How Environmental Regulators Can Address Human Factors in Oil Spill Prevention Using Crew Resource Management

by John Adams Hodge

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Oil is released into the environment from natural seeps and from human activities involved in the exploration, production, transportation, and refinement of oil and its distillation. The effect of oil on the marine environment depends on many factors including the type of oil and the characteristics of the environment into which the oil is released, along with related climatic and meteorological phenomena.[1] In the marine environment, an oil spill environmental sensitivity index (ESI) has been developed to assess the potential risk to different types of shorelines based upon such factors as the shoreline geomorphology, coastal processes affecting the shoreline, and the biological productivity and sensitivity of shoreline habitat.[2] For example, a coastal marsh would be considered a more sensitive endpoint than an exposed rocky headland subject to significant wave activity. At major oil spills, oiled birds, mammals, and larger animals are captured in photojournalist's images, but the impact to macrofauna and meiofauna often goes unreported and uncompensated. These biological resources are extremely important, as the organisms form the basis for the food chain in coastal and marine environments. Federal and state statutes as well as related regulations provide for comprehensive regulation of various phases of petroleum exploration, production, refinement, transportation, and storage, i.e., the oil industry. Missing from the current regulatory approach are mechanisms to minimize the role of human factors in oil spill prevention.

Inasmuch as the Deepwater Horizon accident has now been characterized as the largest environmental disaster in the history of the United States, and the spill ranks among the largest in history, the findings of the U.S. Coast Guard (USCG) and various congressional committees investigating the incident are not yet complete. Nonetheless, based upon news reports, it appears that the accident was the result of technical and human failures. From a cursory review of other major oil spills, it appears that human factors have also played a significant role in the cause of many accidents and significant release of oil into the environment. These circumstances suggest that government regulators have not adequately addressed human factors in oil spill prevention. Environmental agencies should consider the implementation of programs requiring the oil industry to implement error prevention and management programs designed to reduce, minimize, and ultimately eliminate human factors as a cause of oil spills. This author proposes that a model similar to that being utilized by the commercial aviation industry for the last 25 years called Crew Resource Management (CRM) provides an excellent template for adoption. This Article briefly summarizes how human factors contributed to several major oil spills, and then introduces the elements of CRM and suggests means by which regulatory agencies could require the oil industry to implement CRM training. Such safety management systems can be implemented with a minimum of "command-and-control" regulations.

I. Survey of Oil Spills Including Human Factors

Although the official findings and factual determinations surrounding the Deepwater Horizon event have yet to be released, congressional testimony and news reports strongly suggest that human factors were one of the probable causes of the oil spill. It is known that by the April 20th date of the

1. Joanna Burger, Oil Spills 79-89 (1997).
2. Jacqueline Michel et al., *Application of an Oil Spill Vulnerability Index to the Shoreline of Lower Cook Inlet, Alaska*, 2 Envtl. Geology 2, 107-17. (1978).

oil spill, the Deepwater Horizon well was approximately five weeks behind schedule.[3] BP engineers had raised concern in 2009 that the metal casing that BP intended to use could collapse under high pressure.[4] By March 2010, the Deepwater Horizon operation experienced problems with its drilling mud, sudden gas releases occurred, and a pipe fell into the well. In addition, at least three instances were noted in which the blowout preventer experienced hydraulic leaks. A mechanic on the rig indicated that the well had problems for several months and that the drill repeatedly kicked due to high gas pressure, providing resistance to the drilling operation.[5] It has also been reported that the blowout preventer was damaged in an accident that was not divulged at the time to regulators in late March 2010.[6]

In the hours before the accident, there were several significant warning signs prior to the explosion. Instrumentation indicated that methane gas was bubbling into the well, and the drilling mud in the pipes counteracted the upper pressure of the gas in the well.[7] Reports indicate that a BP official on the rig directed the crew to replace the drilling mud with seawater, even though the rig's chief driller protested.[8] The drilling mud is heavier than seawater and was used to counteract the upward hydrostatic pressure of the well. The U.S. House of Representatives Energy and Commerce Committee stated in June 2010 that BP appeared to have chosen riskier procedures to save time or money, sometimes against the advice of its staff or contractors.[9] In addition, it has been stated that a number of rig workers have corroborated that they believed that they could be fired for raising safety concerns that might delay the drilling activity.[10] A survey was conducted in March 2010, in which "less than half of the workers interviewed said they felt they could report actions leading to a potential 'risky' situation without any fear of reprisal . . . . Many workers entered fake data to try to circumvent the system." As a result, the company's perception of safety on the rig was distorted, the report concluded.[11]

On the day of the blowout and fire, four BP and Transocean executives were present on the platform. In addition to receiving a tour of the rig and discussing maintenance planning, annual goals review, and BP's safety campaign ("Drops"), these officials were present to congratulate senior staff on the rig for seven years of operation without a lost time incident.[12]

Testimony before the U.S. Congress on June 17, 2010, indicated a failure in the blowout preventer's control pod may have occurred and that Transocean may have modified equipment, which increased the risk of failure of the blowout preventer, in spite of warnings from a contractor.[13]

In reviewing the aforementioned reports, it is appropriate to ask whether the desire to make up lost time in the drilling schedule, the attitude of rig workers toward raising safety concerns, and the presence of management on the rig, among other factors, were contributing causes to the oil spill.

On March 24, 1989, the *Exxon Valdez* was leaving Valdez, Alaska, and the pilot who had boarded the tanker to steer it out of the Valdez Narrows and into Prince Williams Sound, left the ship and transferred control to the captain. The captain ordered a course change to avoid ice and then left the bridge with the third officer in charge. The captain's order to the third officer to alter course to clear the ice was made, but execution was delayed. In the process, the vessel headed for a shoal called Bligh Reef. The 211,469-ton tanker would not change course, as the crew was unaware that it was locked in an autopilot mode. Within a matter of hours, over 11,000,000 gallons of crude oil spilled into Prince William Sound, and ultimately into the Gulf of Alaska, Cook Inlet, Kodiak Island, and along the Shelikof Straight. Had this spill occurred on the east coast of the United States, it would have covered an area from Connecticut to North Carolina.[14] At the time, this accident was the largest oil spill in U.S. history, and it also occurred in an area that was biologically very rich with commercial salmon and herring fisheries, as well as many marine mammals, birds, shellfish, and other wildlife. It also interfered with Native American subsistence activities. Although many of the biological resources have recovered, oil is still persistent in the environment in Prince William Sound.[15]

On January 1, 1990, a pipeline burst that connected the Exxon Bayway refinery to the Bayonne, New Jersey, plant,

3. Scott Bronstein & Wayne Drash, *Rig Survivors: BP Ordered Shortcut on Day of Blast*, CNN, June 9, 2010, *at* http://www.cnn.com/2010/US/06/08/oil.rig.warning.signs/index.html.
4. Ina Urbina, *Documents Show Early Worries About Safety of Rig*, N.Y. Times, May 29, 2010, *at* http://www.nytimes.com/2010/05/3/us/30rig.html.
5. Bronstein & Drash, *supra* note 3.
6. *Blowout: The Deepwater Horizon Disaster*, CBS News: 60 Minutes, May 16, 2010, *at* http://www.cbsnews.com/stories/2010/05/16/60minutes/main6490197.shtml; Tom Fowler, *BP Prepared for Top Kill to Plug Well*, Hous. Chron., May 18, 2010, *at* http://www.chron.com/disp/story.mpl/business/deepwaterhorizon/7009757.html.
7. Urbina, *supra* note 4.
8. Bronstein & Drash, *supra* note 3.
9. *BP Engineer Called Doomed Rig a "Nightmare Well,"* Assoc. Press, June 14, 2010, *at* http://www.cbsnews.com/stories/2010/06/14/national/main6581586.shtml.
10. Russell Gold et al., *Leaking Oil Well Lacked Safeguard Device*, Wall St. J., Apr. 28, 2010, *at* http://online.wsj.com/article/SB10001424052748704423504575212031417936798.html; Andrew Clark, *BP Oil Disaster Puts Spotlight on Small Texan Firm*, The Guardian, June 18, 2010, *at* http://www.guardian.co.uk/business/2010/June/18/bp-oil-disaster-cameron-international.
11. Mark Langford, *Gulf of Mexico Oil Disaster: Transocean Reports Highlight Workers' Concerns Over Deepwater Horizon,* Sky News, July 22, 2010, *at* http://news.sky.com/skynews/Home/Business/Transocean-Reports-Highlight-Workers-Concerns-Over-Safety-And-Maintenance-On-Deepwater-Horizon/Article/201007415669165?f=rss.
12. *USCG & MMS Joint Investigation of Deepwater Horizon Explosion, Haire and Ezell Testimony,* C-Span, May 28, 2010, *at* http://www.c-spanvideo.org/program/293776-4, event occurs at 38:30, 1:01:05, 1:20:37. A lost-time accident occurred on a service vessel leased and being worked by the Deepwater Horizon rig.
13. Gold et al., *supra* note 10; Clark, *supra* note 10.
14. Burger, *supra* note 1, at 47-61.
15. *Prince William Sound: An Ecosystem in Transition, Assessing Environmental Harm, Emergency Response*, National Oceanic & Atmospheric Administration's (NOAA's) National Ocean Service Office of Response and Restoration, Feb. 1, 2008, *at* http://response.restoration.noaa.gov/topic.

and number two fuel oil was released into an estuary known as the Arthur Kill.[16] A warning light illuminated at the Exxon facility, but workers ignored the light as a false alarm. Apparently, the light had illuminated a number of times during the previous few months, and the staff was lulled into believing that it was another false alarm. The next morning, an oil spill was noticed near the facility. Exxon did little immediately to address the spill; however, and the USCG eventually commenced an assessment and cleanup of the release. Unfortunately, approximately 567,000 gallons of oil were transported due to high tides and storm conditions into the Arthur Kill between Staten Island and Elizabeth, New Jersey, where the oil was deposited into tidal creeks and marshes. Due to the heavy industrialization and population in the vicinity of the Arthur Kill, the marsh served as a significant remaining habitat for birds and fish. Clearly, much of the damage resulting from the Arthur Kill release could have been prevented if workers at the refinery had acted promptly upon illumination of the warning light in notifying authorities of the release.

On February 15, 1996, the *Sea Empress* ran aground due to human error in the vicinity of Milford Haven, Wales, near several British wildlife sanctuaries.[17] The *Sea Empress* was a Liberian-registered ship, loaded with 130,000 tons of light crude oil, that was built in Spain, owned by a Norwegian corporation, registered in Liberia, and manned by a Russian crew. The oil impacted the Pembrokeshire Coastal National Park and the Skomer, Skokholm, and Grassholm Islands. Approximately 120 miles of coastline were affected. The spill caused economic impact to fisherman and others, but also led to significant damage to habitat for birds and to marine life in the coastal zone.

In March 1978, the *Amoco Cadiz* tanker went ashore in a gale in Brittany. In the gale, the ship's steering was lost and a tug came to assist, but the swells snapped towing cables from the tug, and the ship drifted ashore approximately 12 hours later, resulting in a release of approximately 68.7 million gallons of crude oil.[18] Although there were design failures that caused the accident, such as a faulty design for the steering system and failure of the steering gear, the cause of the accident was also attributed to the failure to summon assistance immediately. The captain was found to be guilty of "gross dereliction" for waiting 140 minutes after the grounding to issue a distress call. It was determined that the captain should have issued a distress call at least seven hours earlier when the first tow line broke and should have also done so when the ship ran aground.[19] The *Amoco Cadiz* was a Liberian-flagged tanker built in Spain, owned by Americans, and sailed by an Italian crew. Oil from the spill impacted over 400 miles of the French coast and damaged a mature fishing and tourist industry. Significant damage occurred to marine life and birds.

In each of the aforementioned incidents, human factors caused or contributed to these oil spills. The results suggest that national authorities and international protocols that regulate the oil industry should adopt programs to minimize the role of human factors in oil pollution. Existing programs may be used and adopted as analogues for the oil industry to address the human element in error management that has resulted in oil spills. As a model, the oil industry should consider the impact that such training has had on the commercial aviation industry.

II. Is CRM in Commercial Aviation an Analog for the Oil Industry?

The oil industry should consider the experience of the commercial aviation industry in evaluating and adopting CRM as a means of reducing human error as a cause of aircraft accidents. CRM was coined by aviation psychologist and former U.S. National Transportation Safety Board (NTSB) Member John Lauber in 1979 as "using all available resources—information, equipment, and people to achieve safe and efficient flight operations."[20] A review of aviation accidents by the NTSB indicated that a large proportion of aircraft accidents were the result of crew failures, as opposed to technical or mechanical problems. In many accidents, a perfectly good aircraft was flown into the ground where one or more crew members observed deviations, but no corrective action was taken. The overly simplistic cause given by the media to accidents as "pilot error" only, in the words of one writer, transfers the cause of the accident from one mystery to another.

A Boeing 737 jet was taxiing out in a snowstorm at a major airport, and the copilot made several comments to the captain regarding the amount of ice on the aircraft, yet did not insist that the aircraft be deiced again, nor did he assert himself. As a result of several operational errors, in spite of the obvious signals that were noted by the copilot, the aircraft departed the airport and crashed off the end of the runway due to excessive ice accumulation and improperly set thrust.[21]

In 1978, a four-engine DC-8 jet was approaching Portland International Airport. When the landing gear was lowered, only two of the three green lights indicating that the gear was down and locked illuminated. The crew circled the airport to troubleshoot the problem, but became absorbed in the gear light and failed to monitor the low fuel state and distance from the airport. The four-engine jet ran out of fuel and landed in a sparsely populated area, resulting in fatalities. The NTSB determined that the captain failed to properly monitor the aircraft fuel state and did not respond to crew member advisories regarding the fuel state. The NTSB also faulted the copilot and flight engineer for either failing to "fully comprehend the criticality of the fuel state or to successfully communicate their concern to the captain."[22]

In another accident, two Boeing 747 aircraft collided on a runway on the Spanish island of Tenerife. Although there were multiple causes for the accident that killed 583 people,

16. Burger, *supra* note 1, at 61-69. "Kill" is a Dutch word for creek.
17. *Id.* at 74-77.
18. *Id.* at 38-42.
19. *Id.* at 39.
20. John Lauber, *Resource Management in the Cockpit*, 53 Airline Pilot 20-23 (1984).
21. U.S. NTSB, Aircraft Accident Report AAR 82-2 (1982).
22. *Id.* AAR 79-7 (1995).

contributing to the accident was the behavior of the captain and copilot of one of the aircraft. Thick fog rolled in over the airport. Upon reaching the end of the runway, the captain of one 747 set the throttles to "spool" up the engines for takeoff, and the first officer quickly advised the captain that the aircraft had not received takeoff clearance. Due to a communication error and misunderstanding, shortly thereafter, the captain began the takeoff roll and dismissed the question from the first officer and another from the flight engineer regarding whether the aircraft was cleared for takeoff.[23]

All three of the aforementioned accidents could have been prevented with proper use of CRM, which involved listening and assertiveness skills on the part of the crew. These accidents predate the introduction of CRM training.

Research by the National Aeronautics and Space Administration (NASA), the NTSB, the commercial airlines, pilot unions, and prominent aviation and industrial psychologists set out to determine what types of interpersonal communication, decisionmaking, and leadership skills could be developed by flight crews to enhance safety and minimize aircraft accidents. Since 1981, when United Airlines began the first CRM program (then called Cockpit Resource Management), the industry has evolved in the level of training, sophistication, and embedded CRM into airline training programs for flight crews and now to other employees, such as flight attendants, dispatchers, and maintenance personnel.[24] Since its inception, other industries have embraced CRM, such as the medical profession, including surgical teams, emergency rooms and trauma centers; the railroad industry; the firefighting industry; and some members of the offshore oil industry in the United Kingdom.[25]

CRM training is designed to reduce operational errors that could cause an accident and to give crews additional skills to deal with problems if they are faced with an emergency.[26]

There is no "one-size-fits-all" or standard CRM training program. The Federal Aviation Administration (FAA) allows each air carrier to develop its own program, which is tailored to its organization and air carrier certificate. CRM has evolved based upon the experience of the aviation industry and is incorporated into virtually all phases of training programs conducted by major U.S. airlines and many established foreign carriers. A good summary of the elements that the FAA expects from airlines in creating CRM programs is contained in FAA Advisory Circular AC 120-51E.[27] A summary of the FAA's findings is outlined below:

1. "Human factors" is a multidisciplinary field devoted to optimizing human performance in reducing human error that borrows principles from behavioral and social sciences, engineering, and physiology. Human factors recognize that inadequate system design or inadequate operator training can contribute to individual human error that leads to system performance degradation.
2. Modern CRM uses team management concepts that involve pilots, flight attendants, maintenance personnel, and others. CRM refers to the effective use of all available resources, including human resources, hardware, and information. In order to integrate these concepts into the industry, the FAA has described the training as comprised of initial indoctrination/awareness training, recurrent practice, feedback, and reinforcement. It has further been determined that without recurrent training and continued emphasis by management on CRM, the skills and principles degrade in their effectiveness over time. The FAA further noted that "many problems encountered by flight crews have very little to do with the technical aspects or operating a multiperson cockpit. Instead, problems are associated with poor group decisionmaking, ineffective communication, inadequate leadership, and poor task or resource management."[28] It was further noted that training programs traditionally focused on the technical aspects of flying, but did not "effectively address crew management issues that are fundamental to safe flight."[29]
3. CRM training is based on awareness that a high degree of technical proficiency is essential for safe and efficient operations. Demonstrated mastery of CRM concepts cannot overcome a lack of proficiency. Similarly, high technical proficiency cannot guarantee safe operations in an absence of effective crew coordination.
4. To be effective, CRM concepts must be permanently integrated into all aspects of training and operations.
5. While there are various useful elements of CRM training today, certain essentials are universal:
   (a) CRM training is most effective within a training program centered on clear, comprehensive standard operating procedures (SOPs).
   (b) CRM training should focus on the functioning of crew members as a team, not as a collection of technically competent individuals.
   (c) CRM training should instruct crew members how to behave in ways that foster crew effectiveness.
   (d) CRM training should provide opportunities for crew members to practice skills as necessary to be effective team leaders and team members.
   (e) CRM training exercises should include all crew members functioning in the same roles as they normally perform in flight.

23. Aircraft Accident Report, Tenerife, Canary Islands, Mar. 27, 1971, Airline Pilots Assn. (1979).
24. Robert L. Helmreich et al., *The Evolution of Crew Resource Management Training in Commercial Aviation*, 9 Int'l J. Aviation Psychol. 1, 19-32 (1999).
25. Rhona H. Flin, *Crew Resource Management for Teams in the Offshore Oil Industry*, 3 Team Performance Mgmt. 2, 121-29 (1997); U.S. Federal Railroad Administration (FRA), *Rail Crew Resource Management (CRM): The Business Case for CRM Training in the Railroad Industry*, DOT/FRA/ORD-07/21 (2007).
26. Flin, *supra* note 25, at 121.
27. U.S. Federal Aviation Administration (FAA), *Crew Resource Management Training*, AC 120-51E (issued Jan. 22, 2004), *see also* Table 1.
28. *Id.* at 4.
29. *Id.*

(f) CRM training should include effective team behaviors for normal, routine operations.

6. The FAA recognized that an essential CRM concept is communication. Training manuals and policies and procedures should provide pilots with clear and comprehensive SOPs. In addition, "it is essential that every level of management support a safety culture in which communication is promoted by encouraging appropriate questioning."

The success of any CRM program depends upon the ability to assess the value of the training as a function of crew performance.

The FAA also encourages training for pilots to develop error management skills and procedures, such that the prevention, detection, and recovery from errors can be properly managed, since all errors cannot be prevented. In addition, CRM should consider the professional cultures of the individuals, the cultures of their organizations, and national cultures of such individuals. Cultural differences may degrade crew performance.

In an article regarding CRM for teams in the offshore oil industry, operator programs were borrowed from British Airways, which include a curriculum involving decisionmaking in normal and emergency situations, communication including barriers to effective communication, and awareness of strengths and weaknesses of personal communication skills.[30] The training highlighted the importance of feedback and listening skills and the role of nonverbal communication and effective communication techniques. During training, actual incidents were discussed.

The British Airways program that was adopted by Shell Expro also addressed the assertiveness of team members. For example, in many aircraft accidents, one or more crew members objected and were plainly aware of procedural errors or aircraft deviation from its intended flight path; however, due to their lack of training and interpersonal skills, these errors went unchecked because the personnel were not assertive in bringing such deviations to the captain or flying pilot in a timely manner. It has been recognized that a need exists for junior team members to become more assertive.

> Accident analysis and simulator observations . . . revealed the reluctance of copilots to challenge captain's authority even when they had made a poor decision or an actual error. This was compounded by an attitude held by some captains that it was not the copilot's place to question their decisions . . . . Research shows clearly that high-performing (low error) crews have a climate of openness and trust where team members are receptive to alternative views and team members are not afraid to express them.[31]

Accordingly, training is designed to address crew member attitudes toward each other to ensure that concerns are unambiguously addressed and solutions are offered without fear of rejection.

III. The Role of Corporate and National Culture

The role of corporate and national culture greatly affects the degree of acceptance of CRM, change of attitude, and behavior by workers. Management acceptance of CRM programs is vital to reduce "macho attitude" and to alter hierarchical structures necessary for the success of CRM as an element of error prevention.

In developing programs in aviation, it has also been recognized that different cultural backgrounds will greatly affect the acceptance and outcome of CRM training.

The concept of a power distance index and uncertainty avoidance is based upon the work of Geert Hendrik Hofstede, a Dutch organizational sociologist.[32] Hofstede conducted a survey concerning the values of people in excess of 50 countries who worked for IBM or its local subsidiaries. Based upon a statistical analysis of answers given by similar IBM employees in different countries, Hofstede's results revealed common problems with solutions that differed based upon nationality. The problem areas included social inequality, including the relationship with authority; the relationship between the individual and the group; concepts of national entity and femininity; and ways of dealing with uncertainty, related to control of aggression and the expression of emotions. Among the aforementioned, Hofstede defined the term "power distance" to mean the extent to which less powerful members of organizations and institutions accept and expect that power is distributed unequally. The work of Hofstede suggests that a society's level of inequality is endorsed by followers as much as by leaders. In Hofstede's work, Guatemala, Malaysia, and Panama have the highest power distance index, while Austria, Denmark, and Israel have the lowest power distance index. In cultures with a higher power distance index, subordinates accept their position and are less likely to question their superiors.

The concept of uncertainty avoidance is defined as the extent to which members of a culture feel threatened by uncertain or unknown situations and thus try to avoid such situations. Uncertainty avoidance may be expressed through the need for predictability and a need to have written and unwritten rules. Countries with a high uncertainty avoidance index are cultures in which individuals are uncomfortable with uncertainty and need reliability and predictability in their social interaction.

In teaching CRM concepts to different cultures, one must contend with variations and limitations in cultural traditions and norms as expressed in Hofstede's work. In cultures with high power indices, subordinates are not socialized to question nor are they expected to question persons in authority over them. Similarly, persons from cultures with high uncertainty avoidance may be very uncomfortable speaking up to raise safety concerns, due to the discomfort associated with

30. Flin, *supra* note 25, at 121-29.
31. Flin, *supra* note 25, at 126.

32. Geert Hofstede, Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations Across Nations (2d ed. 2001); Geert Hofstede et al., Cultures and Organizations: Software of the Mind (2d ed. 2005).

uncertainty avoidance and the unpredictable results of their speaking out of turn or contrary to cultural norms. Thus, implementation of CRM has addressed cultural differences when dealing with individuals or groups from other cultures, or in a multinational setting. For example, cultures that have been described as high power distance cultures, that stress the absolute authority of leaders, may find it difficult to adopt effective CRM concepts.[33] In such cultures, subordinates are reluctant to question decisions and actions of their superiors, as they do not wish to show disrespect. In highly individualistic cultures, some individuals may cling to a "lone ranger" attitude that rejects team decisionmaking or behavior. Also, uncertainty avoidance occurs in cultures where there is a strong need for rule-governed behavior and clearly defined procedures. Such cultures may be more accepting of CRM concepts. Also, the degree of trust of automation in modern aircraft cockpits is a function of cultural orientation. Crews from high power distance and/or uncertainty avoidance cultures have demonstrated unquestioning usage of automation, while those from cultures of low power distance or uncertainty avoidance show a greater willingness to disengage automation.

Efforts are being made to adopt CRM in hospitals and medical teams.[34] In researching in a hospital environment, only 55% of attending surgeons rejected a steep hierarchical structure in which junior members should question the decisions of senior team members. Ninety-four percent of airline crew members preferred a flat hierarchy in which authority was exercised in collaboration with others.[35]

Ultimately, CRM has evolved and is embedded in the culture of commercial aviation. Once the corporate structure recognizes that a certain amount of human error is inevitable, CRM can be used as a series of processes to avoid errors and track errors early enough in the process to mitigate the consequences of such errors.[36]

IV. How Can CRM Be Imported Into the Oil Industry?

CRM has been widely accepted in commercial aviation, and it is now being implemented in other occupational settings.[37] Implementation of CRM in offshore oil rigs, refineries, and shipping and related pipeline facilities and transportation could reduce the risk of human error as a cause of oil spills. In developing programs prescribed by regulation, several principles from the aviation industry are apparent:

1. Since there is no "one-size-fits-all" or uniform CRM module, training should be tailored to the company and to the type of operations conducted.
2. Since operations may involve subcontractors, teams on oil rigs, tankers, or other facilities may be employed by different companies. In addition to managing different corporate cultures, these individuals may also have different cultural and ethnic backgrounds that should be taken into account during training.
3. The training should be integrated with initial CRM training and then regular recurrent training, and could be paired with other required training, such as Occupational Safety and Health Administration-required safety training.
4. In order to be successful, management at all levels should endorse CRM.

In considering the agencies that might be responsible for assuring that such training occur, this author suggests that the USCG and the Minerals Management Service (MMS) should share joint responsibility for CRM training and implementation. Both the MMS and the USCG operate under a memorandum of agreement (MOA) regarding overlapping and interrelated responsibilities for well discharge planning, preparedness, and response.[38]

The MOA sets forth joint responsibilities for oil discharge planning, preparedness, and response pursuant to the Outer Continental Shelf Lands Act (OCSLA),[39] the Oil Pollution Act (OPA),[40] and the Submerged Lands Act (SLA).[41] In addition, the statutory authority of the USCG provides for cooperation with other governmental agencies.[42] The MMS role may be generally conceptualized as requiring planning and preparedness for potential releases of oil from regulated facilities in state and federal offshore waters. Jurisdiction includes areas seaward of the coastline and encompassing all offshore navigational waters subject to the jurisdiction of the United States.[43] In contrast, the USCG has jurisdiction over vessels, such as tankers, offshore supply vessels, and other vessels involved in OCS activities.[44] The USCG is also the Federal On-Scene Coordinator (FOSC) for oil and hazardous substance pollution releases or threatened releases from the coastal zone of the United States.[45] With the exception of U.S. Department of Defense (DOD) facilities, the USCG FOSC is charged to respond, investigate, and conduct remedial actions for oil and hazardous substances released into the coastal zone.[46]

The OPA sets forth a comprehensive organization consisting of the National Response Unit, USCG District Response Groups, Area Committees and Contingency Plans, ves-

33. Helmreich, *supra* note 24, at 6.
34. Laura Pizzi et al., *Crew Resource Management and Its Application in Medicine, in* Making Health Care Safer: A Critical Analysis of Patient Safety Practices, 501-10 (K.G. Shojania et al. eds., 43 Evidence Report/Technology Assessment, AHRQ Publication No. 01-E058, 2001); J. Bryan Sexton et al., *Error, Stress, and Teamwork in Medicine and Aviation: Cross Sectioned Surveys*, 320 BMJ 745-49 (2000).
35. *Id*.
36. Helmreich, *supra* note 24, at 7, 8.
37. Flin, *supra* note 25, at 121-29; FRA, *supra* note 25; Pizzi et al., *supra* note 34.
38. Memorandum of Agreement Between the Minerals Management Service-U.S. Department of the Interior and the U.S. Coast Guard-U.S. Department of Homeland Security, MOA: OCS-03 (2007) [hereinafter MOA]. On June 18, 2010, the MMS was renamed the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) pursuant to Order No. 3302 of the Secretary of the Interior. For the sake of continuity and to prevent confusion, this Article maintains reference to the MMS throughout.
39. 43 U.S.C. §§1347, 1348(a).
40. 33 U.S.C. §§2701-2761.
41. 43 U.S.C. §§1301-1315.
42. 14 U.S.C. §141.
43. MOA, *supra* note 38, at 2.
44. *Id.*
45. 40 C.F.R. Part 300.
46. MOA, *supra* note 38, at 2.

sel and facility response plans, and drill requirements that are administered by the USCG.[47] Response spill plans are also required to be submitted to the MMS for approval and periodically updated for covered owners and operators of oil handling, storage, and transportation facilities seaward of the coastline.[48] Oil response plans for deepwater ports are under the jurisdiction of the U.S. Department of Transportation. However, where a deepwater port is co-located with an MMS-regulated facility, the existing regional or subregional oil spill response plans are submitted to both the MMS and the USCG for approval.[49] Both the MMS and the USCG conduct spill response exercises and drills. The MMS is responsible to inspect oil discharge response equipment and MMS-approved oil spill response plans; however, the USCG also conducts preparedness assessments that involve inspection of oil spill response equipment as part of spill response exercises. The MOA between the MMS and the USCG states:

> MMS is responsible for ensuring that the staffs of oil spill removal organizations (OSROs), spill response operating teams (SROTs), and oil spill response cooperatives are trained in the use of oil discharge response equipment and techniques to respond to an oil spill. Whenever practicable, MMS and USCG will attend and audit the training that OSRO and response personnel receive, and provide feedback for improvement of operational readiness.[50]

In addition, owners or operators of offshore facilities must have dedicated spill management teams (SMTs) and such teams must be capable of:

> orchestrating an effective, sustained response to a worst-case discharge from their facilities.[51] Members of such SMTs are required to undergo annual training. The MOA indicates that whenever practicable, MMS and USCG personnel will attend the training and drills to ensure that the teams are functioning properly, provide input for continual improvement of the team, and make members aware of new Agency requirements.[52]

In addition, both the MMS and the USCG undergo oil spill response training, and the MOA encourages joint participation in such training courses and exercises.[53]

In response to actual oil spill events, the USCG acts as the FOSC in accordance with the terms of the national contingency plan. As such, the USCG has the authority to direct federal, state, and private response actions and is involved in coordinating work between the responsible party, the government, and other private actions. If a release occurs from an MMS-regulated facility, the USCG OSC is encouraged to work with the responsible party and the MMS in developing response strategies.[54] As part of the spill response process, upon request of the USCG OSC, the MMS "will provide engineering, technical, and scientific expertise to support responses to significant oil discharges from MMS-regulated facilities in the OCS."[55] The USCG will also deploy personnel to integrate into the MMS incident management team during emergencies in which the team is activated involving emergencies at OCS energy facilities. "The goal of this integration of MMS and USCG personnel is to prevent duplication of efforts, optimize the use of resources, ensure consistency in data collection and reporting, and to expedite search and rescue and oil discharge response operations."[56]

Pursuant to overlapping federal authorities, the MOA provides for joint interaction between federal agencies, state authorities, responsible parties, and private interests responding to a discharge of oil into the marine environment.

In implementing CRM within the oil industry, as well as in emergency response teams, integration of such requirements into existing programs is best suited as a means of training those government and private oil response management teams. Due to the USCG's primary responsibility relating to vessels, and the MMS' primary responsibility to offshore facilities seaward of the coastline, both agencies should have joint responsibility to implement CRM programs and to oversee the training, curriculum, and implementation of CRM on vessels and offshore facilities. The MMS and the USCG should have separate but overlapping responsibilities to ensure that both oil spill response plans and training, as well as implementation during actual drills and events, incorporate the elements of CRM. The CRM requirements could be implemented through a rulemaking that sets forth identical, or at least similar, standards for training, whether it be with respect to vessels or to offshore facilities. The objective is to provide a seamless integration of CRM into the industry without substantial differences whether the CRM training is reviewed or approved by the USCG or the MMS.

A model similar to that adopted by the FAA provides a good structural or procedural analog for the USCG to follow. Coverage could extend to workers who are employed at offshore and onshore facilities that have operational responsibilities, including management. Workers would train as a team, and such training would cross different job titles and classifications. The training would be designed to be informative, practical, and would include simulation and experience in normal and abnormal operations (see Table I). Much like air crews, who may have never met before, but are paired to fly together, SOPs should be developed, such that oil industry workers of different backgrounds who have little or no familiarity with each other would be able to function as a team in conducting operations at oil exploration, refining, and transportation facilities. For subcontractors, the company with final authority for the operation of a rig, vessel, or pipeline is responsible to ensure that subcontractors are adequately given site-specific training on procedures and CRM approaches for the particular operation, vessel, or facility.

The curriculum basics would be outlined by rule, but each operator would have the flexibility to adopt training tailored

47. 33 U.S.C. §1321.
48. 30 C.F.R. Part 254.
49. MOA, *supra* note 38, at 4.
50. MOA, *supra* note 38, at 5.
51. *Id.*
52. *Id.*
53. MOA, *supra* note 38, at 9.
54. MOA, *supra* note 38, at 7.
55. *Id.*
56. *Id.*

Table I

CRM curriculum topics suggested by the FAA include:

- Communication processes and decision behavior. Both internal and external influences on interpersonal communications should be covered. External factors include barriers, such as rank, age, gender, and organizational culture. Internal factors include speaking skills, listening skills, and decisionmaking skills, conflict resolution techniques, and the use of appropriate assertiveness and adequacy. The FAA emphasizes the importance of clear and unambiguous communication in all training activities involving personnel. Related topics include training in briefings by the aircraft captain regarding the establishment and maintenance of open communications, which include safety and security situations.
- Training crew members to see the benefits of advocating a course of action that they feel is best, even though it may conflict with others.
- Self-critiquing crew behavior through debriefings.
- Conflict resolution, including techniques for resolving disagreements among crew members in interpreting information or in proposing courses of action.
- Demonstration of techniques of seeking and evaluating information and subsequent decisionmaking.
  - Team-building and maintenance, which includes interpersonal relationships, including leadership, followership, and how to recognize and deal with diverse personalities and operating styles, including:
  - Practicing leadership through coordinating activities and maintaining a balance between respecting authority and practicing assertiveness.
  - Emphasizing the value of maintaining a friendly, relaxed, and supportive, yet task-oriented tone in aircraft cockpit and cabin.
  - Recognizing symptoms of fatigue and stress, and taking appropriate action.
  - Workload management and situational awareness, which include concepts of planning, preparation, vigilance, workload distribution, and distraction avoidance.
  - Training and demonstration of the negative effects of stress and fatigue on individual cognitive functions and team performance.
- Additional curriculum could include examination of personality and motivational characteristics, self-assessment of personal style, and identifying cognitive factors that influence perception and decisionmaking.

Source: FAA Advisory Circular AC 120-51E, Crew Resource Management Training.

specifically to their facilities and operations. Table II outlines a curriculum utilized by the USCG for CRM training of its aircrews. Oil companies and their contractors would be required to maintain CRM materials and curriculum onsite and to maintain records of each employee's training, including those of contractors.

To maintain mobility in the industry, we suggest that a national training or credentialing organization could assist in credentialing instructors who have adequate knowledge and understanding of CRM concepts and who have been trained to communicate both the theory and practice of CRM. Each employee would be trained initially on CRM practice and procedure, and again on at least an annual basis in recurrent training. Employees would receive a certificate of training. Where employees are organized, labor unions may be of assistance in facilitating CRM training and programs in cooperation with management.

The facility's CRM plan should specifically create a working environment in which open communication and addressing safety concerns is the rule, not the exception. A culture such as evidenced in the statements of workers at Deepwater Horizon, who believed that they might be subject to discipline or termination for speaking up about safety matters, should be a thing of the past. Beyond the obvious risk-reduction, incentives for operating effective and robust CRM programs could come in the form of a change in civil penalty policy, where the operation of safety management systems, including CRM, are in place and resulted in a demonstrable mitigation or prevention of a petroleum release.

This author envisions that the oil industry would be mandated to adopt programs with approved CRM training courses by properly credentialed instructors. Training would occur at least annually, and records of training would be retained by the facility. Any previously trained employees transitioning to a facility would have differences training courses governing particular CRM issues pertinent to the particular facility. The training would extend to contractors working onsite, and documentation of training would be retained by the facility, along with the curriculum. Such information would be available to the USCG and the MMS upon inspection.

Table II

The USCG CRM course modules:

- Introduction to CRM
- Flight Discipline
- Normalizing Excellence
- Fatigue
- Nutrition and Hydration
- Stress
- Hazardous Attitudes (assertiveness)
- Error-Producing Conditions
- Effective Communication
- Situational Awareness
- Mutual Support
- Class Exercise
- Risk Management
- Automated Airmanship

The USCG could require oil tanker personnel operating in U.S. territorial waters and the Exclusive Economic Zone to have completed CRM training. Due to the pervasive use of flags of convenience and non-English-speaking crews, additional considerations will have to be made on how to ensure that an effective program exists; however, a potential partnership with the insurers for oil tankers and their respective organizations could be a mechanism to engage ship owners and operators with the safety and financial benefits to having crews trained in CRM theory, practice, and procedure.

V. The Aviation Safety Action Reporting Program

Another program from the aviation industry that is available to prevent accidents and enhance safety is the Aviation Safety Action Reporting Program (ASAP).[57] Under an ASAP program, employees are encouraged to make voluntary reports of safety information that may be critical to identify potential precursors to accidents. These programs have been very successful in aviation in addressing unsafe conditions and trends. The ASAP program provides for collection, analysis, and retention of safety data as a means of educating employees and management regarding the development of corrective actions to prevent identified safety concerns. A party submitting an ASAP report would be immune from punishment, discipline, or sanction, so long as safety issues are resolved through corrective action. The author has developed ASAP-type programs for regulated facilities, such as wastewater treatment plants.

If adopted by the oil industry, it is recommended that the safety reports generated by employees would be sent to an event review committee or safety committee that analyzes the reports, determines whether the reports qualify for inclusion in a safety database, identifies actual potential problems, and proposes solutions for those problems. In order to be successful, the event review committee or safety committee should adopt procedures to ensure that the ASAP reports are properly de-identified, so as to guarantee anonymity and prevent employee fear of retribution. A regulation or statutory amendment could be enacted allowing ASAP reports for approved or qualifying programs to be exempt from being used in civil enforcement proceedings and in third-party litigation. Such protection would ensure that the ASAP program is focused on accident prevention and that the reporting does not increase the risk of liability to the government or third parties. ASAP reports should be made within 24 hours of the event or occurrence. To qualify for immunity from employee discipline, any violation disclosed in an ASAP report must be inadvertent and should not involve an intentional disregard for safety. If another employee knew of a potential violation and withheld it, the employee would be offered an opportunity to submit an ASAP report or otherwise face potential discipline. Reports that involve intentional acts, falsification, criminal activity, or substance abuse would not be granted immunity.

Where a potential regulatory violation is revealed through an ASAP report, the regulated entity must make a voluntary disclosure and perform corrective action to obtain penalty reduction and/or immunity as allowed by a law or enforcement policy. The creation of an ASAP program within the oil industry could be accomplished through an MOA between the facility and the designated agencies, such as the USCG and the U.S. Environmental Protection Agency (EPA). It is envisioned that a rulemaking could further address confidentiality, employer immunity, and penalty reduction.

In addition, another model program that has been developed and is being implemented at U.S. airports nationwide is the development of safety management systems to ensure a similar safety culture at facilities, as currently exists with air carriers.[58]

VI. Conclusion

Human factors have been a cause of some major oil spills. The oil industry could benefit from the implementation of error management programs, such as CRM, that have been applied and integrated into the commercial aviation industry over the last 30 years. Oil industry employees working on rigs, tankers, pipelines, and other facilities often work in a team environment where decisionmaking depends upon not only the clear and concise communication of team members, but where parties should be encouraged to speak up, point out potential safety or other operational concerns, without fear of retribution, discipline, or termination. In addition, senior team members should be trained to solicit, review, and consider the observations and suggestions of junior team members.

The experience in the aviation industry has been that CRM is a benefit to safety, morale, and accident reduction. The benefits have overshadowed the cost of implementation or reluctance of some employees to obtain and buy into the program. In the aviation industry, initially, there were some who rejected CRM; however, after 30 years of such training, CRM concepts have been adopted and engrained into the industry. A combination of CRM and ASAP programs could vastly reduce the risk of oil pollution through human error. Examination of human error prevention in the oil industry is long overdue.

In considering how environmental regulators could require implementation of CRM, shared responsibility between the USCG and the MMS (recently renamed the Bureau of Ocean Energy Management, Regulation, and Enforcement) currently exists for spill planning, training, and emergency response, thus both USCG and the MMS should require and administer similar CRM programs over facilities, vessels, or operations under their respective jurisdictions. In addition, in developing such a program, experience borrowed from the aviation industry shows that a CRM program must be adapted for each operator. Accordingly, a mechanism of credentialing or certifying instructors is necessary and would be required in facilities and vessels to implement CRM train-

57. FAA, Aviation Safety Action Program (ASAP), FAA Advisory Circular No. 120-66B (2002).

58. FAA, Safety Management System Guidance, FAA Order No. 8000.369 (2008), *at* www.faa.gov/about/initiatives/sms.

ing for their workers, and to be responsible for the training of contractors working on the premises. By certifying the instructors, and then providing approved training to employees, CRM could be implemented within the industry according to a mandated schedule. CRM should occur as initial training, and then at least on an annual basis with recurrent training, and it should be site-specific. Additionally, differences training courses could be held for employees transitioning from one facility or vessel to another. The approved CRM curriculum, training materials, and evidence of training should be retained by the facility and available for inspection. An operator would also be responsible to ensure that training occurred for any contractors who are covered persons working on the operator's premises.

As a means of encouraging the effective use of CRM, EPA, and other agency penalty policy could be amended to allow for a reduction in a penalty if violations occurred and oil pollution was prevented or mitigated through the use of an approved CRM program. In addition, if, upon inspection, a CRM program was substandard and failed to materially meet the items required in a training program, by regulation, the operator could be subject to enforcement. The use of untrained workers would also subject an operator to enforcement.

In the aviation industry, some viewed the introduction of CRM as usurping the captain's authority, and others viewed it as a "charm school" that did not deal with operational issues. After 30 years of experience, the industry has evolved and such claims are outdated. CRM has the potential to avoid and minimize oil pollution events, as well as the liability of the oil industry to the government and to third parties who claim economic damage.