

**Safety Audit Program
for
Oil and Gas Production Facilities in California**

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Abstract

This paper discusses the development and results of the Safety Audit Program conducted by the Minerals Resources Management Division. Several gas releases and spill events in 1999 resulted in the development of Safety Audits to identify and correct operational action items that could cause additional threats to the public or the environment. The duration and emphasis of MRMD Safety Audits and MMS Focused Facility Inspections (FFI) are slightly different, yet each is complementary to the inspection programs run by these agencies. Like the FFI, Safety Audit engineers and inspectors work with company representatives to assess facilities and operations. Five subject area teams inspect and evaluate, creating a list of action items and a final Safety Audit report.

Since 1999, almost half of the oil and gas facilities subject to state review have been audited. Many are in follow up resolving conditions, equipment, design, and procedures. Nearly 4,000 action items have been identified at the 9 facilities audited and over \$3 million has been spent on needed upgrades. Safety system performance and results at monthly MRMD inspections have shown dramatic improvement as a result. This directly translates into reduced risk to the public, personnel, and the environment.

Introduction

The initial Safety Audit at platform HOLLY revealed over 300 action items and clearly demonstrated the benefits of comprehensive auditing. More than twenty of the action items had indicated serious degradation or non-compliance at the facility resulting in a high potential for injury, oil spill, adverse environmental impact, or significant property damage. The number and seriousness of the identified audit items prompted MRMD staff to re-evaluate the entire facilities inspection and oil spill prevention program. The concern was that there were gaps occurring because of the nature of the repetitive monthly inspections and the specific objectives of the inspection program as required by regulation. The conclusion was that the MRMD monthly safety equipment inspection program was not enough to ensure the safe operation of these facilities. Most of the offshore and onshore oil production facilities are over 30 years old and do not employ the most current technology. Production and processing systems have also undergone significant changes since the inception of platform operations. Employing an aggressive audit/inspection program was seen as an essential

environmental protection initiative that could significantly decrease the likelihood of an environmental disaster. Additional audits were envisioned to use electrical, petroleum, chemical, and mechanical engineers to conduct a comprehensive evaluation of all aspects of the operation. These experts would assess age and conditions of the equipment, pipelines, design of the facility, human organizational factors, mechanical and electrical maintenance programs and structural issues using a whole system approach.

Next, a safety audit was conducted using mostly contract engineers from one company, which helped establish costs for this alternative and also gained additional insight or benchmarking on audit methods. A State Budget Change Proposal was approved for FY 2000-2001 and FY 2001-2002 beginning a two-year limited term safety audit program that would use primarily SLC staff. Using existing and newly hired MRMD staff, additional audits were completed on eight distinct facilities located at Rincon Island in Ventura and at the THUMS Long Beach Unit. As had been done at platform HOLLY, these audits sought to take a comprehensive look at conformance with all applicable federal, state, and local laws and regulations and accepted industry standards. Areas or gaps that had not been addressed by the existing inspection program were evaluated and in some instances, the inspection program was adjusted and improved as an outcome. Follow up work from the early audits at platform HOLLY and the Rincon Island and onshore facilities is now complete. Follow up work is underway in earnest at the THUMS Long Beach Unit and the latest Safety Audit is underway at Aera Energy in Huntington Beach.

Authority and Scope

Safety Audits of State tideland oil and gas leases are conducted primarily under CSLC's inspection authority which is provided by California Public Resources Code (PRC) 6103, 6108, 6216, 6301, and 6873 (d). CSLC MRMD Regulations are based on this authority and are contained in the California Code of Regulations, Title 2, Div 3, Chapter 1, Articles 1 through 11. Oil and Gas Production Regulations are contained in Article 3.3 and concern the protection of human health, safety, property, pollution, the environment, and natural resources. This article provides the specific requirements for required safety systems, equipment, and testing for offshore facilities including platforms as well as upland locations serving these leases. *These regulations establish the requirement that the API Recommended Practice RP14C titled Analysis, Design, Installation, and Testing of Basic Surface Safety Systems on Offshore Platforms be the basis for offshore production facilities unless otherwise provided for in the regulations.*

Sections 2129 (b) and 2133 (b) of Article 3.3 further specify that the lessee for these oil and gas leases shall comply with all applicable laws, rules, and regulations of the United States, the state of California, and any respective political subdivision thereof. Sections 2129 (c) and 2133 (c) require operations to

be conducted in a proper and workmanlike manner in accordance with good oilfield practice. These sections clearly bring applicable federal, state, and local requirements as well as common industry standards to bear on these facilities and are subject to verification through inspection or audit. This produces some degree of duplication, such as with the API Recommended Practice RP-750 on Management of Process Hazards, OSHA regulation 29 CFR 1910.119 on Process Safety Management of Highly Hazardous Chemicals, and the similarly titled Cal OSHA regulation 5189 on Process Safety Management of Acutely Hazardous Materials. *It is these safe management standards that bring some of the most important safety design and analysis requirements to the oil and gas facilities and in particular those onshore.*

Pollution control is a particular emphasis in the MRMD and other state regulations. Article 3.4 of the MRMD regulations on Oil and Gas Drilling and Production Operations: Pollution Control, contains specific requirements for operations, plans, and equipment. In Section 2135(a) the CSLC staff shall administer this article and seek to provide for the prevention and elimination of pollution, prevention of waste of natural resources, protection of human health and safety, and the protection of property. The highly publicized Lempert, Keene, Seastrand Oil Spill Prevention Act strengthens spill prevention requirements in California. Part of this Act, Public Resources Code Section 8757(a) contains the requirement for the CSLC to regularly inspect all marine facilities and monitor their operations and their effects on public health and safety, and the environment. The definition of marine facility within these regulations includes the state offshore facilities and related production or processing facilities onshore. Oil producing platforms and islands located within state waters (3 nautical miles) fall under the definition as marine facilities. Upland locations that produce oil and gas from state leased tidelands are also typically considered marine facilities. Onshore processing facilities for state leases or even federal leases on the Outer Continental Shelf also typically fall within the definition of marine facility. *These spill prevention regulations bring requirements for use of best available protection technologies that promote the updating and upgrading of oil and gas facilities.*

Safety Audit Approach

Each Safety Audit is an in depth verification that an oil and gas facility producing from a state lease complies with all applicable federal and state laws and regulations, follows industry standards, and continually re-evaluates and incorporates best achievable technology to safeguard the public and the environment. Each safety audit has five main areas or teams:

- Equipment Functionality and Integrity
- Technical design
- Electrical condition, maintenance, and design
- Administrative

- Human Factors and Safety Management

The teams identify action items with priorities and recommendations that are provided in a matrix as well as a written report that highlights significant problems or design issues.

The **Equipment Functionality and Integrity Team** generally examines the physical condition of the facility including operational and maintenance practices and the proper functioning of safety and spill prevention and response systems and equipment. The team verifies the accuracy of Process and Instrumentation Diagrams (P&IDs), Emergency and Spill Response Equipment diagram, Process Flow Diagrams, and observes required periodic testing of this critical equipment. They review preventive maintenance procedures, equipment specification information for maintenance and design selection of equipment. The team verifies that important tank, pressure vessel, and safety relief valve inspections follow code or recommended industry practices and complete tables of information that summarize this information. They also verify that Cathodic and other corrosion protection system inspections, piping assessment, and pipeline integrity inspections, including smart pigging or hydrostatic tests, are occurring as scheduled.

The **Technical Team** conducts a review of the design of the facilities for compliance with MRMD regulations for oil and gas production facilities as well as other requirements and standards. The design of offshore facilities should follow the guidelines provided in API RP-14J Recommended Practice for Design and Hazards Analysis for Offshore Production Facilities. In particular, the MRMD regulations prescribe that safety systems meet API RP-14C Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms. Onshore oil and gas production facilities normally come under the Cal OSHA version of Process Safety Management requirements contained in regulation 5189. A similar industry standard is available in API RP-750 on management of Process Hazards. Each of these requires that some type of Process Hazards Analysis be conducted to identify appropriate safety systems and operations for the operation. Existing PHAs are normally reviewed for quality with assessment points evaluating adequacy of supporting process safety information, appropriate analysis technique, all hazards addressed, proper documentation, and completion of all requirements. Often, a structured hazards analysis is used to double check the existing facility PHA and the safeguards employed. Some of the most important findings of a Safety Audit can apply to areas not adequately covered by the particular PHA or HAZOP employed at a facility. The Safety Audit may provide valuable guidance for areas to address at the operator's next PHA revalidation.

The sizing of pressure safety relief valves and the relief system are also checked by the Technical Team as well as the coordination of a review of the various detection systems and fire protection systems by a qualified fire protection

engineer. Finally, verification of other design requirements occurs verification of adequate containment volumes as identified in the Spill Prevention and Control Countermeasures (SPCC) Plan.

The **Electrical Team** examines the physical condition of the electrical systems including operational and maintenance practices as well as proper design and installation to meet applicable code requirements. This includes field verification of one line diagrams and hazardous location area classification diagrams. Specific requirements for backup, auxiliary, or emergency power, as well as electrical controls, communications, and other related equipment is also addressed. The Electrical Team combines the condition and diagram assessment functions of the Equipment Functionality and Integrity Team with the design validation work of the Technical Team on a system specific basis. This maximizes efficiency and benefits from the expertise of the contract electrical engineer.

The **Administrative Team** reviews the various manuals, plans, policies, procedures and practices, emergency response plans, training programs, and safe work practices for compliance with laws, regulations, or industry standards. The team also evaluates the use and application of this information by personnel at the facility. This team addresses process safety management issues from a documentation or management standpoint much like the required internal audits required by the various PSM standards. The work of this team typically occurs before the Human Factors Team conducts a Safety Assessment of Management Systems (SAMS) audit.

The **Human Factors Team** conducts a Safety Assessment of Management Systems (SAMS) that is based on interviews of company personnel and contractors at all levels of the organization. While this activity is within the structure of the Safety Audit, the results of the SAMS are confidential and provided in a separate report. The SAMS is an evaluation of the implementation of Process Safety Management Guidelines as seen from the perspective of the employee, supervisor, manager, and contractor. This assessment can enlighten management to actual status in the field, indicate relative strengths and opportunities, and to stimulate continuous improvement. There are no action items identified by this team for Safety Audit report. The SAMS does provide a separate and confidential report intended for impartial third party feedback.

The SAMS was developed as a two-year joint industry project designed to examine the factors that cause human and organizational errors (HOE) at marine oil terminals and offshore platforms. The project was developed under the sponsorship of governmental agencies and oil companies in the United States, Canada, and the United Kingdom with coordination from Paragon Engineering Services and the University of California at Berkeley. The SAMS is intended to free of attribution towards the company and the anonymity of personnel interviewed is maintained.

SAMS have been used extensively by the Marine Facilities Division of the CSLC at marine terminals in California and was the subject of a paper presented to the Prevention First '98 Symposium. MRMD has implemented use of SAMS at offshore platforms and other oil and gas facilities beginning in 1999 as part of the Safety Audit Program. MRMD has conducted five SAMS to date and plans a sixth this fall with a Safety Audit currently underway. The SAMS conducted by MRMD apply to an operating company and often include to multiple offshore facilities, onshore production areas, and onshore processing plants.

Several SAMS have been repeated in sequence prior to and then following a Safety Audit. The initial SAMS findings identified for the operator management opportunities which could result in safety and production efficiency improvements. Often, these SAMS findings would prove to be indicative of root causes for symptoms identified as action items at the Safety Audit. Follow on SAMS typically documented clear improvement in areas where the operators had addressed safe management issues. No operators were observed at the follow on SAMS to regress in conjunction with a Safety Audit. As additional SAMS are conducted within the five year Safety Audit cycle, we will gain perspective on operator performance between Safety Audits. *SAMS can be requested as an MRMD service as a great way to assess Safe Management implementation in advance of corporate or MRMD Safety Audits.*

Comparison with other Programs

In developing the Safety Audit, MRMD staff reviewed similar audits and inspection programs for benchmarking and adopted a number of "best practices." The vessel and port facility inspection activities of the U.S. Coast Guard provide a model for general management of an inspection program as the Coast Guard inspection program has evolved over many decades and is a nationwide program addressing tens of thousands of facilities and vessels. Although a model for general management issues, the Coast Guard focus on offshore platforms does not extend to the oil and gas production operations for which the CSLC is responsible.

The U.S. Minerals Management Service's Focused Facility Inspection (FFI) Program provides an obvious model for offshore oil and gas production operations concerning MRMD. The MMS initiated their FFI Program in 1996 for the Pacific Outer Continental Shelf Region. It is an enhanced inspection program based on a systemic (focused) approach with increased emphasis on the Safety and Environmental Management (SEMP) concept. The FFI is designed to complement the present offshore platform inspection program by integrating engineers and other specialists with inspectors to form teams with technical expertise in drilling, production, and other "specialty" areas of offshore operations. A presentation on the FFI program was made to the Prevention First

2000 Symposium and some comparison was made with the Coast Guard inspection program.

The MRMD Safety Audit Program is very similar in coverage with the exception of drilling. Drilling is not covered since the California Division of Oil, Gas, and Geothermal Resources regulate it. Both FFIs and Safety Audits exist to complement existing inspection programs. Differences in the inspection programs drive major differences in complementary FFI or Safety Audit programs. The MMS conducts comprehensive annual inspections of offshore platforms supplemented by monthly-unannounced partial inspections. The MMS can take enforcement action at inspections for “Incidents of Noncompliance (INCs)” but issue “Action Items” at the FFI to emphasize continuous improvement. MRMD conducts monthly inspections of the offshore facilities including the witnessing of comprehensive tests on all safety systems, condition checks, and operational checks of other required equipment and documents.

The MRMD safety audit adds emphasis with the technical design review of the facility and notably the process safety systems. Since most of the state offshore facilities are more than 30 years old many of the requirements, codes, and standards have changed significantly over this period. This design review is the main driver for the longer Safety Audit duration. The FFI on site facility inspection takes about two days with about 11 weeks elapsing before the final report. Each MRMD Safety Audit runs about 24 to 30 weeks per facility with a significant time spent on site verifying accuracy of Process and Instrumentation Diagrams (P&IDs) and examining system conditions, maintenance, and other checks. Several weeks are included for conducting the SAMS and preparing its own separate confidential report. When safety audits are conducted on operating companies with multiple facilities, durations are longer. By design the MRMD Safety Audits apply extra time and emphasis in these areas:

- Evaluation of condition, maintenance program, inspection records review, and observation of MRMD monthly inspections of all tanks, pressure vessels, PSVs, flare systems, fire systems, and Emergency Shut Down (ESD).
- All Process and Instrumentation Diagrams (P&IDs) and Safety Analysis Function Evaluation (SAFE) Charts are field verified for accuracy.
- Technical design review is conducted on flares, fire systems, ESDs, pressure vessels, PSV sizing, pressure relief systems, sump and containment systems.
- Technical design review of safety systems including P&IDs, SAFE Charts, and Process Hazards Analyses (PHAs) to required codes, regulations, and standards.
- Electrical System condition evaluation with complete field plan verification including one lines, area classification drawings, distribution/protection, emergency power/loads, purging/seals/fire walls, and lighting
- Technical design review of certain aspects of Electrical Systems
- Detailed Administrative reviews of Oil Spill Contingency Plan, Operations Manual, and other policies and procedures and verification of applications.

- Safety Assessment of Management Systems (SAMS) based on interviews with a separate confidential report regarding human factors/safety culture.

The nature of the FFI and the Safety Audits are therefore different. The following table provides a comparison of scope and team coverage.

FFI versus SAFETY AUDIT COMPARISON

FACILITY CONDITION		SAFETY SYSTEMS		DOCUMENTS		TRAINING			
Helideck	✓	Flare Systems	✓	MSDS	✓	Training Programs	✓		
Crane	✓	Fire Systems	✓	Manifest	✓	OSE	✓		
Housekeeping	✓	ESD	✓	Pipeline/Structure	✓	H2S	✓		
Deck/Grating	✓	Fire/Smoke/Lighting	✓	Work Practices	✓	TI/T2/T3	✓		
Stairs/Walkways	✓	H2S/Gas	✓	OSCP	✓	Work Practices	✓		
Piping	✓	Press/Level/Temp	✓	H2S/Gas	✓	Contractor	✓		
Support/Brackets	✓		✓		✓	Qualifications	✓		
Measurement Systems	✓	Lifeboats	✓	P&IDs	✓	Personnel Safety	✓		
MOC	✓	Piping/Instrumentation	✓	SAFE Charts	✓	EEP	✓		
Drilling/Workover Rigs	✓	Pressure Vessels	✓	Personnel Safety	✓	Hazardous Materials	✓		
BOP Equipment	✓	MOC	✓	OSE	✓	Crane	✓		
Sump Systems	✓	SCBA	✓	Welding/Burning Plans	✓				
Containment Systems	✓	Cascade	✓	Welding/Burning Procedures	✓				
				BOP Equipment	✓	Lockout/Tagout Procedures	✓		
				Sump Systems	✓	Work Permit	✓		
				Containment Systems	✓	Rules and Regulations	✓		
				Simultaneous Operations	✓		✓		
				Rig Movement	✓		✓		
				Confined Space Entry	✓		✓		
				Accident Notification	✓		✓		
				EEP	✓		✓		
				Crane	✓		✓		

LEGEND	
MMS FFIs	MRMD Safety Audits
✓ covered	• covered by EFI Team / covered by Electrical Team covered by Technical Team ★ covered by Administrative Team † covered by Human Factors Team / SAMS

ENVIRONMENTAL		HAZARDOUS MTLS		ELECTRICAL		POLICIES/ PERFORM	
Drilling	✓	Hazard Identification	✓ **	System Overview	✓ /	Management	✓ * †
Produced Water	✓ **	MSDS/Manifests	✓ **	One Lines	✓ /	Morale	✓ †
Other Discharges	✓ **	Mgmt of Containers	✓ **	Area Classification Dwgs	✓ /	Cooperation	✓ †
Painting	✓ **	Hazardous Waste Mgmt	✓ **	Distribtn/Protection	✓ /	SEMP	✓ * †
Wildlife	✓ **	Labels/Placards/Sig ns	✓ **	Switching/Ground	✓ /	Reactive/Proactive	✓ * †
NORM	✓ **	Labeling	✓ **	Staffing/training	✓ / †	Lease Stipulations	✓ * †
		Chemical/Vapor Systems	✓ **	Outages	✓ /	Development Plan	✓
		Diesel/Fuel Tanks	✓ **	Spec Contractors	✓ /	MOC	✓ * †
		Confined Space Entry	✓ ** *	Work Policies/ Practices/Control	✓ / †	Contractor Qualifications	✓ * †
		H2S	✓ ** *	MOC	✓ /	Confined Space Entry	✓ * †
		HAZWOPER	✓ ** *	Redlines/ Documentation	✓ /	Human Factors	✓ * †
				Elect Safety	✓ /	Corporate Vision/Values	✓ * †
				References		Simultaneous Operations	✓ * †
				Personal Protective Equip	✓ / †	Orientation/Sign in	✓ * †
				Contingencies	✓ /	Communication	✓ * †
				Emergency Power & Loads	✓ /		
				Area Inspections	✓ /	Delegation of Responsibility	✓ * †
				Div 1 & Div 2 Areas	✓ /	Crew Changeout	✓ * †
				Forced Ventilation	✓ /	Safety Meetings	✓ * †
				Purging/Seals/Fire Walls	✓ /	Priorities - Safety/Env/Prod	✓ * †
				Lighting	✓ /	Hot Work	✓ * †
				High Temperature Devices	✓ /	Lockout/tagout	✓ * †
				Instrumentation	✓ /		

ABBREVIATIONS

Blow Out Prevention (BOP)	Oil Spill Exercise (OSE)
Drilling Well-Control Training (TI)	Piping & Instrumentation Diagrams (P&IDs)
Emergency Evacuation Plan (EEP)	Production Safety System Training (T2)
Emergency Shutdown (ESD)	Safety Analysis Function Evaluation (SAFE)
Management of Change (MOC)	Safety and Environmental Management Program (SEMP)
Material Safety Data Sheets (MSDS)	Self Contained Breathing Apparatus (SCBA)
Naturally Occurring Radioactive Material (NORM)	Well-Completion and Well-Workover
Oil Spill Contingency Plan (OSCP)	Well-Control Training (T3)

Results and Benefits

Since 1999, almost half of the oil and gas facilities subject to state review have been audited. Many are in follow up resolving conditions, equipment, design, and procedures. Nearly 4,000 action items have been identified at the 9 facilities audited and over \$3 million has been spent on needed upgrades. Facility improvements resulting from technical design review findings provide added safeguards that clearly reduce their attributed risks.

The MRMD inspection program also receives fine-tuning as a result of the Safety Audit at each facility. Testing of integrated safety and other critical systems and equipment is reviewed during the audit and adjusted so as to follow accepted practices, improve consistency, and to maximize reliability or level of confidence established by the testing. Safety system performance and monthly MRMD inspection results have shown dramatic improvement after Safety Audits. These physical and performance improvements directly translate into reduced risk to the public, personnel, and the environment.

Conclusion

In today's environment, the safety and environmental practices of any individual operator impacts the entire industry. The agencies responsible for these operations must realign and supplement their activities to adequately handle changing standards and technologies. The Safety Audit Program is an example of such activity to supplement existing inspection programs. The program is proving to ensure, in cooperation with the operator, that each facility is designed, constructed, maintained, monitored, and operated in full compliance with applicable industry codes, regulations, and accepted practices and ensure that each company has adequate safety and environmental programs in place. The author is hopeful that operators will make presentations from their perspective at future Symposiums and that they will have realized financial cost benefits from the safety improvements made.

Author's Biography

Mark Steinhilber is currently serving as a process safety engineer heading the MRMD's Safety Audit Program, having been with the program since April 2000. He retired after 20 years of engineering and operational service to the U.S. Coast Guard in June 2000 at the rank of Lieutenant Commander. During his CG career, LCDR Steinhilber led Marine Safety, Investigation, Vessel Inspection, Port Security, and Spill Contingency Planning staffs in northern and southern California and holds marine inspector and accident investigation qualifications. He was previously a staff engineer in Washington D.C. and New Orleans reviewing designs for new and modified tankers, chemical ships, gas ships, barges, and mobile offshore drilling platforms. He earned mechanical engineering P.E. from Virginia in 1988. He holds Master's Degrees in Mechanical Engineering and in Naval Architecture and Marine Engineering from MIT (1987) and a BS Degree in Naval Architecture and Marine Engineering from the U.S. Coast Guard Academy (1980.)

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