CALIFORNIA
DEPARTMENT OF FISH AND WILDLIFE
OFFICE OF SPILL PREVENTION AND RESPONSE

REPORT ON
BEST ACHIEVABLE TECHNOLOGY
PREVENTION/MITIGATION

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State of California
Edmund G. Brown Jr., Governor

Natural Resources Agency
John Laird, Secretary

Department of Fish and Wildlife
Charlton H. Bonham, Director

Office of Spill Prevention and Response
Thomas M. Cullen Jr., Administrator

Contributing Writers and Reviewers

Gus Bannan, United States Coast Guard
Chris Beckwith, California State Lands Commission
John Berge, Pacific Merchant Shipping Association
Robin Blanchfield, California Coastal Commission
Heather Kirkiring, Central and Northern California Ocean Observing System
Joy Lavin-Jones, Office of Spill Prevention and Response
Annie Nelson, Office of Spill Prevention and Response
Craig Ogawa, Bureau of Safety and Environmental Enforcement
Bob Poole, Western States Petroleum Association
Steve Ricks, Marine Spill Response Organization
Linda Scourtis, Bay Area Conservation and Development Commission
Michael Sowby, Office of Spill Prevention and Response
Gary Toledo, Office of Spill Prevention and Response
Gerry Wheaton, National Oceanographic and Atmospheric Administration

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EXECUTIVE SUMMARY

The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 delegates responsibility and authority to the Administrator of the Office of Spill Prevention and Response (OSPR), a Chief Deputy Director of the Department of Fish and Wildlife, for prevention and planning measures, response, and restoration needed in order to provide Best Achievable Protection (BAP) from the impacts of oil spills into marine waters. In 2014, Senate Bill (SB) 861 expanded that jurisdiction to the inland environment. In 2016, SB 414 required the Administrator to submit a report to the Legislature assessing the Best Achievable Technology (BAT) for prevention, preparedness, and response.

OSPR continuously works to identify and facilitate the use of BAT in several categories: prevention/mitigation, mechanical response, Applied Response Technologies (ART), and remote sensing. This report focuses on the latest technology for oil spill prevention and mitigation, identifying BAT with relation to the risk of spills from tank and nontank (e.g., container) vessels and facilities, including offshore platforms, marine terminals, refineries, pipelines, onshore production fields, and rail transportation.

BAT for the prevention of vessel spills consists primarily of electronic aids to navigation and other tools that enhance vessel safety; this report also outlines the importance of established best practices and regulations that aim to prevent spills from vessels. Facilities serve a wide variety of functions: drilling, refining, transporting, and storing oil and petroleum products. BAT for the prevention of spills from facilities, includes a broad range of tools, such as well blow-out preventers, fire protection systems, pipeline “pigs” and other testing equipment, and above-ground containment/storage areas that keep spills from reaching state waters. Inspections, training, and other preventative measures are required by state and federal regulations for facilities.

This report also includes detailed descriptions of the state and federal agencies that have significant oil spill prevention jurisdiction in California. Federal government prevention programs exist within the United States Coast Guard (USCG), the Bureau of Safety and Environmental Enforcement (BSEE), the US Environmental Protection Agency (EPA), and the Department of Transportation’s Pipeline and Hazardous Materials Safety Administration (PHMSA). State agencies include OSPR, the California State Lands Commission (CSLC), the California Coastal Commission (CCC), the San Francisco Bay Conservation and Development Commission (BCDC), the Division of Oil, Gas, and Geothermal Resources (DOGGR), and the Division of Occupational Safety and Health (Cal/OSHA). The report concludes with an accounting of current international standards, guidelines, and oil spill prevention initiatives.

INTRODUCTION

In 1990, the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act (the Act, California Government Code §8670.28, et al.) was enacted to protect marine waters of the state from oil pollution. This Act created a comprehensive statewide program which consolidated the primary authority for prevention and response for marine oil spills. The Act included the regulatory responsibility for contingency planning (both prevention and response), wildlife rehabilitation, and cleanup and abatement; this authority rests with the Administrator of OSPR within the Department of Fish and Wildlife. In 2014, SB 861 (Budget and Fiscal Review), Ch. 35, Statutes of 2014 expanded that jurisdiction to the inland environment. The Department of Fish and Wildlife is the only state agency in the United States with combined regulatory, law enforcement, pollution response, and public trust authority within state waters.

OSPR is mandated to ensure that BAP from oil spills is provided in California. To that end, the OSPR Administrator is required to periodically evaluate the feasibility of requiring new technologies to aid in prevention, response, containment, and cleanup. In 1995, OSPR accordingly generated a report to the Legislature entitled, "The Feasibility of Requiring New Technology for Oil Spill Prevention and Response." At the time, this report was a requirement under Government Code §8670.13. While much has been done to research, study, and improve prevention and response technology since that time, there has not been a comprehensive overview of these efforts. Furthermore, in light of recent major oil spills, such as the Motor Vessel *Cosco Busan* oil spill in San Francisco and the *Deepwater Horizon* spill in the Gulf of Mexico, OSPR determined an update was appropriate and began the process several years ago. Then, in 2016, SB 414 (Jackson), Ch. 609, Statutes of 2015 required the BAT update to be submitted to the Legislature by January 1, 2017. For purposes of this report, OSPR divided spill technology into four components: spill prevention, applied response technologies, mechanical cleanup, and remote sensing. This report is the spill prevention technology overview while the other three components are described in separate reports.

Oil spill prevention measures include systems, initiatives, and programs that can enhance the safety of ship navigation and the transportation of oil and thereby be extremely useful in avoiding oil spills into the marine environment. The oil spill prevention measures in the 1995 report focused primarily on "electronic ship positioning systems," including the Physical Oceanographic Real-Time System (PORTS®), the Differential Global Positioning System (DGPS), and the Electronic Chart Display and Information System (ECDIS). The prevention elements of that report focused on vessel activities and navigational safety. This updated report will add an extensive discussion on prevention activities related to marine facilities, as much progress has been made in this area since 1995.

Other measures to aid in spill prevention were briefly mentioned in the 1995 report, including Vessel Traffic Information Systems, now more commonly referred to as Vessel Traffic Services (VTS); Tank Vessel Escort Tug requirements; and

California's five Harbor Safety Committees (HSC). These systems and programs are discussed in greater detail in this current report because of the vital role they play in prevention today. Currently, there are many more technologies used to aid in oil spill prevention. This report includes an update on those technologies as well as discussions of the existing regulations and best practices that promote prevention of oil spills for both facilities and vessels.

An area of vessel spill prevention and mitigation technology that has significantly improved is electronic navigation information technology. These technologies provide up-to-the-minute data on changing weather conditions, sea state, global positioning, and other nautical chart information, enhancing awareness of navigation dangers during transits. The National Integrated Ocean Observing System (IOOS) is an emerging comprehensive system for obtaining ocean data, critical for safe and efficient navigation and also for oil spill response. The Global Positioning System (GPS) is a worldwide navigation system which consists of 24 medium-altitude, earth-orbiting satellites. By utilizing appropriate GPS receivers, seagoing vessels and other users can obtain reliable position, timing, and navigation information, further enhancing safety at sea.

Also of note, SB 414 required California's five HSCs to assess the presence and capability of tugboats within their respective geographic areas of responsibility to provide emergency towing of tank vessels and nontank vessels to arrest their drift or otherwise guide emergency transit. The HSCs for San Francisco and Los Angeles/Long Beach initiated their studies in early 2016, and the HSCs for San Diego, Port Hueneme, and Humboldt will initiate similar assessments in the coming years. These assessments will consider data from available USCG VTSs, incident and accident data, any relevant simulation models, identification of transit areas where risks are higher, and the condition of tank and nontank vessels calling on harbors, including crew training and professionalism. The findings of these reports may lead to future recommendations.

Marine facility improvements in prevention and spill mitigation technology have resulted from regulations that include more stringent and specific requirements for well design, drilling fluids, blowout prevention systems and system components, and operating procedures. Marine terminals have undergone, and are undergoing, extensive seismic analyses and engineering audits to determine fitness for purpose of structures; mooring and berthing systems; fire protection, detection and suppression systems; and mechanical and electrical systems. Additionally, refineries have implemented oil spill prevention and counter control plans that include regular exercises with agency coordination, mobilization of specialized watercraft for spill containment and clean up, and other procedures to prevent and mitigate spills.

Best Achievable Protection and Best Achievable Technology Mandates

The Act requires the OSPR Administrator to provide BAP and BAT standards to protect the waters of the state from the impacts of oil spills. These standards are defined in Government Code §8670.3 as follows:

> "Best achievable protection" means the highest level of protection that can be achieved through both the use of the best achievable technology and those manpower levels, training procedures, and operational methods which provide the greatest degree of protection available. The Administrator's determination of best achievable protection shall be guided by the critical need to protect valuable natural resources and state waters, while also considering (1) the protection provided by the measures, (2) the technological achievability of the measures, and (3) the cost of the measures.
>
> "Best achievable technology" means that technology that provides the greatest degree of protection, taking into consideration (1) processes which are being developed, or could feasibly be developed anywhere in the world, given overall reasonable expenditures on research and development and (2) processes which are currently in use anywhere in the world. In determining what is best achievable technology, the Administrator shall consider the effectiveness and engineering feasibility of the technology.

The standards of BAP/BAT are not static but rather are an evolving improvement-seeking process. To that end, improvements are often initiated by OSPR through the use of in-house multidisciplinary workgroups that identify improvements, corrections, and changes to the statutory and regulatory requirements. An example of this improvement-seeking process is the changing of the Reasonable Worst Case Spill Volume calculation for offshore platforms. The calculation was amended to increase the daily production volume factor from seven (7) days to thirty (30) days. This change was in response to the *Deepwater Horizon* platform spill in the Gulf of Mexico, which was an uncontrolled release for several months. Contingency plans for offshore platforms in California marine waters now have to address longer uncontrolled oil releases that could result from any natural or man-made incident. Additional examples of the aforementioned improvements in BAP/BAT can be found throughout this report.

BAP is provided through the use of both BAT and best achievable practices (e.g., manpower levels, training procedures, operational methods, improved systems, etc.) Technology alone is not the sole solution to achieve BAP; BAT and BAP are a continuum of steps/components that overlap: prevention, preparedness, response, recovery, and remediation. The key, and the focus of this report, is to systematically evaluate the combination of human and technological elements that can be used to provide the highest level of prevention and protection from oil spills.

SECTION I: VESSELS: SPILL PREVENTION TECHNOLOGIES, PROGRAMS, AND BEST PRACTICES

Safe navigation of ships is paramount to incident prevention. Information needed to operate in the unique oceanographic and geographic settings of different ports and harbors is acquired through local expertise and experience, utilizing familiarity with underwater hazards and obstructions, above-water landmarks and topographic features, local tide and current conditions, shoaling conditions, weather patterns, changes or deficiencies in aids to navigation, and other matters of local concern. A navigational aid or aid to navigation (navaid or ATON) is any type of marker that assists the mariner in navigation. Manmade markers, including lighthouses, buoys, fog signals, and day beacons, supplement natural landmarks to indicate safe and unsafe waters.

Electronic navigation information technologies are either part of the standard components on a vessel's bridge or based onshore. These technologies provide up-to-the-minute data on changing weather conditions, sea state, global positioning, and other nautical chart information that can enhance situational awareness during transits and will be discussed in detail.

ELECTRONIC AIDS TO NAVIGATION TECHNOLOGY

The 1995 legislative report was comprised of six separate sections detailing specific technologies including "Electronic Positioning Systems." Today, in addition to electronic positioning systems, numerous electronic tools assist the mariner in safely navigating the marine waters of California:

- The Physical Oceanographic Real Time System, or PORTS®, provides the mariner with real-time oceanographic and meteorological data.
- IOOS is another more comprehensive system that provides critical ocean information to users.
- Differential Global Positioning Systems, or DGPS, are navigation devices used on board to determine vessel positioning with a high degree of accuracy.
- ECDIS is a computer-based electronic information system that provides a continuous visual chart display depicting a vessel's position and navigational safety information.

This report will also cover several other technologies available to the mariner that have significantly enhanced safe ship navigation over the last decade and a half.

PHYSICAL OCEANOGRAPHIC REAL-TIME SYSTEM

Purpose and Capabilities

PORTS®[1] supports safe and cost-efficient navigation by providing ship masters and pilots with accurate real-time oceanographic and meteorological information to aid in avoiding incidents that could result in oil spills in marine waters. The system is also a planning and informational tool utilized by recreational boaters, local and state agencies, and academic institutions. PORTS® is a program of the National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service (NOS).

Real-Time Data

PORTS® sensors record data in bays and harbors, measuring oceanographic parameters (e.g., water levels, currents, and salinity) and meteorological parameters (e.g., winds, atmospheric pressure, and air and water temperatures). PORTS® processes the data through a series of quality control checks and provides this real-time data to the maritime community in a variety of user-friendly formats, including telephone voice response and the internet. The NOAA PORTS® processing center is located in Silver Spring, Maryland.

Nowcasts and Forecasts

Additionally, PORTS® provides 'nowcasts' and forecasts, which are scientific predictions of the present and future states of water levels and other oceanographic parameters, using numerical circulation models. Telephone voice access to accurate real-time water level information allows US port authorities and maritime shippers to make sound decisions regarding loading of cargo (based on available bottom clearance), thus maximizing loads and limiting passage times without compromising safety.

PORTS® in California Today

- ***Humboldt Bay PORTS®*** - In January 2013, PORTS® went on-line in the Port of Humboldt Bay. The Port secured funding to purchase and install PORTS® through a one-time federal security grant. NOAA oversaw the project. Chevron has agreed to provide PORTS® operating and maintenance funding for 5 years. Humboldt State University is providing vessel support in this endeavor.

- ***San Francisco Bay PORTS®*** - There are nineteen (19) active PORTS® sensor sites in the San Francisco Bay region. These data gathering sites range from Crissy Field in San Francisco to the west, to Pittsburg Marina Breakwater to the northeast, to the Redwood City Wharf to the south. One more sensor will be installed at San Francisco's Pier 27 (new cruise ship terminal). The SF Bay PORTS® is operated under an agreement between NOAA's National Ocean Service (NOS) and the Marine Exchange of the San Francisco Bay Region (SFMX). The SFMX is tasked with the enhancement, management, operations,

[1] PORTS® real-time oceanographic and meteorological data: http://tidesandcurrents.noaa.gov/ports.html

maintenance, and repair of the system under a NOS agreement. Since around 1997, funding for the SF Bay PORTS® system has been solely provided by OSPR via the Oil Spill Prevention Administration Fund.

- ***Los Angeles-Long Beach Harbor PORTS®*** - The Southern California PORTS® consists of meteorological sensor sites located at strategic locations in Los Angeles (LA) and Long Beach (LB) harbors. Operations and maintenance of PORTS® in the ports of LA and LB are not funded by OSPR but through a cooperative agreement between the Port of Long Beach and the local pilots.

- ***Other Harbors in California*** - The other two major California ports, Hueneme and San Diego, do not yet have an operational PORTS®.

Providing PORTS® Data via the Automatic Identification System
The USCG and NOAA are working together to provide PORTS® data via the Automatic Identification System (AIS) at USCG Vessel Traffic Services (VTS) sites, and ultimately through sites established under the National Automatic Identification System (NAIS) project. (For more information on AIS and VTS technologies, see sections of the report that follow.) PORTS® data is currently made available to mariners via the internet, by telephone, and on request by radio from VTS.

NATIONAL INTEGRATED OCEAN OBSERVING SYSTEM

Purpose and Capabilities
The National IOOS[2] is a comprehensive system for obtaining critical ocean information and making it available to those relying on it for safe and efficient navigation and oil spill response. IOOS collects and delivers data and information needed to increase understanding of our oceans and coasts (physical, geological, chemical and biological), so decision makers (e.g., shipping industry, USCG, and oil spill responders) can take action to improve safety, enhance the economy, and protect the environment.

Regional Associations
The Integrated Coastal and Ocean Observation System Act was signed into law by President Obama in March 2009. The law established NOAA as the authorizing body of IOOS, a partnership among 17 federal agencies and 11 Regional Associations (RAs) for Coastal Ocean Observing.

Two RAs, the Central and Northern California Ocean Observing System (CeNCOOS)[3] and the Southern California Coastal Ocean Observing System (SCCOOS),[4] represent California's coast in the national IOOS. Combined, partners

[2] Nationwide IOOS's real-time and forecasted ocean observing information: http://www.ioos.noaa.gov/

[3] Central and Northern California Ocean Observing System (CeNCOOS): http://www.cencoos.org/

[4] Southern California Ocean Observing System (SCCOOS): http://www.sccoos.org/

of these two RAs include over 100 state and federal agencies, non-profit programs, industries, and research institutions.

Data Integration Framework

The IOOS' coordinated network of people and technology generates and disseminates continuous data, information, models, products, and services about our coastal waters, Greats Lakes, and oceans. IOOS' real-time and forecasted ocean observing information, such as surface currents, wind forecasts, and wave model predictions, can be accessed via the internet.

NOAA IOOS has initiated efforts to increase access to and compatibility of NOAA and non-NOAA ocean information through a data integration framework in order to improve national applications, products, and services. Hundreds of federal, state, and local programs collect information on our nation's oceans and coasts. Many of these programs collect, distribute, and archive the *same* data (e.g., temperature and salinity) but in *different* formats. This disparity results in data that cannot be combined or analyzed together, are not easily accessible, and which few people know exist. Consequently, time and resources are wasted converting disparate data and potentially duplicating data collections. Data from existing observing systems would be much more useful and timely if it were linked and presented in an integrated, standardized way.

With IOOS, the country can more effectively monitor and address the increasing demands on our coasts and oceans. Improved capabilities could provide better predictions of hazardous events; allow more accurate measurement or prediction of risks of illness, injury, and death; route ships more cost effectively through US waterways; and improve search, rescue, and emergency response efforts.

Through the IOOS Program, NOAA and its national, regional, and other partners will enable the sharing and application of data necessary to drive advanced models and predictive capabilities. IOOS will provide a markedly more robust and consistent data stream for scientists, emergency responders, natural resource managers, mariners, and the American public, enabling them to make substantially better-informed decisions that produce economic, environmental, and societal benefits.

Real-time Information and Products

Accurate real-time ocean and weather information and forecasting are critical for effective maritime safety, navigation, incident response, and risk management in our nation's ports and harbors. Sea state conditions, including surface current speed and direction, wave dynamics, tides, subsurface current speed and direction, wind, temperature, and salinity, influence activities within California's ports and along our coastline. Maritime activities can be better managed with reliable and timely sea state predictions in useful formats and packaged products. IOOS can provide and package this information, as well as other value-added products, with ship tracking through AIS, NOAA nautical charts, bathymetric data, and shipping lanes and ferry channels. To date, this information has aided in the calculation of under-keel

clearance for navigation, search and rescue, oil spill tracking, and route planning in California.

Federal and State Support
Partnerships with the larger NOAA community and with external partners in the regions are critical to the success of NOAA's IOOS program. By making use of existing investments in observing technology and applying the vast expertise and resources around the country, the NOAA IOOS program is able to support development of national applications, products, and services that meet critical needs at the state and local levels.

Advanced Technologies
In order to provide information on marine conditions, advanced technologies are needed to sample the required oceanographic variables in an efficient and timely manner. The systems and technologies that provide this information must be sustained and long-term. IOOS is currently using the most advanced and modern technologies available to collect and communicate oceanographic and meteorological information. These systems will continue to evolve with changing technologies and funding, as they work toward including BAT. Examples of utilized advanced technologies include the following:

- High Frequency Radar for measuring surface currents
- Acoustic Doppler Current Profiles for measuring underwater currents
- Datawell Directional Buoys for measuring and forecasting waves
- Synthetic Aperture Radar (SAR) and the Coupled Ocean-Atmosphere Mesoscale Prediction System for measuring and forecasting winds
- Conductivity, Temperature, and Depth (CTD) Sensors for determining buoyancy
- Autonomous Underwater Vehicles

Future of Integrated Ocean Observing System in California
California's two IOOS RAs aim to build and implement the Marine Operations application for the entire west coast (for example, see the LA/LB Harbor on the SCCOOS webpage at http://www.sccoos.org/data/harbors/lalb/). Another goal is to make all data compatible with the latest technology ued by marine operators (e.g., Portable Pilot Units).

Oceanographic data collection and dissemination is supported by a wide array of state and federal agencies. The State of California recognizes the need for real-time, high-quality marine data. Creation and delivery of better management tools, and the technologies and innovation required to implement these tools, is a mission of the California Ocean Protection Council in order to effectively achieve the policy established by California's 2004 Coastal Ocean Protection Act. This mission is also shared by the West Coast Governor's Agreement on Ocean Health. Both of these regional governance structures recognize the value and benefit of the Ocean Observing System.

The ultimate goal is to have a central site or system for Ocean Observing Systems comprised of the PORTS®, SCCOOS, and CeNCOOS data that can be accessed by any user for "one-stop shopping."

DIFFERENTIAL GLOBAL POSITIONING SYSTEM

Purpose and Capabilities

Global Positioning System (GPS)[5] is a worldwide navigation system which consists of 24 medium-altitude, earth-orbiting satellites that transmit radio signals back to earth. By utilizing appropriate GPS receivers, seagoing vessels and other users can obtain reliable position, timing, and navigation information. GPS position accuracy is within 15 meters and is considerably greater with the use of an enhancement referred to as Differential Global Positioning System (DGPS).

DGPS uses a series or network of fixed, land-based reference stations that broadcast correction signals to GPS receivers via Ultra High Frequency (UHF). These correction signals allow the GPS receivers to more accurately determine a ship's geographical position. DGPS position information is also utilized in ECDIS.

History

In 1995, DGPS was just becoming available to enhance the accuracy of GPS data. In 1999, the USCG maritime DGPS[6] became fully operational, which improved position accuracy to within 5 meters or better. Navigation safety has been greatly enhanced with this improved accuracy of vessel positioning. Improved navigation safety directly correlates to reducing the risk of a vessel incident that could potentially result in an oil spill.

Differential Global Positioning System in California Today

Today, virtually all commercial ships and the vast majority of recreational boaters utilize GPS with DGPS capability for navigation purposes. It is the most widely used navigational tool, employing BAT today.

Future of Differential Global Positioning Systems

The United States government is currently working toward access to additional signals to further increase the accuracy and reliability of GPS information.

ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM

Purpose and Capabilities

ECDIS[7] is a computer-based navigational information system that provides an automated decision aid capable of continuously determining a vessel's position in relation to land, charted objects, aids-to-navigation, and unseen hazards. ECDIS

[5] Global Positioning System website: http://www.gps.gov/
[6] US Coast Guard Navigation Center website: http://www.navcen.uscg.gov/
[7] Electronic Navigational Charts: http://www.nauticalcharts.noaa.gov/mcd/enc/index.htm

integrates GPS data and other navigational sensors, including radar, fathometer, and AIS, to provide continuous position and navigational safety information. For more information, see the description of AIS later in this report.

Since the ECDIS is a "smart" system which combines several different functions into one computerized system, the International Maritime Organization (IMO) standards require that certain alarms be made available on the ECDIS. These alarms, which consist of audible and visual warnings, include the following:

- Vessel is deviating from a planned route
- Chart is on a different geodetic datum from the positioning system
- Vessel is approaching waypoints and other critical points
- Vessel is exceeding cross-track limits
- Chart data displayed is over scale (i.e., larger scale than originally digitized)
- A larger scale chart is available
- A positioning system is experiencing failure
- The vessel is crossing a safety contour
- A system is experiencing malfunction or failure

The navigator may determine some set points. For example, he/she may designate a safety depth contour or set a maximum allowed cross-track error. Operational details vary from one system to another, but all ECDIS will have these common basic alarm capabilities.

History

ECDIS was discussed briefly in the 1995 OSPR report. At that time, ECDIS development and usage was in its infancy and international performance standards had just been adopted by the IMO. The USCG conducted tests in the early 1990's to evaluate these electronic charts. Test results indicated that mariners using electronic charts were able to decrease the bridge workload and allow more attention to higher risk tasks.[8]

AUTOMATIC IDENTIFICATION SYSTEMS

Purpose and Capabilities

The AIS provides a means for ships to electronically exchange data, including identification, position, course, and speed, with other nearby ships and VTS stations. AIS integrates a Very High Frequency (VHF) transceiver system with an electronic navigation system, such as a GPS receiver and other navigational sensors, onboard the ship. This data is utilized by the ship's bridge watch officers during navigation to aid in collision avoidance. The AIS information can also be displayed on an ECDIS

[8] Electronic Chart Display and Information System:
http://www.uscg.mil/hq/cg5/cg553/NAVStandards/ECDIS.asp

screen to further enhance awareness of other vessel traffic and their movements. AIS data is also utilized by VTS to aid in vessel traffic management in the California port regions of LA/LB and San Francisco Bay.

History of Automatic Identification Systems in California

AIS is an international standard for ship-to ship, ship-to-shore, and shore-to-ship communication of information, including vessel identity, position, speed, course, destination, and other data of critical interest for navigation safety and maritime security. AIS equipment is required domestically and internationally aboard most commercial vessels.

AIS development and standardization began evolving in the early to mid-1990s. In 1995, AIS was not yet commercially available onboard sea going ships on a large-scale basis. The IMO introduced performance standards for the carriage of AIS in 1998. During this time period, OSPR provided grant funding to the San Francisco Marine Exchange (SFMX) to task a committee of stakeholders to help identify, evaluate, and develop new technologies (i.e., BAT) that would provide BAP for enhancing navigational safety. AIS was identified as one possible tool.

The system began to be phased in formally in 2002 by the International Convention for the Safety of Life at Sea (SOLAS), as part of the IMO. The USCG requirement for carriage began in 2003, becoming fully effective in 2004; the IMO requirement for AIS carriage on all ships also became effective that same year. In December 2008, the USCG proposed rulemaking to expand the carriage of AIS to smaller vessels.

Automatic Identification Systems in California Today

AIS is extensively used by professional mariners to aid in safe ship navigation and collision avoidance throughout the globe, as required by national and international regulations.[9] OSPR partially funds the SFMX AIS operations in the San Francisco Bay.

Future of Automatic Identification Systems

In compliance with the Maritime Transportation Security Act, emerging homeland security requirements and the need to improve VTS and navigational safety, the USCG is developing a Nationwide Automatic Identification System (NAIS)[10] that will support Maritime Domain Awareness (MDA)[11] of the nation's territorial waters and adjacent sea areas. MDA is the effective understanding of anything associated with the global maritime domain that could impact the United States' security, safety, economy, or environment.

The information provided by the NAIS will support the nation's multi-faceted maritime safety interests, from the safety of vessels and ports through collision avoidance to

[9] IMO AIS carriage requirements: http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx/

[10] US Coast Guard AIS: http://www.uscg.mil/acquisition/nais/

[11] US Department of Homeland Security's National Plan to Achieve Maritime Domain Awareness: http://www.dhs.gov/files/programs/editorial_0753.shtm

the safety of the nation through detection, traffic management, and classification of vessels when they are still thousands of miles offshore.

The NAIS will consist of an integrated system of individual AISs (e.g., base station radios, antennas), data storage, processing, and networking infrastructure. NAIS will also be integrated with other systems for the purpose of sharing infrastructure and improving performance. The NAIS will send and receive AIS messages, via a VHF data-link, to and from AIS equipped vessels, Aids to Navigation, and search and rescue aircraft.

NAIS will leverage several types of platforms to support AIS reception and transmission infrastructure. While some platforms support receive-only capabilities (e.g., satellites, buoys, and aircraft), others will support both receive and transmit capabilities (e.g., towers). AIS message data will be transported between system components over a wide-area network (WAN) and diverse, remote-site connectivity (e.g., leased analog circuits and microwave).

The USCG Research and Development Center is working on a project to develop, design, and evaluate AIS binary messaging capability. This capability will enhance how mariners can receive critical real-time navigation safety notices, such as waterway closures, wreck markings, high-wind and/or low-visibility warnings, etc. AIS equipment on board the ships will receive PORTS® data and then display the information on ship navigation systems, such as electronic charts. Real-time information on wind speed and direction, current speed and direction, water level, air and water temperature, and barometric pressure will be accessible to mariners. Easy access to this data will help facilitate safe navigation planning and operations in harbors where PORTS® is in place.

PILOTAGE SERVICES

Purpose and Capabilities

Ship pilots are licensed mariners who come aboard to guide, or "pilot," ships between the open sea and berths or anchorages within harbors. They possess the requisite local knowledge of the particular port, river, or lake (e.g., currents, navigation hazards), reducing the risk of navigational incidents and resultant oil spills. Pilotage is one of the oldest known professions and one of the most important in maritime navigation safety. The use of pilot services by ships arriving and departing California ports is compulsory for almost all ships; the OSPR Administrator is required to evaluate all pilotage areas in the state based on specific criteria established in statute.[12]

[12] CA Code– Pilotage Areas; evaluations. Government Code, Title 2, Division 1, Chapter 7.4, Article 3 Marine Safety, § 8670.24

Pilotage Oversight

Although all of California's major commercial shipping ports have requirements for the use of pilots, the model varies among ports. Ports within San Francisco, San Pablo, Suisun, and Monterey Bays, as well as ports situated along the Sacramento and San Joaquin Rivers, require pilots serving in the San Francisco Bar Pilots Association to be licensed by the State Board of Pilot Commissioners.

State licensing by the San Francisco Board of Pilot Commissioners is not a requirement for vessel masters with federal pilotage transiting in San Francisco Bay. The requirement for California state pilot licensing is unique only to the Port of San Francisco and to the San Francisco Bar Pilots Association. Those ship masters with a valid USCG federal pilotage endorsement for the San Francisco Bay may also pilot their ships into and out of the port, without the state licensing requirement. In this case, the USCG exercises oversight of the masters piloting their ships in these waters.

State licensing of pilots is not required for ships transiting other California ports. Ships masters who have the respective required federal pilotage endorsements may also pilot their ships in the other major commercial shipping ports in California (e.g., San Diego, Los Angeles-Long Beach, Port Hueneme, and Humboldt Bay) without the state licensing requirement. These ports are also serviced by pilot associations that are either private enterprises or employees of the port who also operate under the federal pilotage endorsement. Each harbor's Port Authority provides oversight of pilots and regulates pilotage rates and practices through tariffs filed with the Federal Maritime Commission.

Portable Pilot Units

Ship pilot associations are using new technologies in an effort to enhance navigational safety during harbor transits. Many pilots today use a Portable Pilot Unit (PPU), which consists of a laptop navigation computer with navigational software. The PPU is a tool that pilots can bring onboard a vessel for use in facilitating a vessel's safe transit into and out of harbors. As with any navigational equipment or practice, the PPU cannot be solely relied upon; it is used to add another layer of safety to the operation.

The laptop displays Flag State (USCG, in this case) approved Electronic Navigation Charts (ENCs) for the areas being transited. Although most aspects of electronic charts and navigational systems are standardized, some particulars of the visual display can vary from vessel to vessel. By using a PPU, the pilot is using the same familiar navigational display regardless of the vessel.

The information displayed on the PPU is identical to that of any approved electronic chart and includes vessel position, speed, course, AIS data, etc. The PPU is equipped with an AIS Pilot Plug interface connection that can be connected to the ship's own AIS receiver. The PPU is also capable of providing vessel position information by use of an independent GPS receiver. This feature enables the pilot to

have an independent cross-check with the ship's electronic position-determining system.

Portable Pilot Units in California Today

The PPU system has other applications that can aid port pilots. It is used by pilots to aid in risk mitigation, especially for deep draft vessels transiting inside the harbors. It can be used as a simulation tool to determine the feasibility of moving large vessels within the harbor. It also has value as a training tool to provide a look-back for pilots who have completed a ship movement in the harbor, as well as a look-forward tool for those pilots who will be conducting a similar operation in the future. A PPU system is currently used by pilots in the Long Beach (Jacobsen Pilot Service) and Los Angeles Port Pilot Associations for vessel movements in those harbors. In both Los Angeles and Long Beach harbors, these transits can also be monitored at an onshore installation by a shore-based pilot to provide further assistance to the pilot on board.

After the Motor Vessel *Cosco Busan* allided with a San Francisco Bay Bridge tower in 2007 and spilled more than 53,000 US gallons of IFO-380 of heavy fuel oil, the San Francisco Board of Pilot Commissioners' Navigation Technology Committee called for a requirement for San Francisco Bar Pilots to be equipped with and trained to use PPUs. The expectation is that PPUs are employed at all times while piloting, unless deemed unsafe by the pilot when embarking or disembarking from a vessel.

The San Francisco Bar Pilots sponsored legislation in 2009 (SB 300 (Yee), Chapter 576, Statutes of 2009) establishing a one-year surcharge on pilot invoices to be administered by the Board of Pilot Commissioners. The surcharge provides a one-time reimbursement to state licensed pilots for their costs of acquiring and being trained in the use of PPUs. Other pilotage organizations in the state that use PPUs have not proposed separate surcharges for providing reimbursement for the cost of the units.

Future of Portable Pilot Units in California

Although pilots serving the two major commercial shipping ports in California are now using PPUs, the smaller ports of Humboldt Bay, Port Hueneme, and San Diego have not found the need for such technology at this time. Because these ports have very little traffic or congestion and very short pilotage transits, there is little benefit in employing the technology. As PPUs become more ubiquitous in the future, their use may expand to all commercial ports.

NATIONAL WEATHER SERVICE FORECASTING TECHNOLOGY

Purpose and Capabilities

The NWS is a federal agency under NOAA, a part of the United States Department of Commerce (DOC). The mission of the NWS is to provide weather, water, and climate data, forecasts, and warnings for the United States, its territories, and adjacent waters and ocean areas for the protection of life and property and the

enhancement of the national economy. Forecast programs and products serve the marine, aviation, fire, weather, and hydrologic communities, as well as the general public. Weather products are widely and freely disseminated via the internet, telephone, and NOAA Weather Radio. The NWS operates 24 hours per day, 365 days per year.

Marine forecast products are designed to serve a wide variety of mariners, ranging from crews of large ocean-going vessels to fishermen and recreational boaters. When potentially hazardous wind, weather, or sea conditions develop or are projected to occur, special watches, warnings, and advisories are issued.

National Weather Service Forecasting Technology in California Today

NWS forecasts are now constructed and produced digitally and together compose the National Digital Forecast Database (NDFD). The NDFD consists of gridded forecasts of each of the different sensible weather elements, including wind, wind waves, weather, sky coverage, primary and secondary swell heights and periods, and air temperature. A benefit of these gridded forecasts is their ability to provide easy, internet-based access to these details.

In making forecasts, the NWS has available a wide range of detailed observational and numerical model data, in addition to the NDFD. Two key examples in California are the Scripps Coastal Data Information Program (CDIP) buoy data (see IOOS section of this report) and the Coastal Ocean Dynamics Applications Radar (CODAR) high frequency radar (http://www.codar.com/news_01_2_2010.shtml). One of the CDIP buoys is situated just outside the main ship channel through the San Francisco bar (See Figure 1 below). The NWS also uses data from the CDIP buoys to predict the marine forecasts at Humboldt Bay, San Pedro Bay, and other areas along the California coast.

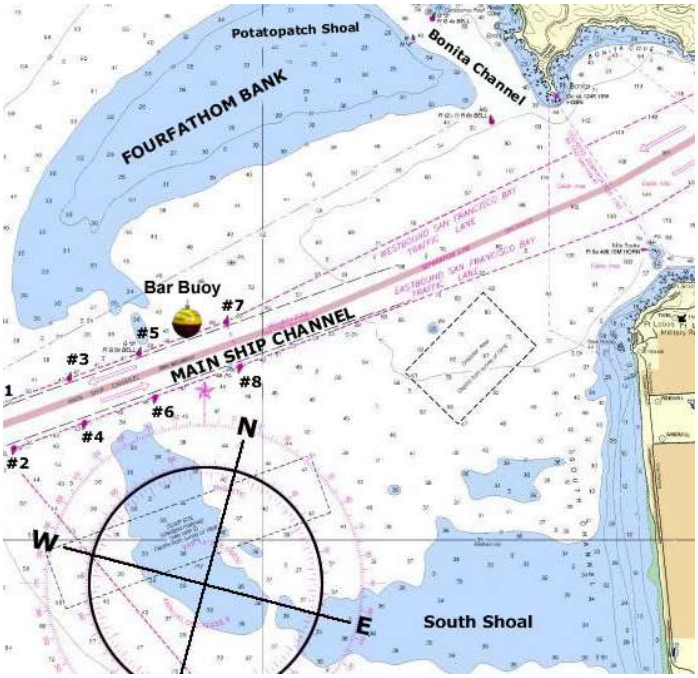

Figure 1. CDIP buoy sited just outside the main ship channel through the San Francisco Bar, as shown on this navigational chart.

In addition to the real-time wind and sea state observations provided by the San Francisco buoy, forecasters at the Weather Forecast Office in Monterey also examine the associated CDIP "nowcasts" and forecasts of wave height and period, both for this location in particular, as well as more generally across the bar and over adjacent coastal waters. The data collected at this particular buoy is routinely accessed by the San Francisco Bar Pilots and Tug and Barge Operators to aid in determining sea conditions at the main ship channel to ensure safe vessel transits.

Future of Weather Forecasting Technology

Advances are being made across a wide range of observational and numerical prediction systems. In general, the future lies in increasing the quality, density, and comprehensiveness of real-time meteorological and oceanographic observations to support more accurate and higher-resolution forecast models. Most of NOAA's present meteorological and oceanographic models rely on relatively sparse measurements to make their predictions. A greater density of actual observations (e.g., water level, current, wind, barometric pressure, etc.) will facilitate increased accuracy of the models.

Advances will also include integration of newer technologies, such as surface current mapping High Frequency radar, with existing observational systems like PORTS®. In addition, as wireless technology continues to mature, it should be possible to transmit files that are currently too large to be handled by the AIS to an underway vessel, thus opening the door to the use of an expanding number of meteorological and oceanographic models in planning a ship's voyage.

VESSEL TRAFFIC SERVICES

Purpose and Capabilities

The USCG has established VTS[13] in critical congested ports. Using the AIS, radar, closed-circuit television, and radiotelephone equipment, VTS monitors vessel traffic in designated areas. VTS also receives information from various sources about predicted vessel movements, hazards to navigation, aids to navigation discrepancies, and other information of interest to VTS users. Monitoring vessel traffic allows VTS to ensure that vessels are navigating safely and efficiently in accordance with applicable regulations and navigation rules.[14] VTS uses BAT to enhance navigational safety and pollution prevention in California's busiest harbors.

Vessels participating in a VTS report their position, identity, and intentions to the Vessel Traffic Center (VTC), from which they are continuously tracked and monitored. VTS analyzes the information gathered and then informs participants as applicable. This is done at the user's request, when it appears necessary to VTS personnel, or at regular intervals.

Regulations

Each VTS operates under the regulations outlined in 33 CFR 161. VTS participation is mandatory for power-driven vessels, 40+ meters long while navigating, while towing vessels 8+ meters long, and vessels certified to carry 50+ passengers for hire while engaged in trade.

In carrying out their duties under these regulations, each VTS may use different operational tactics depending upon the variables presented by port topography and operations (e.g., weather conditions; channel size and depth; and type, size, and volume of vessel traffic). Watchstanders in the VTC employ a range of techniques and capabilities aimed at keeping commercial traffic moving efficiently in all weather.

Intervention in Navigational Decision Making

VTS may participate in the navigational decision-making process with appropriate advice or directions to the master and/or pilot. This information, coupled with the master's and pilot's qualifications and experience, allows for safe travel of vessels. VTS serves as an active waterways management tool but rarely as a direct control tool. Within a VTS, the vast majority of "control" is exercised through information, recommendations, and ensuring compliance with navigation rules and policies to help the mariner make safe navigation decisions.

Other existing "passive" waterways management tools, such as Traffic Routing Measures, Regulated Navigation Areas, Aids to Navigation (ATON), Collision Regulations (COLREGS), and other waterways regulations, are combined with VTS

[13] US Coast Guard Sector San Francisco VTS: http://www.uscg.mil/d11/vtssf/
[14] Navigation Rules: http://www.navrules.com/

information to maximize safe navigation (COLREGS are recognized internationally. Rules for conduct of vessels on inland waters are also stipulated in similar format to the "*International Regulations for Prevention of Collisions at Sea*." These rules include requirements for navigation lights, dayshapes, and steering, as well as sound signals for both unrestricted and restricted conditions of visibility). Directions from VTS, if given, are normally provided in the form of a desired outcome rather than specific conning orders (i.e., ship's course and speed). For example, a vessel may be directed not to proceed beyond a certain location or to remain at the dock until it is safe to transit.

Automatic Identification System Usage with Vessel Traffic Services
All vessels that are required to participate in the VTS are also required to carry and operate AIS equipment. The development and use of the AIS is an additional tool available to provide more information to mariners in a way that can be presented on existing navigation systems. AIS capability has been installed at all USCG VTS.

TANK VESSEL ESCORT TUGS

Purpose and Capabilities
Escort tug boats are required to accompany loaded (laden) oil tankers and oil tank barges being towed when transiting California waters.[15] [16] The objective of requiring tugs to escort laden tankers and tank barges is to render immediate assistance in the event that the tanker or tow vessel sustains a loss of propulsion or steering and thus help prevent an oil spill. Escort tugs are matched to their respective vessels according to matrices developed to ensure that the tugs can effectively control the vessel in the event of a serious mechanical failure.

Tank Vessel Escort Tug Technology in California Today
The advancement of tug boat technology and design has enhanced safety and protection of the marine environment by escorting laden tank vessels while they transit California waters to better ensure their safe passage.[17]

In the past, "conventional" tugs were the predominant type of tug involved in towing, escorting, or ship assist operations. Conventional tugs are those tugs with either a single or twin (double) fixed propeller configuration. These were most effective as escorts when made up (tied) to the stern of the escorted vessel.

Since 1995, there have been many improvements to the tank vessel escort tug industry. Over the past 15 years, the tug industry has continued to evolve and foster improvements to both tug boat operations and equipment.

[15] Assembly Bill 1549: http://www.leginfo.ca.gov/pub/95-96/bill/asm/ab_1501-1550/ab_1549_bill_951016_chaptered.pdf

[16] See Chapter 4 of the OSPR Regulations: https://www.wildlife.ca.gov/OSPR/Legal/OSPR-Regulations-Index

[17] Utilization of Tug Escorts in Restricted Waters, by Captain G. Brooks & Captain S. W. Slough: http://www.towingsolutionsinc.com/technology-escort_restricted.html

The evolving design and construction of today's tugs have contributed significantly to the safety and effectiveness of the escort tug industry. The type of tug predominantly involved with ship assist and escort operations today is referred to as a "tractor" tug. Tractor tugs are more versatile as escorts than conventional tugs and are normally tied up and tethered to the stern of a vessel by a much longer tow line (200 to 300 feet in length). Tractor tugs utilize a different type of propulsion system, which allows for greater maneuverability and "bollard pull." Bollard pull is an industry standard used for rating tug capabilities and is the pulling force imparted by the tug to the towline. These tugs are powered by one of three types of propulsion systems: "Z-Drive," "Cycloidal," or "Reverse Tractor" (which is a modified conventional tug design).

Tractor tugs can deliver performance on a scale that is far more effective than conventional tugs. The tractor tug design allows the tug to execute maneuvers that greatly enhance the effect the tug has on the escorted tank vessel. The tractor tug design, coupled with the latest technology in main propulsion engines, has significantly increased the overall power and braking force (bollard pull) of escort tugs. This factor has helped facilitate the escorts in adapting to the larger tank vessels that we see transit California waters today.

Future of Tank Vessel Escort Tugs in California

- ***San Francisco Bay***

The Tug Workgroup, a subcommittee of the San Francisco HSC, continues to convene regularly and is comprised of numerous escort tug operators with hands-on, practical tug operator experience, who meet and discuss related issues and make recommendations for improvements to enhance navigation safety. The Workgroup developed a Best Maritime Practice recommending that the tug industry include the use of simulators in their personnel training programs.

- ***Port of Los Angeles / Long Beach***

The LA/LB HSC's Subcommittee Number Three, "Tug Utilization," continues to reevaluate the state's escort tug regulatory requirements and industry standard operating procedures in the dynamically changing harbors of both Los Angeles and Long Beach. Subcommittee Number Three convenes regularly to discuss issues that include, but are not limited to, the following:

- Revisions for OSPR's tanker and escort tug matching matrix and regulations for the Ports of LA/LB.
- Development of tandem towing procedures for large tankers (tandem towing is an operation where two escort tractor tugs are made fast to the stern of a tanker and utilized to arrest ship movement through the water in the event of a mechanical failure on the ship).
- Development of scenarios for use in ship bridge simulators to test and evaluate shallow water maneuvering characteristic and capabilities for

Ultra Large Crude Carrier tankers and their corresponding escort tugs' emergency response capabilities.

SHIP BRIDGE SIMULATORS

Purpose and Capabilities

Ship bridge simulator installations are in operation throughout the United States and abroad. The objective of using bridge simulators is to promote safe navigation and spill prevention, through training exercises and vessel navigation scenarios, that would otherwise be extremely difficult and unsafe to recreate in a real-world setting.

History of Ship Bridge Simulators in California[18]

Simulators were pioneered in the 1960s and 1970s and used crude panoramic views (wall projections) of what would be seen from the bridge of a ship. In 1976, one of the first full-mission ship bridge simulators with computer graphic generated images was put into operation at the US Merchant Marine Academy at King's Point, New York. The six other State Maritime Academies in the United States installed similar ship bridge simulators by the mid-1990s.

California Maritime Academy Bridge Simulator

In 1995, the California Maritime Academy (CMA) installed its first full-mission bridge simulator. The simulators were stand-alone, computer-based trainers that were able to emulate the functions of the navigation bridge of a ship. The simulators were comprised of a large projector screen to simulate the virtual world as seen from the bridge of a ship, in addition to all the equipment that would be found on a ship's bridge helm (steering console), engine controls, gyro compass, radars, VHF radios, etc. The ship models and geographic databases, although powerful at the time, are considerably more advanced today in terms of graphic displays, hydrodynamic accuracy, and interactive capacity (See Figure 2, below).

[18] "*Marine Simulation and Ship Maneuverability*" by M.S. Chislet: http://books.google.com/books?id=o7TxZYRO_XMC&pg=PR11&lpg=PR11&dq=ship+bridge+simulator+history&source=bl&ots=HMT4kop3bE&sig=5JT-iDO_bqyz75SRafImXJzMCUY&hl=en&ei=i0SdSufNGZSssgPrqfUq&sa=X&oi=book_result&ct=result&resnum=7#v=onepage&q=ship%20bridge%20simulator%20history&f=false

Figure 2. Today's Bridge Simulator at the California Maritime Academy in Vallejo

Ship Bridge Simulators Today

The use of simulators as a tool for promoting safe navigation has evolved over the past 15 years. During recent years, mariner training facilities have updated or added new simulator capability to their curriculum. Some are comprised of as many as eleven full-mission bridge simulators of various capabilities which can include an oil spill trajectory simulator, a liquid/gas cargo handling simulator (both of which can also integrate with the bridge simulators), or even a crisis management center.

The simulator exercise operator has full control of all environmental factors, including currents, sea conditions, wind, and visibility, as well as independent control of the vessels depicted in the exercise in order to simulate mechanical failures. Multiple bridges are capable of acting as separate, stand-alone vessels in the same training exercise, with each able to see the others; each bridge is capable of communicating with the others and even interacting with one another in the virtual world.

In addition to each of the ship bridge simulators having the latest navigation and communication technologies, they are also capable of emulating many different propulsion systems with the actual operating hardware utilized in the industry. By incorporating multiple interactive ship bridges, it is possible to train groups of stakeholders (e.g., pilots, ship captains, bridge watch officers, as well as tug escort captains) at the same time, in the same exercise, with each group interacting but focusing on their particular task in both routine and emergency situations.

Future of Ship Bridge Simulators in California

The CMA conducts ship simulator training on a regular basis. CMA is currently working with the tug industry and pilots to simulate escort tug emergency operations while transiting the virtual San Francisco Bay. Their goal is to better prepare tug operators in the event of an emergency during an escort transit with a laden oil tanker or tank barge.

The IMO, in keeping with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) of 1978, has designed model simulator courses and set standards for required training of ship bridge watch officers in Bridge Teamwork. The goal is to further facilitate access to the knowledge and skills demanded by increasingly sophisticated maritime technology.

HARBOR SAFETY COMMITTEES[19]

Purpose and Composition

The five HSCs in California are responsible for planning the safe navigation and operation of vessels within their respective geographic regions (harbors). As part of meeting this responsibility, each committee annually revises and submits a Harbor Safety Plan to the Administrator, which encompasses all vessel traffic within its region and addresses the region's unique safety needs.

The OSPR Administrator appoints committee members and their alternates that comprise a representative cross section of each of the harbors' stakeholders, including the USCG, US Army Corps of Engineers, NOAA, US Navy, Port Authorities, Dry Cargo Operators, Tug and Tank Barge Operators, Tank Ship Operators, Marine Oil Terminal Operators, Ferry Boat Operators, Pilot Organizations, Vessel Operation Labor Organizations, Commercial Fishing Operators, Nonprofit Environmental Organizations, the CCC, and the BCDC. Each HSC then appoints members to participate in work groups that address various issues impacting navigational safety in their respective harbors.

History of Harbor Safety Committees in California

In 1990, the California State Legislature enacted the Oil Spill Prevention and Response Act. At that time, the goals of the Act were to improve the prevention, removal, abatement, response, containment, and clean up and mitigation of oil spills in the marine waters of California. In addition to creating OSPR, the Act created HSCs for the major harbors of the state.

The HSC of the San Francisco Bay Region was officially sworn in on September 18, 1991, at its first meeting. The harbors of Humboldt, Port Hueneme, Los Angeles/Long Beach, and San Diego were established shortly thereafter.

[19] California Office of Spill Prevention and Response, Harbor Safety Committees and Harbor Safety Plans: https://www.wildlife.ca.gov/OSPR/Marine-Safety/Harbor-Safety

Harbor Safety Committees in California Today

The full HSCs hold regular public meetings. Each committee chairperson appoints a series of workgroups to review mandated components of the Harbor Safety Plan and other timely issues. All committee and workgroup meetings are noticed to the public. Public comments are received throughout discussions of the various issues, resulting in full public participation in the development of Harbor Safety Plan recommendations.

California's five HSCs update their respective Harbor Safety Plans annually to reflect initiatives designed to increase navigation safety and prevent maritime accidents that may result in an oil spill. Many are adopted as Best Maritime Practices, or BMPs, as discussed below.

Harbor Safety Committees' Best Maritime Practices

A Best Maritime Practice (BMP) is an accepted and agreed upon method to conduct an operation or process that will enhance safety for vessels, personnel, dockside facilities, and marine resources. In October 2007, OSPR directed the HSCs in California to adopt BMPs for each harbor to ensure that vessels in transit are aware of the guidelines of operation in California harbors. Beginning in 2008, California's five HSCs developed BMPs to include in their Harbor Safety Plans.

BMPs reflect recommended Standards of Care for vessel operation to ensure safe, environmentally responsible transit, in an effort to avoid incidents that could potentially lead to spilling of oil into state waters. BMP's are not to be in conflict with, nor shall they replace, existing regulations (federal, state, and local) or individual company policies already in place.

For further details on BMPs, refer to the Harbor Safety Plan host websites listed below.

- ***Humboldt Bay:***
  http://humboldtharborsafety.org/sites/humboldtharborsafety.org/files/2012%20HSP%20Humboldt%20Bay.pdf

  http://www.humboldtbay.org

- ***San Francisco-San Pablo-Suisun Bays:***
  http://www.sfmx.org/support/hsc/hscbestpractices.php

  www.sfmx.org

- ***Port Hueneme:***
  http://www.portofhueneme.org/documents/harbor_safety_plan2009.pdf

  www.portofhueneme.org

- ***Los Angeles/Long Beach:***
  http://www.mxsocal.org/pdffiles/VOP.pdf

  http://www.mxsocal.org/HARBOR-SAFETY-AND-SECURITY/HARBOR-SAFETY/Harbor-Safety-Plan.aspx
  www.mxsocal.org

- ***San Diego:***
  http://www.portofsandiego.org/maritime/safety-and-emergencies/1648-san-diego-harbor-safety-committee-get-involved.html

  http://www.portofsandiego.org/maritime/safety-and-emergencies/227-harbor-safety-plan.html

PACIFIC STATES/BRITISH COLUMBIA OIL SPILL TASK FORCE

The Pacific States/British Columbia Oil Spill Task Force[20] (Task Force) was authorized by a Memorandum of Cooperation signed in 1989 by the Governors of Alaska, Washington, Oregon, and California and the Premier of British Columbia following the motor tanker EXXON VALDEZ and fuel barge NESTUCCA oil spills. These events highlighted the Task Force members' common concerns regarding oil spill risks and the need for cooperation across shared borders. In June 2001, a revised Memorandum of Cooperation was adopted to include the State of Hawaii and expanded the focus to spill preparedness and prevention needs of the 21st century. The Task Force provides a forum where members can work with stakeholders from the Western United States and Canada to implement regional initiatives that protect 56,660 miles of coastline from Alaska to California and the Hawaiian archipelago. The mission of the Task Force is to strengthen state and provincial abilities to prevent, prepare, and respond to oil spills.

An example of one of the Task Force's spill prevention and response accomplishments is the West Coast Offshore Vessel Traffic Risk Management Project, which was co-sponsored by the Task Force and USCG Pacific Area. The project recommended that, where no other traffic management areas exist (such as Traffic Separation Schemes, VTS, or recommended routes), vessels 300 gross tons or larger transiting anywhere along the coast between Cook Inlet and San Diego should voluntarily maintain a minimum distance of 25 nautical miles offshore. It is also recommended that tank ships laden with persistent petroleum products transiting along the coast between Cook Inlet and San Diego should voluntarily stay a minimum distance of 50 nautical miles offshore. Vessels transiting short distances between adjacent ports should seek routing guidance as needed from the local USCG Captain of the Port or VTS authority for that area. These recommendations are intended to reduce the potential for vessel groundings and resulting oil spills in the event of a vessel casualty. For more information, see the Task Force website listed below.

[20] The Pacific States/British Columbia Oil Spill Task Force website: http://www.oilspilltaskforce.org

SECTION II: FACILITIES - BEST ACHIEVABLE TECHNOLOGIES AND BEST PRACTICES FOR OIL SPILL PREVENTION

As of 2012, California is the third largest oil and gas producing state in the United States and ranks third in the nation in refining capacity. Drilling operations are concentrated primarily in Kern County and the Los Angeles Basin, although production also takes place offshore Southern California at platforms in both state and federal waters. A network of pipelines transport crude oil from offshore and onshore production areas and foreign crude oil received at marine terminals in the Los Angeles, Long Beach and San Francisco Bay areas to refineries in Los Angeles, San Francisco Bay, and the Central Valley.[21]

Oil Spill Risk and Best Achievable Protection/Best Achievable Technology
Oil spills from marine facilities primarily result from pipeline leaks and breaks; blowouts during drilling, production, workover, or completion[22] activities at an oil well; breach of containment systems; containment and/or tank overfill, leaks, or failures; and accidental discharges during oil transfer operations. History has shown that most accidents are likely to happen from combinations of technological malfunction/failures, lack of maintenance, human error, and/or natural disasters (e.g., earthquakes). Many spills arising from incidents that involve human error can and are minimized by maintaining equipment in good working order, employing good engineering and oilfield practices, training personnel, following proper operational procedures, and conducting periodic drills and exercises of the facility's oil spill contingency/response plan.

BAP for the prevention and mitigation of oil spills at marine facilities is provided through the use of both BAT and other best practices, such as manpower levels, training procedures, operational methods, and drills and exercises. Technology alone is not the sole solution for achieving BAP. For example, at some facilities the latest technological widget may be inappropriate and may actually produce a higher risk of an oil spill. For such facilities, BAP may be better achieved by focusing on the human factors. The key is to systematically evaluate and implement the combination of human and technological elements that provides the highest level of protection from oil spills.

Agency Oversight and Types of Facilities
In California, multiple state and federal agencies have regulatory oversight over oil and gas facilities to ensure safe operations and the prevention of oil spills. More detailed information about these agencies and their programs, regulations, and standards for BAT and BAP is provided in Section III of this report.

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[21] See United States Department of Energy website at: http://tonto.eia.doe.gov/state/state_energy_rankings.cfm?keyid=28&orderid=1

[22] See Oil and Gas Field Technical Terms Glossary website at https://www.osha.gov/SLTC/etools/oilandgas/glossary_of_terms/glossary_of_terms_w.html

This section of the report focuses on discussing oil spill risks and oil spill prevention technologies and practices for the following types of facilities in California:

(1) Offshore oil and gas platforms (in state and federal waters)
(2) Marine terminals
(3) Pipelines
(4) Onshore oil and gas production fields
(5) Refineries and oil and gas processing facilities

Please note that pipeline components exist at each of these facility types, but this report consolidates the discussion about pipeline technologies and best practices under one Pipeline section. In addition, note that above ground storage tanks and small craft refueling docks will not be discussed; these facility types are not covered under the provisions of the Act.

OFFSHORE PLATFORMS

Sources of Spill Risk

The potential sources for a risk of oil spills at offshore platforms are from exploratory and production wells, pipeline ruptures, and overflows of tanks/pipes. The 1969, the Union Oil Platform A oil spill in the Santa Barbara Channel and the more recent 2010 *Deepwater Horizon* "Macondo" well blow-out in the Gulf of Mexico have provided significant lessons for improving the safety of operations and prevention of spills at California's offshore oil and gas platforms.

The 1969 Union Oil 'Platform A' Oil Spill

The cause of the January 28, 1969, blowout and oil spill from Platform A in the federal waters of Santa Barbara Channel cannot be attributed to one single event but rather to a chain of events, including human organizational and procedural errors. The personnel working on the rig did not recognize signs that potential problems were developing in the well and, therefore, did not use appropriate drilling and well-control techniques. A contributing cause to the blowout may have been the well-casing program used by Union Oil Company of California, the operator of the lease. Use of a different drilling and casing program, including different casing setting depths or additional casing, would probably have prevented the oil from traveling to the sea floor and into the ocean via fractures. In addition, had an appropriate oil spill response plan been in place and followed, there would probably have been significantly less impact to the environment.

The 1969 Platform A spill was a major factor in the development of a series of new laws and regulations in the United States and California with a focus on environmental protection and safety. As a result, there have been significant improvements in well technologies and safety procedures for offshore platforms in California. Over a billion barrels of oil and 1.5 trillion cubic feet of gas have been

produced and over 1,200 wells drilled in California with minimal spillage since the 1969 Platform A spill through 2010.

The 2010 *Deepwater Horizon* Oil Spill

The April 20, 2010 Macondo Well blowout and explosion on the *Deepwater Horizon* in the Gulf of Mexico resulted in the death of eleven crew members and a release of over 4 million barrels of crude oil. The immediate cause of the blowout can be traced to a number of identifiable human mistakes, revealing a systematic failure in risk management. According to the National Commission on the *Deepwater Horizon* Oil Spill and Offshore Drilling, the technical root cause of the blowout was that cement, pumped to the bottom of the well during temporary abandonment operations, did not seal off hydrocarbons in the formation.[23] In addition to the report from the National Commission, a number of teams and Boards were established to investigate the cause. Immediately after the *Deepwater Horizon* incident, Secretary of the Interior, Ken Salazar, established the Outer Continental Shelf (OCS) Safety Oversight Board to make recommendations to strengthen permitting, inspections, enforcement, and environmental stewardship.[24] Based on those recommendations, the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE)[25] developed an implementation plan.[26]

In response to the *Deepwater Horizon* oil spill, USCG Commandant, Admiral Robert J. Papp, chartered an Incident Specific Preparedness Review (ISPR) Team to examine the USCG's preparedness process in conjunction with the implementation, integration, and effectiveness of national, regional, and local oil spill response plans. The ISPR team published a report with their findings on March 18, 2011.[27]

Agencies with Regulatory Oversight

The California State Lands Commission's Minerals Resource Management Division (MRM) has regulatory authority over the construction, drilling, and

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[23] *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling.* Report to President, National Commission on the BP Deepwater Horizon Spill and Offshore Drilling, January 2011. http://cybercemetery.unt.edu/archive/oilspill/20121210200431/http:/www.oilspillcommission.gov/final-report

[24] The OCS Safety Oversight Board's recommendations and report: http://www.doi.gov/news/pressreleases/Salazar-OCS-Safety-Board-Report-a-Blueprint-for-Next-Steps-on-Internal-Reforms-of-Offshore-Energy-Oversight.cfm.

[25] The Minerals Management Service was renamed the Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) by Secretarial Order No. 3302. Secretarial Order 3299 creating the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement from BOEMRE, went into effect on October 1, 2011.

[26] The BOEMRE implementation plan: https://www.doi.gov/sites/doi.gov/files/migrated/news/pressreleases/upload/BOEMRE-Implementation-Plan.pdf

[27] The ISPR team report: http://www.uscg.mil/foia/docs/DWH/BPDWH.pdf

production operations of offshore oil platforms and their associated undersea pipelines in California waters.

Bureau of Ocean Energy Management (BOEM) is an agency within the United States Department of the Interior responsible for managing environmentally and economically responsible development of the nation's offshore resources. Its functions include offshore leasing, resource evaluation, review and administration of oil and gas exploration and development plans, renewable energy development, National Environmental Policy Act analysis, and environmental studies.

Bureau of Safety and Environmental Enforcement (BSEE) is an agency within the United States Department of the Interior responsible for safety and environmental oversight of offshore oil and gas operations, including permitting and inspections of offshore oil and gas operations in federal waters of the US Outer Continental Shelf. Its functions include the following: development and enforcement of safety and environmental regulations; permitting offshore exploration, development, and production; inspections; offshore regulatory programs; oil spill response and training; and environmental compliance programs.

More detailed information about the MRM, BOEM, and BSEE regulations and programs that have been implemented to improve oil spill prevention and safety at offshore platforms is provided in Section III.

Summary of Technology, Design, and Human Factor Measures for Oil Spill Prevention

The following is a summary of the major improvements that have been implemented by BSEE and MRM to prevent spills from oil and gas platforms offshore California:

Training

- All drilling personnel are required to complete extensive training in drilling and well control.
- Oil company personnel who operate oil spill response equipment are required to take annual training in the use of the equipment.

Drilling

- Federal and state regulations have been, or are being, updated to require more stringent and specific requirements for well design, drilling fluids, blowout prevention systems and their components, and operating procedures.
- Lessees are required to conduct shallow hazards surveys at proposed drilling rig/production platform locations to facilitate detailed analyses of the seafloor and geology.

Technology

- Programs have been developed by agencies and industry to assess new drilling technologies.
- Federal and state regulations and/or policies are continually updated to incorporate new equipment and procedures that enhance operational safety.
- Agencies require that the "best available and safest technologies" (BSEE) and "best achievable technologies" (MRM) be used in drilling and production operations at the platforms.
- Agency and industry research programs have resulted in continual improvements in offshore oil and gas operations and spill response-related technologies.
- Industry groups have developed standards and practices that, in some cases, have been incorporated into federal and state regulations.

Equipment and Testing

- Requirements for blowout prevention and system components were expanded and include pressure tests and well-control drills and, since the *Deepwater Horizon* blowout in the Gulf of Mexico, third-party verification and certification of the blowout prevention equipment and systems and their fitness for purpose.
- Spill response equipment is required to be inspected and tested periodically to ensure optimal performance.
- Safety devices are required to be installed, maintained, and regularly tested to ensure safety and environmental protection.

General

- Federal and state inspection personnel and inspections have increased significantly since the 1990 motor tanker *American Trader* oil spill.
- Federal and state agencies conduct stringent inspections.
- Effective civil and criminal penalty programs are in place as an incentive for operators to operate safely and within the regulations.

MARINE TERMINALS

Sources of Spill Risk

The potential sources of oil spills from marine terminals include pipeline failures, cargo hose ruptures, coupling leaks at manifolds and connections between terminal and vessels, and tank or sump overflows. Oil spills and other incidents are typically the result of more than one cause. Human and organizational errors, such as poor procedures, supervision, training, or performance, are common precursors.

Inadequate design, construction, inspection, maintenance, and repair of a facility's infrastructure and hardware can lead to severe incidents if not mitigated. The average age of marine terminals in California exceeds 55 years. Over time, these marine terminals have been upgraded to moor ships of much larger sizes than they were originally designed to accommodate.

Agencies with Regulatory Oversight

In 1990, a significant oil spill occurred at a marine terminal when the tank ship *American Trader* "sat down" on its own anchor at a mooring offshore Huntington Beach. That incident led to the passage of the Act in 1990, which created several oil spill programs; the Marine Facilities Division within the California State Lands Commission (MFD, now the Marine Environmental Protection Division) became the lead regulatory authority over the operation of all marine terminals in California. More detailed Information about the MFD (Marine Environmental Protection Division) programs and rules that have been implemented to improve oil spill prevention and safety at marine terminals is provided in Section III.

Summary of Technology, Design and Human Factor Measures for Oil Spill Prevention

In the years since the passage of the Act, marine terminal operators have collaborated with MFD and other government agencies to make measurable improvements in those areas that are most critical in order to prevent oil spills. The Planning Branch of MFD is tasked with exploring national and international trends in BAP/BAT. Along with input from engineering, environmental, and operations experts, these trends are examined via presentations and/or exhibits at CSLC's biennial Prevention First Symposium and Technology Exhibition. Additionally, BAP/BAT is a frequent topic at MFD's periodic Customer Service meetings, hosted by their two field offices.

The following is a summary of the technology, design, and human factor measures that have been implemented at marine terminals in California:

Seismic Safety Upgrades

- Marine terminals have undergone, and are undergoing, extensive seismic analyses and engineering audits to determine fitness for purpose of structures; mooring and berthing systems; fire protection, detection and suppression systems; and mechanical and electrical systems.

Technology

- BAT and best practices are required to be used in the design, upgrades, and operations of marine terminals in California.
- Agency and industry collaborative forums have resulted in continual improvements in marine terminal technologies and operations (e.g., biennial Prevention First Symposium and Technology Exposition).

Pipeline Testing and Maintenance

- Pipeline testing and maintenance procedures have been improved to evaluate the fitness of an often aging system.

Operations Procedures and Personnel Training

- Operations manuals for marine terminals are closely reviewed first by the terminal staff and then approved by both state and federal agencies.
- Training requirements have been expanded to include all terminal staff, not just persons-in–charge.
- Work hours have been capped for operations staff, where it may have been previously common for terminal staff to work back-to-back extended overtime shifts.
- Communications and exchange of information between marine terminals and tank vessels have improved.
- California refineries have implemented oil spill prevention and counter control plans that include regular drills with agency coordination, mobilization of specialized watercraft for spill containment and clean up and other procedures to prevent and mitigate spills.

PIPELINES

Sources of Spill Risk

Pipelines can be one of the most efficient and safest methods of transporting large quantities of crude oil. The lines must be inspected, maintained, tested, monitored, and operated by properly trained personnel. Crude oil pipelines, if not properly maintained, may be susceptible to internal and external corrosion, resulting in a reduction of wall thickness and subsequent failure that can cause an oil spill. Pipelines could also sustain damage from a third party, resulting in a spill. Such damage may cause an immediate release from a pipeline or damage the coating or cathodic protection on the pipeline, eventually leading to a spill.

Agencies with Regulatory Oversight

The California State Fire Marshal (CSFM) is responsible for regulating and enforcing safety on all intra-state hazardous liquid transport pipelines within the state.[28] The CSFM is the recognized intrastate agent of the US Department of Transportation's PHMSA and, therefore, also responsible for the inspection, investigation, and emergency response for all intrastate pipelines transversing California. More detailed information about the CSFM and PHMSA regulations and programs that

[28]There are some overlaps in jurisdiction with other state agencies for the regulation of smaller pipelines. For example, gathering lines used solely within onshore oil production fields are regulated by DOGGR and certain pipelines within marine terminals are regulated by the State Lands Commission – Marine Facilities Division. CSFM and these agencies have developed Memoranda of Understanding to clarify the jurisdictional overlaps.

have been implemented to improve oil spill prevention and safety in pipelines is provided in Section III.

Summary of Technology, Design and Human Factor Measures for Oil Spill Prevention

The following is a summary of the pipeline technologies, programs, and best practices that have been implemented in California to improve pipeline safety and prevent oil spills:

Pipeline Design

- Public agencies and industry groups have developed standards and practices that have been incorporated into federal and state regulations (e.g., American Petroleum Institute (API) pipeline standards).

Pipeline Inspection and Maintenance

- Pipelines are required to be inspected internally and externally periodically.
  - Internal inspection methods can include Inline Line Inspection (ILI), ultrasonic testing, guided wave testing, and pressure testing.
  - External inspections include "walking" the pipeline by foot, vehicle, or aerial flights for above-ground onshore pipeline and using remotely operated vehicles and instruments for submerged pipelines.
- Routine maintenance is required to ensure that internal corrosion is mitigated to prevent possible leakage of the pipelines.
- Operators can use chemical treatment, such as inhibitors, that are injected into the pipeline or batched to prevent internal corrosion.
- The effectiveness of inhibitors in preventing internal corrosion is monitored by using "corrosion coupons"[29] or other monitoring equipment.
- Other maintenance methods include the passing of cleaning pigs[30] through the pipelines.
- Cathodic protection is required on all pipelines.

Pipeline Integrity Testing

- Pipeline integrity testing is carried out to ensure that the pipeline has not been compromised.

[29] The coupon is the original form of "intrusive" corrosion monitoring. It consists of a strip of metal about 3 inches long and 1/8-inch thick, made of material similar to the pipeline. It is weighed, then inserted into an access point and left for at least six months. The operator then removes the coupon and weighs it again to calculate what percentage is missing.

[30] A "pig" is a device that is driven through a pipeline for performing various internal activities (depending on the pig type) such as separating fluids, cleaning or inspecting the pipeline. For more information see: http://www.pipelineoperators.org/publicdocs/POF_specs_2009.pdf

- Pipeline geometry pigs record conditions, such as dents, wrinkles, bend radius, etc., by taking measurements of the internal diameter of the pipeline.
- Operators also use metal loss/crack detection tools, ILI, to monitor pipeline wall thickness. ILI tools include Ultrasonic Testing (UT) and Magnetic Flux Leak (MFL).
    - UT ILI tools emit a high frequency sound pulse to determine pipe wall thickness and detect anomalies.
    - MFL ILI tools establish a strong magnetic field in the pipeline wall to detect abnormalities. Changes in the magnetic field are used to determine the pipe wall thickness.
- "Guided Wave" Long Range Ultrasonic Testing is comprised of a collar which emits a low frequency ultrasound wave and detects pipeline anomalies within 30 to 40 feet of the collar. This is also used to determine pipe wall thickness.

Pipeline Monitoring

- Pipeline operators are required to maintain and update operation procedures in compliance with federal and state pipeline operation safety regulations and standards.
- Pipeline operators are required to be trained in compliance with federal and state pipeline safety training regulations and standards.
- Pipeline operators must have redundant safety devices, maintain 24-hour monitoring, and have a means to detect leaks in the pipeline system in compliance with federal and state regulatory standards.
- Operators use current pipeline technologies/best practices with respect to leak detection.
- Methods to detect pipeline leaks include volumetric balance leak detection, pressure leak detection, duct with monitoring annulus, hydrogen sulfide (H2S) sensors, walking the pipeline route with a gas sensor (for surface pipelines), and high- and low-pressure safety settings.
- Large leaks are detected by Supervisory Control and Data Acquisition (SCADA) systems through flow or pressure deviations from normal operating conditions or low-pressure safety settings.
- Small leaks are more difficult to detect and may require a Computational Pipeline Monitoring (CPM) system like volumetric balance leak detection. The CPM system incorporates a mathematical model that detects leaks based on real-time SCADA data.

- Other methods for detecting pipeline leaks include Distributed Temperature Sensing[31] systems (uses fiber-optic technology) and Acoustic leak detection technology.[32]

ONSHORE OIL PRODUCTION FIELDS

Sources of Spill Risk

Spills from onshore oil production fields continue to be an on-going concern in California. Spills occur from ruptured storage tanks, corroded pipelines, and overflowing injection ponds. Oil from many of these spills threatens to flow into nearby waterways.

Agencies with Regulatory Oversight

California's Department of Conservation's DOGGR is responsible for supervising the drilling, operation, maintenance, and plugging of oil and gas wells and geothermal wells within the state. Their jurisdiction also includes the operation, maintenance, and removal of related production and exploration facilities that are within oil field boundaries, such as tanks and pipelines. Please see Section III for additional details on DOGGR Spill Prevention Requirements and Programs.

Summary of Technology, Design and Human Factor Measures for Oil Spill Prevention

The following is a summary of the technologies, programs, and best management practices that have been implemented, or are in development, in California to improve the safety of operations and the prevention of spills at oil field facilities:

Technology

- Programs have been developed by agencies and industry to assess new drilling technologies.
- State regulations have been updated to incorporate new equipment and procedures that will enhance operational safety.

[31] The Distributed Temperature Sensing (DTS) system uses fiber-optic technology to take adjacent temperature measurements along a given length of pipeline. Single fiber-optic probes can take the place of thousands of sensors. DTS eliminates the need to predict where incidents may occur, as the whole length of the pipeline is covered by probes. This type of monitoring is not corrupted by electromagnetic noise and does not pose a spark risk in volatile environments. It can also be used to detect pipeline movement due to landslides or earthquakes.

[32] An Acoustic In-Line inspection device can identify leaks by detecting the characteristic acoustic "signature" produced when pressurized product escapes to a lower pressure environment. An acoustic fiber-optic monitoring system can detect leaks and help prevent unauthorized activity in the vicinity of the pipeline.

- Public agency and industry research programs have resulted in improvements in onshore oil and gas operations and spill response-related technologies.
- Industry groups, in partnership with the agencies, have developed standards and best practices, some of which have been incorporated by reference into federal and state regulations (e.g., API and the American Society for Testing and Materials).

Equipment and Testing

- Requirements for blowout prevention and system components are being expanded and include third-party verification and certification of operability and design.
- Safety devices are required to be installed, maintained, and regularly tested to ensure safety and environmental protection.

Additional Requirements for Oil Field Operator and Facilities

Assembly Bill (AB) 1960 (Nava, Chapter 562, Statute 2008) went into effect in January, 2009, and regulations were approved to minimize the occurrence of accidental releases of oil through enhanced maintenance, planning, and reporting requirements. The final AB 1960 implementation regulation changes became effective on January 29, 2011.[33]

These regulation changes increased maintenance, contingency planning, and reporting requirements for oil field operators and facilities. Changes included enhanced requirements for the following:

- Leak detection
- Corrosion prevention and testing
- Tank inspection and cleaning
- Valve and gauge maintenance
- Secondary containment maintenance
- Notification prior to construction, alteration, and decommissioning of a production facility
- Record-keeping
- Spill contingency plan preparation, including deadlines

The new regulations also allowed for the following:

- Authorization for DOGGR to seek reimbursement for enforcement costs
- Increased bond requirements for operators with a history of violating regulations or with outstanding liabilities to the State

[33] The final text of the implementation regulations can be seen at the DOGGR website: http://www.consrv.ca.gov/dog/Pages/AB1960Implementation.aspx

- Increased civil penalties for violations

Enhanced Management of Pipelines in Environmentally Sensitive Areas
In 1998, DOGGR updated its regulations to require special pipeline management plans for pipelines located in environmentally sensitive areas, including pipelines within 100 feet of waterways and all pipelines in the coastal zone. This pipeline management plan requires more frequent inspections, testing, and maintenance.

Hydraulic Fracturing in California[34]
Oil and gas wells in California are constructed to meet stringent standards; DOGGR reviews well designs, before drilling, to ensure the construction plans meet these standards. Some states have lower standards for "typical" oil and natural gas wells and then raise their standards for wells through which a production stimulation practice, like hydraulic fracturing (HF), will occur. California maintains a high construction standard for ***all*** wells.

Well construction standards have a fundamental purpose – to ensure "zonal isolation," which means that oil and gas coming up a well from a productive, underground geologic zone will not escape the well and migrate into other geologic zones (including zones that might contain fresh water). Zonal isolation also means that the fluids an oil and gas operator puts down a well for any purpose will stay in that zone and not migrate to another zone. To achieve zonal isolation, current rules require that a cement barrier be placed between the well and the surrounding geologic strata or stratum.

In some cases, oil or natural gas will not flow freely to the well and must be stimulated. There are a variety of stimulation techniques, including HF, intended to improve the flow of oil or natural gas from the geologic strata to the well, so that resources can be produced.

The practice of HF involves the temporary application of high pressure to the oil and gas producing strata with the aim of creating new fissures through which oil or gas can flow back to the well. Without these fissures, the geologic zone would not as easily release the oil or gas, and these raw materials would not flow.

In HF, a fluid with chemicals and additives is injected under pressure into the formation. Specific chemicals and additives in the fracturing fluid help to ensure that the proppant (typically sand, or small resin or ceramic beads) remains in a gel-like solution (instead of settling to the bottom of the fluid) for circulation into the fissures. The proppant is added so that the fractures created by the pressure do not collapse back on themselves. Other additives dissolve the gel after the fractures are created

[34] More information on hydraulic fracturing in California can be found at the following site: http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx

to allow the "fracturing fluid" to come back to the surface and leave the proppant behind in the fissures. Still others are inserted to ensure that bacteria from the surface are not accidentally injected into the geologic strata, where they might form biofilms or cultures that could clog the flow of the well. Some of the chemicals used in fracturing fluids are non-toxic, but others have potential health hazard properties in certain concentrations. Once the fluids are injected, most of them are produced back to the surface through the well into which they were applied to the geologic formation.

California oil and natural gas is almost always associated with "produced water" – that is, brackish water that already exists in the oil and gas formation. Generally, there is far more water in a reservoir formation than there is oil or natural gas; 80-90% water is not uncommon in California oil and gas fields. This means that, on average for all wells in the state, more than 80 of every 100 barrels of fluid produced are brackish water. One of three things can happen to this water: 1) it can be used for enhanced oil operations, 2) it can be re-injected into wastewater disposal wells, or 3) it can be treated. When HF occurs, most of the fracturing fluid is pumped to the surface along with the formation water, making separation of the fracturing fluids from the produced water impossible. The fracturing fluid is then co-disposed with the produced water. Current regulations specify the disposal requirements for these fluids: how they are disposed of in disposal wells, how they are used to increase oil production from existing reservoirs, and how they are treated.

REFINERIES AND OIL AND GAS PROCESSING/SEPARATION FACILITIES

Sources of Spill Risk

Refineries in California primarily operate in the San Francisco Bay and Los Angeles/Long Beach areas and handle large volumes of oil. In addition, oil and gas processing/separation facilities service both onshore oil fields and offshore platforms. The refining and separation process is a major cause of corrosion of the facility components necessitating repair and replacement projects (i.e., turnarounds) that occur routinely throughout each year. Oil spills at these facilities can occur from pipeline ruptures, overflow of tanks/pipes, and storage tanks that can contaminate resources aboveground as well as underground soil and water resources.

Agencies with Regulatory Oversight

The EPA has jurisdiction and requires facilities to prepare Spill Prevention, Control, and Countermeasure (SPCC) plans. Under the Act, refineries and oil and gas processing facilities are required to comply with OSPR's facility contingency plan regulations (14 CCR §817.01, et seq.). Detailed information about EPA and OSPR regulations and programs that have been implemented to improve oil spill prevention and safety is provided in Section III.

Summary of Technology, Design, and Human Factor Measures for Oil Spill Prevention

Pipeline Testing and Maintenance

- Pipeline testing and maintenance procedures have been improved to evaluate the fitness of an often aging system.

Operations Procedures and Personnel Training

- SPCC plans and oil spill contingency plans are required to include risk and hazard evaluations that identify oil spill risk components and design, maintenance, and monitoring measures to mitigate the risks. These plans are reviewed by facility staff and then approved by both state and federal agencies.

Training

- All personnel are required to take extensive training in compliance with federal and state regulatory requirements.
- Oil company personnel who operate oil spill response equipment are required to take annual training in the use of the equipment in compliance with federal and state regulations.

Technology

- Programs have been developed by federal and California agencies, as well as the oil and gas industry, to assess new technologies.
- Federal and California regulations and policies are updated as needed to incorporate new equipment and/or procedures that enhance operational safety.
- Industry groups have developed standards and practices that, in some cases, have been incorporated by reference into federal and state regulations.

Equipment and Testing

- Spill response equipment is required to be inspected and tested periodically to ensure optimal performance in compliance with federal and California regulations.
- Safety devices are required to be installed, maintained, and regularly tested.

General

- Federal and California agencies conduct facility inspections.
- Effective civil and criminal penalty programs are in place as an incentive for operators to operate safely and in compliance with federal and California regulations.

OIL AND GAS TRANSPORTATION BY RAIL

Risks to public safety and the environment due to oil and gas transportation by rail continue to be an emerging concern in California. Although current US production and subsequent crude shipments are at a low level, rail shipments of oil into California, including North Dakota "Bakken" crude oil, have fluctuated with market conditions since 2012 and are certain to increase in the not-too-distant future. Bakken oil is extremely flammable, and its transport increases the risk of serious accidents, as demonstrated by the tragic rail incident in Lac-Megantic, Quebec, in July 2013. A proposal was included and passed in the FY 2013-14 State Budget that expanded California's marine oil spill program to mitigate the increased risk of inland oil spills by supporting prevention, emergency response preparedness, cleanup, and enforcement measures across the state. OSPR has begun to implement the program outlined in SB 861.

SECTION III: GOVERNMENT AGENCIES WITH SIGNIFICANT OIL SPILL PREVENTION JURISDICTION

FEDERAL GOVERNMENT SPILL PREVENTION REQUIREMENTS AND PROGRAMS

United States Coast Guard and Prevention

The USCG regulates many facets of industry to promote oil spill prevention as described in this report. The scope of this report, however, will not cover all the applicable USCG regulations. The following are a few examples of USCG studies that promote navigation safety and spill prevention: Ports and Waterways Safety Assessments (PAWSA), Port Access Route Studies (PARS), and Waterways Analysis and Management Studies (WAMS).[35] In an average year, the USCG performs two PAWSAs, two or three PARSs, and about 300 WAMSs throughout the nation.

Ports and Waterways Safety Assessments

PAWSAs are a tool to identify risks and provide mitigation measures in the nation's ports and waterways. The USCG involves stakeholders (e.g., professional mariners and industry) in the process. This provides the USCG with more information concerning the environmental, public safety, and economic consequences of its actions.

The ultimate purpose of PAWSA is not only to establish a baseline of ports for consideration for VTS, but to provide the Captain of the Port and the port community with an effective tool to evaluate risk and work toward long-term solutions to mitigate these risks. The goal is to find solutions that are both cost-effective and meet the needs of waterways users. It is important to note

[35] For more information about these studies, see the USCG National Pollution Funds Center home page: http://www.uscg.mil/npfc/Publications/OSLTF%20Report/default.asp#sum2

that the PAWSA process is carried out in other ports across the nation as well as the State of California.

Port Access Route Studies
The Port and Waterways Safety Act of 1978 [PWSA, 33 U.S.C. §1223 (c)] requires that the USCG conduct a PARS prior to establishing or adjusting a Traffic Separation Scheme (TSS) or any other routing measure. A TSS is an internationally recognized measure that minimizes the risk of collision by separating vessels into opposing streams of traffic through the establishment of traffic lanes. The USCG estimates the costs and benefits of these improvements.

In 2009, the USCG completed a PARS to evaluate the continued applicability of and the need for modifications to current vessel routing in the approaches to Los Angeles-Long Beach and in the Santa Barbara Channel. The goal of the study was to help reduce the risk of marine casualties and resulting recommendations aimed to increase the efficiency of vessel traffic in the study area.

The USCG also completed a PARS to evaluate the San Francisco Bay TSS area west of the Golden Gate Entrance.

Waterways Analysis and Management Studies
A WAMS encompasses all aspects of the marine thoroughfare to check the effectiveness of USCG programs and resources. A typical WAMS will look at the physical dimensions of the channel, bridges, marine facilities, obstructions, traffic density and patterns, vessel size, and aids-to-navigation systems. As a result of a WAMS, the USCG often makes navigational improvements such as increasing the number of aids to navigation.

Bureau of Safety and Environmental Enforcement[36] – Offshore Facilities

Authority
The Outer Continental Shelf Lands Act and the Submerged Lands Act give the BSEE, a Bureau under the Department of the Interior, the authority to regulate oil and gas activities on the OCS. The Energy Policy Act of 2005 amended the OCS Lands Act to include renewable energy projects on the OCS. The Oil Pollution Act of 1990 provides BSEE oil spill planning and preparedness authority for all offshore facilities (except those associated with deep-water ports).

Responsibilities
The mission of BSEE is to promote safety, protect the environment, and conserve resources offshore. BSEE is responsible for safety and spill prevention oversight of offshore facilities on the OCS. These include fixed and floating operations engaged in the exploration, development, and production activities that involve any form of

[36] BSEE: http://www.bsee.gov/

liquid hydrocarbons. Submarine pipelines that transport hydrocarbons between facilities are also under the jurisdiction of BSEE. BSEE requires that operators of these facilities, both in federal and state waters prepare and maintain oil spill response plans (OSRPs), conduct response drills, and exercise oil spill prevention measures. The Oil Spill Response Division[37] reviews and approves the OSRPs, conducts Government Initiated Unannounced Exercises, and verifies spill response equipment listed in the OSRPs to ensure the operators are prepared to respond to a spill.

BSEE also maintains and operates Ohmsett, the National Oil Spill Response Research and Renewable Energy Test Facility located in Leonardo, New Jersey. Ohmsett[38] is the premier oil spill training facility for response personnel. Testing at Ohmsett strengthens awareness of oil spill pollution prevention and response methods, while providing an environmentally safe place to conduct objective testing and to develop devices and techniques for the control of oil spills.

Spill Prevention Measures

BSEE's comprehensive regulatory program includes spill prevention measures and covers all aspects of exploratory and development drilling, completion work (preparing a well for production), and production and workover (operations on a completed well to clean, repair, and maintain the well for the purposes of increasing or restoring production) activities. Spill prevention measures include the design of the well "casing," which is a length of pipe that is cemented to the surrounding rock, and set to depths below the surface depending upon a conservative forecast of the subsurface pressures expected to be encountered in the well.

Operators are able to monitor and measure temperatures, pressures, and other conditions occurring "downhole" in real time, due to improvements in drilling technologies. Downhole pressures are managed during drilling by circulating a material called "drilling mud" through the wellbore. In terms of well control, the purpose of the drilling mud is to provide a constant fluid weight to offset pressures and fluids encountered downhole.

Blowout Preventers (BOPs) are installed at the wellhead to control pressures in the annular space between the casing and the drill pipe during drilling, completion, and certain workover operations. Some BOPs can close over an open wellbore. Some are designed to seal around tubular components in the well, and others are fitted with hardened steel-shearing surfaces that can actually cut through drill pipe. Safety devices are required to be installed, maintained, and regularly tested to ensure safety and environmental protection on all offshore facilities. This includes subsurface safety valves in producing wells which can be closed manually or automatically depending on the condition.

[37] BSEE Oil Spill Preparedness Division: http://www.bsee.gov/About-BSEE/Divisions/OSRD/index/
[38] Ohmsett: http://www.ohmsett.com/

Oil spill response plans require that operators address the risk of small spills from offshore operations such as those from fuels and lubricants as well as worst-case discharge from their facility. Offshore platforms are designed with curbing and barriers to contain the oil from these small spills before they can enter the water.

US Environmental Protection Agency Emergency Management –Onshore Petroleum Facilities and Marine Terminals

Responsibilities

EPA Emergency Management administers the Oil Pollution Prevention regulations (40 CFR §112.1 - §112.21) that cover Onshore Petroleum Facilities. SPCC plans are required to be submitted.[39] These plans are developed to include operating procedures and control measures implemented by the operator to aid in preventing any discharge of oil into or upon navigable waters of the United States or adjoining shorelines (40 CFR §112.1 - §112.1). The plans must also include countermeasures to contain, clean up, and mitigate effects of an oil spill.

Spill Prevention Devices

Spill prevention devices currently utilized at petroleum facilities include metered pumps, self-adjusting cargo pipe connections, concrete traps constructed below storage tanks to protect against groundwater contamination, over-fill protection devices, and cathodic corrosion prevention. The industry also utilizes new oil storage tank materials and durable coatings to prevent corrosion.

These facilities are also required to provide catchment basins and leak detection devices on tanks and associated pipelines. Double-walled oil storage tanks are also utilized. The space between the double walls may be filled with brine and equipped with a float sensor to detect any increase in brine level due to product escaping from the inner wall. Line leak detectors are also required, which monitor the pressure of the delivery line with a spring-loaded arm. If the pressure in the petroleum pipeline is low (potentially due to a leak), the arm makes contact and triggers an alarm to a monitoring station.

US Department of Transportation Pipeline and Hazardous Materials Safety Administration– Pipelines

Responsibilities

PHMSA is responsible for implementing regulations regarding pipelines. These regulations include construction procedures and material specifications, inspections, operations, spill containment, spill response, and leak detection.[40]

[39] SPCC Plans Overview: https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations/overview-spill-prevention-control-and

[40] PHMSA regulations: http://www.phmsa.dot.gov/pipeline/regs

Pipeline Inspection and Maintenance
Each operator must have a means to detect leaks on its pipeline system as required by the applicable federal regulations (49 CFR §195.452(i)(3)).

Pipelines are required to be inspected several times per calendar year by use of various methods that can include "Smart Pigs," ultrasonic testing, guided wave testing, and pressure testing. Each pipeline operator is also required to maintain and update operation procedures, ensure employee minimum qualifications are met and maintained, provide for redundant safety devices, and maintain 24-hour operations monitoring.

Routine maintenance is required to ensure that internal corrosion is mitigated to prevent possible leakage of the pipelines. This can be achieved by using such methods as chemical treatment with inhibitors injected into the pipeline and use of coupons or other monitoring equipment to determine the effectiveness of the inhibitors. Other maintenance methods include the passing of scraper pigs through the pipelines. Regulations also require cathodic protection to be installed on submerged or buried pipelines.

CALIFORNIA GOVERNMENT SPILL PREVENTION REQUIREMENTS AND PROGRAMS

California Department of Fish and Wildlife, Office of Spill Prevention and Response

Authority
Government Code §8670.7 gives "the [OSPR] Administrator the primary authority, subject to the Governor, for the removal, response, abatement, containment and clean-up efforts with regard to all aspects of any oil spill in waters of the state." Government Code §8670.28 further provides that:

> *"The administrator, taking into consideration the facility or vessel contingency plan requirements of the State Lands Commission, the Office of the State Fire Marshal, the California Coastal Commission, and other state and federal agencies, shall adopt and implement regulations governing the adequacy of oil spill contingency plans to be prepared and implemented under this article. All regulations shall be developed in consultation with the Oil Spill Technical Advisory Committee, and shall be consistent with the California oil spill contingency plan and not in conflict with the National Contingency Plan. The regulations shall provide for the best achievable protection of waters and natural resources of the state. The regulations shall permit the development, application, and use of an oil spill contingency plan for similar vessels, pipelines,*

terminals, and facilities within a single company or organization, and across companies and organizations."

As a result of this requirement, OSPR has promulgated contingency plan regulations covering the following: all facilities with a potential for discharge into waters of the state, all tank vessels that transit within state waters, and all non-tank vessels or vessels carrying oil as secondary cargo that transit within state waters.[41]

Responsibilities

Prevention measures and programs currently implemented by OSPR include the following:

- Formation of HSCs for the major port areas (Humboldt Bay, San Francisco, Port Hueneme, Los Angeles/Long Beach, and San Diego).
- Oil Spill Contingency Plan requirements for prevention measures— marine facilities, small marine fueling facilities, tank vessels, vessels carrying oil as secondary cargo, and non-tank vessels.
- Bunkering and lightering (i.e., oil transfer) monitoring and spill prevention requirements.
- Tug Escort requirements for laden tank vessels for the major port areas.
- With the USCG, establishment of the VTS in the Los Angeles/Long Beach Harbors (later federalized).
- Funding to support the Physical Oceanographic Real-Time System in San Francisco Bay.
- Identification of Potential Place(s) of Refuge, which are locations where a vessel needing assistance can be temporarily moved and where actions can then be taken to stabilize the vessel and help prevent or minimize potential adverse effects to the vessel, the public, the environment, and resource users.
- Involvement of OSPR staff with various committees, task forces, and workgroups on prevention issues, including, but not limited to, the following:
    - Spill Response Planning Area Committees
    - HSCs (including numerous subcommittees)
    - Pacific States-British Columbia Oil Spill Task Force
    - Oil Spill Technical Advisory Committee

[41] OSPR regulations: https://www.wildlife.ca.gov/OSPR/Legal

California State Lands Commission– Requirements

Authority

Since 1938, CSLC has served as manager of the state's sovereign lands, including most historic tidelands, submerged lands, and navigable waterways. This jurisdiction is found in Division 6 of the Public Resource Code (PRC) and more specifically in PRC §6301, which reads in part:

> *"The Commission has exclusive jurisdiction over all ungranted tidelands and submerged lands owned by the State, and of the beds of navigable rivers, streams, lakes, bays, estuaries, inlets, and straits, including tidelands and submerged lands or any interest therein, whether within or beyond the boundaries of the State as established by law, which have been or may be acquired by the State ... [t]he Commission shall exclusively administer and control all such lands, and may lease or otherwise dispose of such lands, as provided by law, upon such terms and for such consideration, if any, as are determined by it."*

Under PRC §6108, the Legislature also authorized the Commission to make and enforce all reasonable and proper rules and regulations consistent with law for the purpose of carrying out the provisions of Division 6.

PRC §8755, adopted as part of the Act, provides, in part, that:

> *"…the [State Lands] Commission [SLC] shall adopt rules, regulations, guidelines, and commission leasing policies for reviewing the location, type, character, performance standards, size and operation of all existing and proposed marine terminals within the state, whether or not on lands leased from the commission, and all other marine facilities on lands under lease from the commission to minimize the possibility of a discharge of oil... The [SLC] shall ensure that the rules, regulations, guidelines, and commission lease covenants provide the best achievable protection of public health and safety and the environment."*

Mineral Resources Management Division

The CSLC's MRM is staffed with specialists in oil and gas, geothermal and mineral leasing, exploration, and development; many are registered professionals or have advanced degrees. The MRM is headquartered in Long Beach and has field offices in Huntington Beach and Santa Barbara. Its priority is the orderly development of state resources in a safe and environmentally protective manner. MRM has been mandated to inspect, or cause to be inspected, all marine facilities for operations and lease compliance (where applicable) in order to ensure that all oil and gas facilities in state waters are using the best current technology in their safety and pollution prevention systems and to identify and mitigate potential pollution incidents.

The MRM has been responsible for regulating all oil and gas activities on state leases for over seventy years and maintains ongoing monthly inspections of all facilities on state offshore leases. Because of the multiple drilling and production environments and the long length of time that oil fields typically produce, these regulations have always been considered "dynamic" and require the use of better technology as it is developed under the all-encompassing blanket of "good oilfield" or "good engineering" practice.

The MRM reviews and approves drilling programs on state leases both for resource management and for safety and spill prevention purposes. Reviewers inspect and monitor the structural performance of offshore platforms, conducting recurring structural surveys for fitness and periodic major structural evaluations. All new drilling projects from current platforms require a rigorous structural requalification to ensure that the facility is capable of bearing the additional loads necessary to implement the project and to implement any strengthening or maintenance needed to bring the facility up to current codes. Finally, the MRM reviews, inspects, and monitors those pipelines under CSLC jurisdiction and cooperates with other agencies where there is joint responsibility.

A Safety and Oil Spill Prevention Audit Program was implemented by the MRM beginning in 1986. The Safety Audit tasks include (1) a comprehensive evaluation of the design of the safety and pollution prevention systems of offshore platforms, islands, and associated onshore processing facilities serving state leases, and (2) a human factor review of the corporate safety culture of the facility operator on a five-year recurring interval.

The MRM is also responsible for the management of any new offshore oil and gas drilling and production projects. This responsibility includes coordinating the reviews (CEQA, safety, technical, and economic) required before consideration by the Commission for ultimate approval or denial of the project.

Marine Environmental Protection Division

Formerly known as the Marine Facilities Division (MFD), the Marine Environmental Protection Division (MEPD) houses the CSLC's oil spill prevention program, which is directly funded by the Oil Spill Prevention and Administrative Fund. The MEPD works as an oversight system to provide for the BAP of public safety, health, and the environment. A marine facility is, with some exceptions, any facility, other than a vessel, located on marine waters or where a discharge could impact marine waters. A marine terminal is any facility used for transferring oil to or from tankers or barges. As mandated by the Act, regulations with performance standards, where possible, have been adopted for marine terminal operations. MEPD requires and approves operations manuals at all marine terminals. Highly experienced MEPD staff members monitor compliance in the field, observing oil transfers seven days a week. Monitoring is prioritized using an algorithm, so the highest risk events are attended and monitored. The staff also monitors all first-time tank vessel visits to California.

All marine facilities are routinely inspected, and terminals regulated by CSLC must follow up on deficiencies noted during inspections. If violations of other agencies' requirements are observed, the facilities and agencies are notified. The entire MEPD compliance program relies heavily on an up-to-date, extensive database of activities and compliance issues and an outreach program to the industry and community, in order to share knowledge of better performance, equipment, procedures, and personnel qualifications.

All the information and knowledge gained by the compliance and outreach programs are fed back into the regulatory cycle. As a result, a number of new regulatory programs have been promulgated by the CSLC. Marine terminals have been required to increase the range of personnel with certified training, from management down through contractors. Pipeline testing and maintenance standards have been greatly improved by regulation. Engineering inspections of terminal fitness for purpose led to the adoption of the Marine Oil Terminal Engineering and Maintenance Standards)[42] by the CSLC and the California Building Standards Commission. Regulations that provide the standards against which terminals are inspected are periodically updated, pursuant to Public Resource Code §8756. Due to the international nature of maritime transportation, many standards incorporated in the MFD/MEPD regulations are from international bodies like the Oil Companies International Marine Forum (OCIMF). This method of regulatory updating provides homogeneity in methods and technology at the ship-shore interface.

The staff has observed that small spills/leaks in oil terminals are corrosion-related and often from buried or submerged pipelines, making them difficult to detect. To counter this problem, the CSLC is working to revise pipeline integrity regulations, based on BAT developed by the API, OCIMF, and PHMSA guidelines in 49 CFR 195.[43]

California Coastal Commission

Authority

The primary authority of the CCC is derived from the California Coastal Act of 1976 (Public Resource Code Div. 20, §30000 - 39000). The CCC, in partnership with coastal cities and counties, issues coastal development permits for projects proposed within the coastal zone that qualify as "development" [PRC §30106].

The CCC is also the state agency responsible for implementing the Federal Coastal Zone Management Act (CZMA), except in areas where the San Francisco BCDC is the designated agency (specifically San Francisco, Suisun and San Pablo Bays). Under the CZMA, the CCC has authority to review any activity conducted by or permitted by federal agencies that "affects any land or water use or natural resources of the coastal zone" for consistency with the policies of the California Coastal Management Program (CCMP) (See CZMA §307(c)(1)(A) and

[42] CSLC MOTEMS: http://www.slc.ca.gov/Programs/MOTEMS.html
[43] CSLC Regulations: http://www.slc.ca.gov/Laws-Regs/Laws-Regs.html

§307(c)(3)(A)).[44] Under this authority, the CCC reviews all oil and gas leasing, exploration, production, and oil transportation activities in the federal OCS waters offshore of California for consistency with the policies of its CCMP.

Project proposals that require a CCC permit or federal consistency review include major oil and gas projects in state and federal waters (e.g., leasing, exploration, development, production, and oil transportation, processing and refining), power plant projects, and other development projects that have a risk of oil spill impacts to California's coastal zone resources. In reviewing these proposals, the CCC requires an applicant to demonstrate effective oil spill prevention and response measures that meet the standard of providing BAP for the coastal and marine resources of California.

Coastal Act Policies Related to Oil Spill Prevention and Response

The Coastal Act contains strong policies for the prevention of and response to oil and hazardous substance spills (PRC §30232),[45] protection of coastal waters and marine resources (PRC §30214 – 30236), protection of environmentally sensitive habitats and rare or especially critical species of wildlife and plants (PRC §32040 and 30107.5), and protection of fishing activities (PRC §30234.5).

When reviewing project proposals within its jurisdiction, the CCC requires a proposed project to demonstrate effective oil spill prevention and response measures that meet the standards of Coastal Act §30232:

> *"Protection against the spillage of crude oil, gas, petroleum products, or hazardous substances shall be provided in relation to any development or transportation of such materials. Effective containment and cleanup facilities and procedures shall be provided for accidental spills that do occur."*

Coastal Act §30232 requires a proposed project to meet three important tests. The first test requires the applicant to submit an oil spill risk analysis for the proposed project that includes identification of potential impacts to California's coastal and ocean resources. The second test requires the proposed project to provide oil spill prevention technologies, programs, and procedures "to protect against the spillage of crude oil, gas, petroleum, or other hazardous materials." The third test requires a proposed project to identify sufficient oil spill response capability to provide "effective containment and clean-up facilities and procedures…for accidental spills that do occur."

Under the CCC's permit and federal consistency authority, findings must be made that the proposed project is consistent with (or, with added conditions, will be consistent with) Coastal Act policies. The CCC requires submittal of an oil spill

[44] Federal Consistency Program: http://www.coastal.ca.gov/fedcd/fedcndx.html
[45] CCC Oil Spill Program: http://www.coastal.ca.gov/oilspill/ospndx.html

contingency plan and other oil spill prevention and response technologies and measures that demonstrate adequate protection against spills and effective containment and clean-up facilities and procedures, in order to make findings of consistency with §30232. If there are gaps in the protection provided under the oil spill contingency plan or oil spill prevention and response measures, the CCC can condition the project to provide additional equipment or to implement additional prevention procedures.

The Coastal Act and the CCMP give the CCC a strong role in regulating the siting, design, and permitting of major oil and gas facilities onshore and offshore California. The CCC also has enforcement powers and can issue "cease and desist" orders, restoration orders, or level penalties for violations of permit requirements.

San Francisco Bay Conservation and Development Commission[46]

Authority

Pursuant to the 1965 McAteer-Petris Act (Title 7.2, Government Code §66600), the *San Francisco Bay Plan* (Bay Plan) contains policies to guide future uses of the Bay and shoreline. To carry out these policies, the Act granted BCDC permitting authority over the waters of San Francisco, Suisun, and San Pablo Bays and the first 100 feet of shoreline inland from the Bay. The law directs BCDC to regulate filling and dredging in tidal areas, certain creeks and tributaries, salt ponds, and other areas diked-off from the Bay and to regulate development within the shoreline band to ensure maximum feasible public access to the Bay.

Additionally, BCDC administers the Suisun Marsh Preservation Act (Public Resources Code, Division 19, §29000) in cooperation with local governments to protect the Suisun Marsh, the largest brackish wetland in California. BCDC also is the agency responsible for implementing the federal CZMA for this area. This gives the Commission "consistency review" authority to analyze federal projects, including local projects funded or permitted by a federal agency, for consistency with its laws and policies, which comprise the adopted Federal Coastal Zone Management Plan for San Francisco, Suisun, and San Pablo Bays.

In 1990, the Act specified that BCDC must carry out certain critical responsibilities. BCDC actively participates in planning to reduce the risk of oil spills in California waters through its membership on the San Francisco Bay HSC (navigation safety) and to better respond, if a spill does occur, by its participation on the San Francisco Bay Delta Area Committee (contingency planning). During a spill event, BCDC assists the response by providing technical expertise. When needed, BCDC can authorize emergency response activities that meet its laws and policies.

Best Achievable Protection or Equivalent Mandate

[46] BCDC website: http://www.bcdc.ca.gov/

Relative to the prevention and the clean-up of oil spills, BCDC's permit authority would rely heavily on relevant water quality, environmental and navigational safety, and oil spill policies contained in the McAteer-Petris Act, the Bay Plan, the Suisun Marsh Protection Act, and the Suisun Marsh Protection Plan. Through its statutory permit authority, BCDC can condition a project within its Bay jurisdiction to meet the objectives of the McAteer-Petris Act and policies of the Bay Plan, equivalent to achieving BAP for the Bay. However, BCDC does not have the authority to expressly condition a permit to provide BAT for spill prevention.

Division of Oil, Gas, and Geothermal Resources – Inland Facilities

Responsibilities

DOGGR[47] is the primary state agency responsible for supervising the drilling, operation, maintenance, and plugging of oil and gas production and geothermal wells within the territorial boundaries of California. DOGGR's jurisdiction also includes the operation, maintenance, and removal of related production and exploration facilities, such as tanks and pipelines.

California AB 1960 (Nava, Ch.562, Statutes of 2008),[48] which amended and added various sections to the Public Resources Code, went into effect on January 1, 2009. In order to better prevent expensive and environmentally damaging oil spills, DOGGR was given expanded authority to regulate oil and gas production at inland facilities.

The primary goal of DOGGR is to prevent damage to life, health, property, and natural resources from oil and gas exploration, production, and plugging and abandonment operations. To accomplish this, DOGGR requires applications, permits, safety equipment, prevention programs, response plans, and the on-site inspection and testing of installed equipment.

All operators must apply for a permit to drill any new exploratory or development well or to conduct any well work that would change the mechanical condition of an existing well. The proposed well work must meet comprehensive engineering standards and, in most cases, some form of financial insurance is required before a permit is issued.

DOGGR regulations require operators to maintain facilities in a clean and orderly manner, test long-term idle wells on a regular basis, install and test specified well blowout detection and prevention equipment, install spill containment systems around all tank facilities, fence and screen all sumps, fence all urban facilities, prepare oil spill contingency plans, and perform site restoration when wells or facilities are removed. DOGGR routinely inspects all wells and facilities to ensure

[47] Division of Oil, Gas, and Geothermal Resources website: http://www.conservation.ca.gov/dog/Pages/Index.aspx

[48] AB 1960 – Bill Analysis: http://www.leginfo.ca.gov/pub/07-08/bill/asm/ab_1951-2000/ab_1960_cfa_20080814_213418_asm_floor.html

compliance with statutes, regulations, and site specific permits. Well permits can require DOGGR inspection of specific safety equipment, well-plugging and abandonment operations, and well integrity. Six oil and gas district offices with engineers on call 24-hours a day are maintained throughout the state by DOGGR.

DOGGR's current facility maintenance regulations, contingency plan regulations, and reporting requirements reflect the legislature's efforts to minimize the occurrence of accidental releases of oil.[49]

California Division of Occupational Safety and Health

Authority

Cal/OSHA enforces federal and state occupational and public safety laws and provides information and assistance to employers, workers, and the public regarding workplace safety and health issues. Cal/OSHA's authority includes safety orders specific to the petroleum industry, including drilling and production (8 CCR §6500 – §6693),[50] as well as refining, transportation, and handling (8 CCR §6750 – §6894).[51] It is important to note that this authority applies only to shore-side facilities.

Responsibilities

Cal/OSHA's primary objectives are to ensure public and worker safety. However, many of the safety requirements established in Title 8 of the California Code of Regulations, including those listed below, significantly decrease the risk of accidental releases of liquids and gases from petroleum-related facilities. The following Cal/OSHA safety regulations augment spill prevention efforts:

- Requirements for adequate drainage for pumps and tanks
- Good housekeeping practices for oil facilities
- Maximum allowable working pressures for fired and unfired pressure vessels and pumps
- Maintenance, inspection, and repair procedures for fired and unfired pressure vessels
- Written, risk-based inspection programs for fired and unfired pressure vessels and tanks
- Pressure relief devices for fired and unfired pressure vessels
- Identification/labeling of tanks, vessels, pipelines, and valves containing flammable, corrosive, or hazardous liquid
- Oil saver equipment to prevent releases of oil or gas
- Requirements for proper loading and unloading of petroleum products to prevent accidents, including spills
- Requirements for blowout prevention equipment for wells

[49] See Article 3 of DOGGR's regulations: ftp://ftp.consrv.ca.gov/pub/oil/laws/PRC10.pdf
[50] http://www.dir.ca.gov/Title8/sub14.html
[51] http://www.dir.ca.gov/Title8/sub15.html

- A risk-based classification system for piping system inspections based on service and pressure/temperature rating:
    - Class 1 – piping systems that will result in an immediate emergency should a leak occur
    - Class 2 – piping systems that contain hydrocarbons that will vaporize slowly during release, strong acids or caustics, hydrogen, fuel gas, or natural gas
    - Class 3 – piping systems that contain a flammable liquid that does not significantly vaporize and is potentially harmful but located in remote areas
    - Class 4 – piping systems where there is a minimal risk based on the likelihood and consequence of failure
- Protocols for blinding and isolating pipelines and equipment prior to maintenance or repair
- Leakage and spill control measures, such as frequent gauging during liquid transfers or high-level alarms
- A written overpressure relief plan for each safety relief device associated with refining, transportation, and handling operations
- Requirements for automatic or remotely operated manual shut-off valves for loading/unloading operations
- Conspicuous delineation of safe smoking areas
- Provisions to prevent the accumulation of static electrical charges
- Provisions to prevent spontaneous ignition of materials, such as iron sulfide
- Hot-work procedures to minimize fire and explosion hazards

INTERNATIONAL STANDARDS, GUIDELINES, AND OIL SPILL PREVENTION INITIATIVES

Since commercial shipping is international in scope, the same environmental and safety issues addressed in the United States and California are also addressed through a variety of international forums. These include governmental and non-governmental organizations whose focus includes the development of safety, management, and risk-reduction protocols and standards.

The International Organization for Standardization (ISO) is a non-governmental organization and, thus, does not carry the force of international treaties. However, many of the members of the ISO institutes are part of the governmental structure of their respective countries or are mandated by their governments. The ISO also has representation from the private sector, often through the established national partnership of industry associations. Thus, the ISO is a consensus organization with both public and private representation.

Within the ISO, Quality Management systems are developed to provide planning, implementation, auditing, and reporting of management functions. It also provides for a standardized, independent analysis of company management programs that demonstrate a company's dedication to, and compliance with, the established

standards and protocols, essentially providing an independent quality rating. While ISO management standards can be so generic as to apply to any industry, company, or function, the ISO 14000 family of standards is specific to various aspects of environmental management and has been adopted by many shipping lines and marine facility operators.

There are also industry groups that have proactively established standards and protocols on a voluntary basis. These programs are shared and often adopted, with the assistance of regulatory agencies, and have proven to provide significant reduction in the risk of marine incidents and oil spills.

Because commercial ships trade on the international stage, there is great benefit in the establishment of international standards and protocols. They provide uniformity and consistency that promotes easier compliance and less opportunity for confusion for the regulated population.

International Maritime Organization[52]

A division of the United Nations, the International Maritime Organization (IMO) is a formal governmental organization with representation from countries involved in international shipping, working within the framework of formal international treaties. It develops both mandatory and voluntary standards and protocols that signatory countries (often referred to as “flag states”) endorse. The standards and protocols adopted upon the ratification of treaties, conventions, and amendments at the IMO, provide the framework for implementing legislation in Congress and respective regulation by federal agencies, normally the USCG and the Environmental Protection Agency. IMO standards generally provide a baseline, with the ability to pursue standards and protocols that are more protective or that better address specific conditions of the member states.

Ship Safety and Pollution Prevention Responsibilities

The IMO’s primary objective is to "develop and maintain a comprehensive regulatory framework for the shipping industry" through the efforts of numerous committees and subcommittees. This regulatory framework covers issues related to "safety, environmental concerns, legal matters, technical cooperation, and maritime security.” The IMO's specialized committees cooperate with industry, as well as intergovernmental and non-governmental organizations, to promote safe operation of the global shipping industry."

Under the IMO, the International Convention for Prevention of Pollution from Ships (MARPOL) convened to develop provisions to prevent and minimize pollution from ships. The IMO amended MARPOL in 1992 to require mandatory double-hull construction for new vessels of 5,000 deadweight tons or greater ordered after July 6, 1993. An additional amendment was later adopted to apply to existing ships, which must be converted or taken out of service at a prescribed age.

[52] International Maritime Organization (IMO): http://www.imo.org/

This measure was to be adopted over a phased schedule, based on worldwide dry-dock availability, to accomplish the conversions. Following the Motor Vessel ERIKA sinking off the coast of France in December 1999, the phase-out schedule for single-hull tankers was accelerated twice -- first in 2001 and subsequently in 2003. The latest, stricter schedules entered into force in April, 2005. These schedules required a phase-out of single-hull tankers in 2005 for certain classes of vessels and 2010 for all remaining tankers.

Additionally, the IMO adopted an amendment to MARPOL Annex I in 2006 to require oil fuel tank protection for ***all new ships*** delivered on or after August 1, 2010. This requirement applies to all vessels with a total oil fuel capacity of 600 cubic meters or greater. It includes requirements for the protected location of the fuel tanks and performance standards for accidental oil fuel outflow. The new standards also include provisions that set the maximum capacities of oil fuel tanks at 2,500 cubic meters per tank.

Although not required by international regulations, some oil companies have opted to incorporate major redundancy systems in their oil tanker design to further reduce the risk of a navigational incident. These redundant systems include dual, segregated main engine rooms and main propulsion units, as well as dual, segregated steering motors, providing propulsion and steering back-up should a failure of one of these systems occur.

International Safety Management Code for Ships

In 1993, the IMO adopted the International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention (ISM Code); it became mandatory in 1998. The ISM Code established safety management objectives, “to ensure safety, to prevent human injury or loss of life, and to avoid damage to the environment, in particular, the marine environment, and to property." Its provisions require a Safety Management System (SMS) to be established by the “Company,” defined as the ship owner or any person who has assumed responsibility for operating the ship.

The Company must establish and implement a policy with appropriate resources and shore-based support to achieve the ISM Code objectives. Verification of SMS compliance is the responsibility of the “flag state" administrator of the vessel. In the United States, this administrator is the USCG. Such verification is certified by issuance of a “Document of Compliance” and a “Safety Management Certificate” to the shipping company and vessel, respectively.

The ISM Code and the SMS provide an international standard for the safe management and operation of ships and for pollution prevention. Considering that a great percentage of incidents related to safety and pollution are the result of human error, the ISM Code and SMS seek to reduce the risk of such incidents through established protocols for training, documentation, and verification. These protocols include the following:

- Qualification and certification requirements for seafarers
- Plans, instructions, and checklists for operations concerning safety and pollution prevention
- Reporting and analysis of non-conformities, accidents, and hazardous occurrences
- Ship and equipment maintenance, inspection, and reporting procedures
- Documentation and auditing protocols

The ISM Code shares many common themes with ISO Certification (see below), however ISO is more generic in nature, and covers other aspects of a company's operations beyond specific shipboard management.

Standards of Training, Certification and Watchkeeping Convention
Also established under the IMO was the Standards of Training, Certification, and Watchkeeping (STCW) Convention. These standards were drafted at the IMO in 1978, with significant amendments added in 1995. The STCW established standards for experience and training and went into force on February 1, 2003, for all commercial mariners/seafarers. Over the years, the provisions of STCW have been revised to account for technological advances in the industry and established a method to enforce the Convention's requirements.

In the United States, its provisions are enforced by the USCG. Some of the required training includes Basic Safety Training for all mariners, Bridge Resource Management (BRM) for deck officers, and Proficiency in Survival Craft and Rescue Boats for deck and engine officers. Of these training regimens, the development of standardized BRM has most significantly helped reduce the risk of navigational incidents.

International Convention for the Safety of Life at Sea Convention
The IMO administers the International Convention for the Safety of Life at Sea (SOLAS) Convention, which provides guidelines for emergency equipment and safety procedures. The SOLAS Convention was updated in 2002 to include the International Ship and Port Facility Security (ISPS) Code, which prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to detect security threats and take preventative measures against security incidents affecting international trade. The ISPS Code therefore aids in preventing the risk of oil spills due to security-related maritime incidents.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION – THE SHIPPING INDUSTRY[53]

The ISO is a non-governmental organization that administers programs and sets standards to "improve quality, safety, security, and environmental and consumer

[53] International Organization for Standardization: http://www.iso.org/iso/about.htm

protection." ISO Certification is not compulsory; however, many commercial shipping companies adopt these protocols for both commercial and non-commercial reasons.

The ISO established ISO 9001:2000 Quality Management Systems, which provides the required standards for quality management systems to be implemented into international organizations in an effort to foster safer and more globally competitive operations. Universal quality management systems can be applied to many different businesses, industries, and organizations and are generally developed on a company-wide basis. Similar in nature to the required SMS programs, they are also applied in shipboard management to help improve operational performance and safety.

ISO 1400:2004 Environmental Management Systems provides standards for environmental management systems to ensure that organizations operate in an environmentally responsible manner.

OTHER INDUSTRY OIL SPILL PREVENTION INITIATIVES

Oil Companies International Marine Forum[54] – Oil Tankers/ Terminals

Oil Companies International Marine Forum (OCIMF) is a voluntary association of oil companies formed to promote safety and to prevent pollution from oil tankers and terminals. OCIMF administers the Ship Inspection Report Exchange (SIRE) Program, which is a voluntary inspection program to address concerns about sub-standard shipping, specifically tankers. The SIRE system is comprised of a database of up-to-date critical information on tankers around the world, focusing tanker industry awareness on the importance of meeting ship safety standards.

In 2004, OCIMF began including oil tank barges and small tankers into the SIRE program to further aid in promoting vessel quality and safety. OCIMF is also extremely active in the development and publishing of recommended operational best practices to address safety and environmental issues related to oil tanker and terminal operations.

There are many other examples of voluntary industry initiatives to reduce the risk of oil spills that are specific to business sectors, companies, or individual projects or locations. The proposed Pier 400 project in Los Angeles Harbor is an example of the extensive pollution mitigation measures undertaken on a project basis.

American Petroleum Institute

The American Petroleum Institute (API) is an oil and natural gas industry trade group. API members pledge to operate their facilities in a manner that protects the environment and the safety and health of their employees and the public.

[54] OCIMF: http://www.ocimf.com/

To this end, the API maintains a number of programs related to oil spill prevention including a robust standards program and training and certification program. API began creating Standards and Recommended Practices in 1924 and currently maintains some 500 industry standards covering all aspects of the oil and gas industry.[55] Federal and state regulations incorporate by reference many of the API standards and recommended practices into their oil and gas regulations.

API supports a number of publications related to the oil and gas industry including those related to spill prevention. API also sponsors the Spills Advisory Group (SAG), which meets periodically to discuss oil spill issues. The SAG is comprised of representatives from federal and state agencies as well as industry and other interested parties involved in spill prevention planning and response. The OSPR Administrator is a member of the SAG and participates in their meetings.

Other Oil and Gas industry Standard Groups

In addition to the API Standards Committees, there are a number of other United States and international organizations that develop standards to ensure safety and protection of the environment by preventing accidents and spills. As with API standards and practices, some of these standards are incorporated by reference into federal and state regulations. Organizations such as the American National Standards Institute,[56] American Society for Testing and Materials,[57] and American Society of Mechanical Engineers,[58] in addition to others, have developed standards used throughout the oil and gas industry with the goal of promoting safety and protection of the environment by preventing spills.

[55] API Standards: http://www.api.org/Standards/
[56] ANSI Standards: http://www.ansi.org/
[57] ASTM International Standards: http://www.astm.org
[58] ASME: http://www.asme.org