United Kingdom government agency that enforces health and safety laws.
USW	United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union
Variable Pay Program (VPP)	A compensation program in which all BP refinery employees participate, where pay is partially determined by a set of annual metrics, milestones, and targets relating to financial, availability, and safety objectives for that refinery.

ACKNOWLEDGEMENTS

Members of the BP U.S. Refineries Independent Safety Review Panel give special thanks and appreciation for the outstanding support provided by its legal counsel, Baker Botts L.L.P. The Baker Botts team made extensive contributions to the Panel's efforts while remaining mindful of its position and role of supporting the Panel. Special thanks go to partners Joseph A. Cialone, II, Mark L. Farley, Pamela M. Giblin, Joe S. Poff, and David D. Sterling and to John B. Williams, policy assistant to James A. Baker, III. Coordination of the Panel's schedule and other administrative services were superbly performed by Baker Botts personnel including Charlotte Cheadle, Adele Dubicki, and Catherine Duke.

The Panel would also like to thank its other advisors and consultants who contributed to the Panel's work. In particular, Jack L. McCavit of J.L. McCavit Consulting, LLC and J. S. (Steve) Arendt and Walter F. Frank of ABSG Consulting Inc. led the technical reviews of the process safety management systems at BP's five U.S. refineries. Jack McCavit served as coordinator for the technical reviews, and Steve Arendt served as project manager for the ABS team. International Survey Research LLC acted as consultants to the Panel in connection with the Panel's culture survey conducted to understand the process safety-related beliefs, attitudes, and concerns of employees and contractors at BP's five U.S. refineries. The Panel wishes to thank Gary J. Berger, Ph.D., Executive Director, and Joseph R. Dettman, Senior Project Manager, of International Survey Research.

The Panel also wishes to thank Carolyn W. Merritt, Chairman of the U.S. Chemical Safety and Hazard Investigation Board, and Leo W. Gerard, International President of the United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union for their contribution to a video prepared by the Panel and shown at BP's five U.S. refineries in connection with the Panel's process safety culture survey. The Panel also wishes to thank Chairman Merritt and other representatives of the Chemical Safety Board for meeting with the Panel at its initial meeting in November 2005.

Finally, Panel members thank the many individuals interviewed by Panel members and staff. The Panel received candid and frank responses from hundreds of BP employees, contractors, union leaders, public officials, and residents located near the company's five U.S. refineries, and from other individuals associated with the refining and petrochemical industry. The thoughts and advice of those who observe and understand BP and the refining industry played an indispensable role in helping the Panel develop this report. The valuable insight of these individuals can help BP become a safer company.