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Managing Environmental, Health, and Safety Risks

A Comparative Assessment of the Minerals Management Service and Other Agencies

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Managing Environmental, Health, and Safety Risks: A Comparative Assessment of the Minerals Management Service and Other Agencies

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Abstract

This study compares and contrasts regulatory and related practices—in particular, regulatory decisionmaking, risk assessment and planning processes, inspection and compliance, and organization structure, budgets, and training—of the Minerals Management Service (MMS, now the Bureau of Ocean Energy Management, Regulation, and Enforcement, or BOEMRE) with those of the Federal Aviation Administration (FAA) and the Environmental Protection Agency (EPA). Comparing MMS practices with those of other federal agencies that also manage low-probability but high-consequence environmental risks provides a basis for identifying opportunities for enhancing regulatory capacity and safety performance in managing deepwater energy exploration and production. Our research finds important differences in processes for setting standards; peer review contribution to the rulemaking process; establishment of tolerable risk thresholds; and training of key staff. The paper concludes with several recommendations for how various EPA and FAA practices might be modified and used at BOEMRE to strengthen its regulatory and risk management processes.

Key Words: Minerals Management Service, Federal Aviation Administration, Environmental Protection Agency, risk management

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All findings, opinions, statements, and recommendations contained in this report are solely those of its authors. The report has been submitted to the staff of the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, but the report is not the work product of the Commission or its staff, and should not be construed in any respect as the official or unofficial findings, opinions, statements, or recommendations of the Commission or its staff.

Executive Summary

The ability of the federal government to manage current and future environmental, health, and safety (EHS) risks associated with offshore energy exploration and production depends in large part on the technical practices, procedures, accountability, and effectiveness of the responsible regulatory agency. Comparing these practices with those of other federal agencies that also manage low-probability but high-consequence EHS risks provides a basis for identifying opportunities for enhancing regulatory capacity and safety performance in managing deepwater energy exploration and production. In this study, we compare and contrast regulatory and related practices of the Minerals Management Service (MMS, now the Bureau of Ocean Energy Management, Regulation, and Enforcement, or BOEMRE) with those of two other agencies: the Federal Aviation Administration (FAA), which regulates aviation safety, and the Environmental Protection Agency (EPA), which administers all or part of 32 statutes, including 10 major ones covering air, water, and land pollution, and pesticide and chemical regulation.

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Historically, offshore oil spills have resulted from three types of incidents: platform events, pipeline events, and tanker spills. Before the *Deepwater Horizon* oil spill, the Outer Continental Shelf (OCS) area regulated by MMS had not suffered a platform or pipeline spill larger than 1 million gallons since 1970, according to records maintained by MMS (BOEMRE). In the past, tankers accounted for most spill volume, but since 1990 that distribution has shifted toward nontanker sources.

MMS handled planning, leasing, technical and other safety regulations, and compliance inspections and enforcement. Planning, regulatory, and permitting processes include four elements relevant to understanding how safety and environmental management might be improved: regulatory decisionmaking, risk assessment and planning processes, inspection and compliance processes, and organization structure, budgets, and training. We examine these structures and processes and compare them with related processes of FAA and EPA.

Regulatory Decisionmaking

Processes for setting standards in the three agencies differ in several ways, including (1) the extent to which they draw upon industry voluntary consensus standards to develop agency regulations; (2) their use of performance-based versus prescriptive regulations; and (3) their use of independent analyses, including peer review, to identify, recommend, and assess regulations and safety.

Voluntary Consensus Standards

Through voluntary consensus standard-setting processes, companies, equipment manufacturers, regulators, and others establish best practices and standards for technology and operational procedures. These voluntary standard-setting processes, encouraged under federal law, must conform to various practices concerning transparency, governance, and open participation.

MMS (BOEMRE) participates in consensus-based standard-setting processes for offshore energy production and incorporates some of the resulting standards, in whole or in part, into agency safety and other regulations. The agency periodically has contracted with outside engineering and other experts to review emergent technologies and undertake comparative risk assessments. In some instances, as a result of these analyses, MMS opted for different standards in its regulations or made modifications to voluntary consensus standards.

FAA also uses voluntary consensus standards to establish minimum operational performance standards for equipment or specifications for procurement. However, FAA does not use voluntary consensus standards for its aviation safety standards. EPA seldom uses voluntary consensus standards. EPA believes that voluntary consensus standards are “too broad to be useful in a regulatory sense,” “lack quality control and quality assurance requirements,” or are

"too general, too broad, or not sufficiently detailed to assure compliance with EPA regulatory requirements." Instead, in almost all cases, EPA uses its expertise and the authority granted to it by Congress to establish its own standards.

The different uses of voluntary consensus standards result, in part, from different regulatory purposes and focuses of the three agencies. A review of agency records and industry performance indicates that use of such standards does not, per se, appear to compromise safety or result in "lowest common denominator" standards. Considerations include extent of participation in the standard-setting process by diverse stakeholders with relevant expertise, agency use of independent reviews when evaluating whether to incorporate such standards in its regulations, and transparency of safety and environmental performance goals.

Performance-Based versus Prescriptive Standards

MMS and its successor agency BOEMRE have relied on a combination of performance-based and prescriptive standards. Though offshore performance for four decades was relatively good in terms of environmental releases, discussion around two issues has persisted over more than a decade. First is whether and how to use a performance-based approach to safety regulations. Second is how to shift more responsibility and accountability to companies for their overall safety and environmental performance.

A performance approach emphasizes clear safety standards, audits, verification, investigations, and significant interaction between industry and the regulator to undertake joint safety studies and develop regulations. In a prescriptive system, laws and regulations set specific structural, technical (engineering and equipment), and procedural requirements as the basis for minimizing environmental, health, and safety hazards. Under the prescriptive system, compliance is achieved by using specified structures and equipment, adhering to specified types of training, and following specified procedures.

Increasingly, across many industry sectors, regulatory frameworks are moving toward performance standards. This trend is evident in the offshore oil and gas realm. Norway, for example, now uses primarily performance-based standards, with some supplemental prescriptive requirements. As described in a 2010 Norwegian report delineating differences between U.S. and Norwegian approaches to offshore regulation, performance-based regulations involve specifying "the performance or function which is to be attained or maintained by the industry. The regulatory role here involves defining the safety standards which companies must meet and checking that they have the management systems which permit such compliance."

Although MMS (BOEMRE) uses some performance-based regulations, it has not emulated Norway or the United Kingdom, which require companies to identify risks at specific offshore sites and show how their technologies and practices would mitigate those risks to specific safety performance levels. However, MMS has sought other ways to enhance safety

practices and encourage development of "safety cultures" within firms, including issuance of a new environmental and safety management rule.

On October 15, 2010, MMS issued a final rule requiring all firms to have a safety and environmental management system (SEMS). A quality management approach to controlling risk, SEMS provides managers with a detailed roadmap for monitoring safety-related processes. It emphasizes safety and environmental management as a fundamental business process to be incorporated within the organization and provides a framework to support a sound safety culture. SEMS applies to overall company practices rather than to site-specific performance assessment, mitigation measures, and operational procedures, as required in the Norwegian and U.K. regulations.

The SEMS approach parallels a similar trend within FAA. In 2004, FAA established guidelines for the adoption of "safety management systems" by air carriers and others activities in the aviation sector. With recent adoption of the Airline Safety and Federal Aviation Administration Extension Act, FAA must establish requirements for safety management systems within aviation's organizational structures (e.g., air service providers and government air traffic controllers). Similarly, many firms regulated by EPA use these systems approaches to environmental and safety management, though such approaches are not generally mandated by EPA.

Site-specific and general environmental and safety management systems aim to strengthen safety cultures and accountability within firms. Challenges to their effective implementation include ensuring that they (1) are comprehensive in their identification and mitigation of significant hazards, including human behavior considerations; (2) provide clear documentation; and (3) include means of effectively addressing changing or unexpected circumstances. Consequently, such systems, though potentially helpful in enhancing a focus on safety, require periodic independent audits of their substance, implementation, and effectiveness in improving safety results.

Independent Analyses and Peer Review

MMS has used various organizations and processes to provide some outside advice, peer review, and assessment of its regulatory and related activities. However, the agency does not have regular procedures for conducting peer review of its risk models, safety standards, and regulations. A review shows that the agency contracted on numerous occasions with various academic experts and other consultants to undertake quantitative risk assessments of different technologies, review its regulations for adequacy, and complete other tasks.

MMS has also used incident panels to review accidents, spills, and other compliance issues, but it manages these panels internally, unlike the air transportation industry, in which an independent board, the National Transportation Safety Board (NTSB), undertakes all evaluations

of airplane crashes and related safety incidents. Based on these evaluations, NTSB makes recommendations to FAA for regulatory action and evaluates the FAA response. NTSB also conducts safety studies and evaluates the effectiveness of regulatory programs for the transportation agencies. Finally, it reviews the appeals of enforcement actions taken by FAA involving aviation certificates and appeals of FAA civil penalty actions. Although FAA typically does not rely on peer review of its regulations, its regulations are under the continuing scrutiny of NTSB.

In addition to NTSB, FAA uses independent forums or institutions to provide peer review, recommendations, and other input into the regulatory process. With industry, it formed the Civilian Aviation Safety Team (CAST) in 1998 with the goal of reducing fatal commercial accidents by 80 percent by 2007. CAST has analyzed data from hundreds of fatal accidents and thousands of incidents to identify and recommend safety enhancements. In its second decade, CAST is developing a "proactive" approach to assessing emerging risks before accidents occur, a shift from the "reactive" approach of reviewing data from accidents and incidents.

FAA has adopted a structural approach to ensuring safety. FAA's *System Safety Handbook* sets out a matrix of the severity and likelihood of an incident as a basis for establishing priorities for agency response. Once FAA identifies an area of concern and begins its investigation for rulemaking, it relies on joint industry-FAA committees to develop recommendations on the appropriate regulatory response. These committees do not provide a venue for regulatory negotiation; FAA is not bound by their recommendations. FAA seeks to balance the likelihood and severity of the incident with the cost of implementing corrective action. Thus, where it can reasonably quantify the consequences of safety hazards, FAA uses benefit-cost and cost-effectiveness analysis in making its regulatory decisions.

Among the three agencies, EPA has placed the greatest emphasis on peer review and independent analysis. EPA has established a formal policy for conducting peer review of scientifically and technically based outputs, including economic and social science products, that are intended to inform its decisions. Peer review is deemed to occur when the designated work products are evaluated by relevant experts who were not involved in creating the product itself. EPA also relies on a series of committees established under the authority of the Federal Advisory Committee Act (FACA) to obtain advice on a wide range of environmental issues.

Risk Assessment and Planning Processes

MMS risk management occurs in (1) the planning and leasing process and (2) the regulatory process for establishing safety and environmental regulations. MMS uses an oil spill risk model to evaluate the likelihood of a spill's occurrence and, if a spill occurs, the risks of adverse environmental impacts. The model has three basic components: (1) estimates of the probability that a spill will occur; (2) simulated trajectories of spills to critical environmental

resources; and (3) combined results of the first two elements to estimate the risks from potential oil spills.

In addition to its use in National Environmental Policy Act environmental impact statements, the MMS risk model is used in environmental assessments, oil spill response plans, environmental reports completed by companies, biological opinions for Endangered Species Act consultations, and other federal agency reports to satisfy various legal requirements. Any concerns about the model thus propagate through most oil spill analyses.

The Oil Spill Risk Model itself has been subject to various technical and analytical critiques. However, for understanding risk management in the offshore oil and gas context, our focus is on three broader institutional and decisionmaking issues: (1) what formal, regular, and transparent processes exist to periodically review, validate, and improve risk models used by the agency and industry; (2) how information generated by models is used to inform decisionmaking, including decisions about risk mitigation; and (3) what standards, if any, are used as the benchmark or goal for managing and mitigating risk.

How the model is used to inform decisionmaking has raised concern because any initial estimate of extremely low probability of a spill has cascading effects. For the Macondo well, the risk model generated estimates of 4,600 barrels of oil as the most likely size of a large spill and no more than 26,000 barrels spilled over the entire 40-year life of production activity on six leases, including the Macondo well site. These estimates resulted in a determination of "no significant impact" from the project.

Even if the Oil Spill Risk model is useful in estimating probabilities of a spill and projecting likelihood that such spills will result in adverse impacts, a larger decisionmaking issue looms: how safe is safe enough? Risk models themselves do not establish what constitutes "acceptable" or "tolerable" risk. Central challenges in determining safety policy are whether to set a quantitative risk standard and whether and how to use quantitative risk analysis. In general, MMS has not set numeric standards for unacceptable, tolerable, and acceptable risk either in its planning process or in setting safety standards.

Many other agencies have established numerical thresholds for unacceptable risk. Quantifying risks and evaluating them against a numerical threshold are not straightforward, involving assumptions and uncertainties. However, such calculations, in many circumstances, can be accomplished and provide agencies with means for determining whether additional safety enhancements are necessary to achieve a specified risk threshold. If data and assumptions used in these calculations are transparent, others can independently review and critique such analyses, facilitating analytic improvements and public acceptance of agency risk management choices.

The rationale for use of qualitative rather than quantitative assessments relates, in part, to data quality. In one quantitative risk assessment comparing different deepwater production systems, two of five recommendations pertain to data. The report's second recommendation

states, "[T]he quality of existing data sets for the Gulf of Mexico should be improved so that they are of greater value in future risk analyses." The report's third recommendation reads, "Additional information about the populations of offshore facilities and operations in the Gulf of Mexico should be collected on an annual basis."

Despite data and analytic challenges, other agencies, including EPA and FAA, use numerical risk thresholds or ranges of tolerable risk. For example, in support of its wide array of regulatory actions, EPA has issued scientific documents outlining principles and concepts that guide risk assessment for carcinogenicity, mutagenicity, developmental toxicity, exposure, chemical mixtures, and other risks. For these purposes, the agency has established a lifetime human health risk range of 1 in 10,000 to 1 in 1,000,000 as generally acceptable for regulatory decisions and for site cleanup. Substantial portions of EPA's $2.9 billion program and management budget are devoted to quantitative risk assessments, as well as to technology and economic assessments, including regulatory impact analyses.

FAA is enhancing its risk assessments by adopting a "proactive" approach to data analysis to identify precursors that could result in aviation safety risks. FAA views this shift as necessary because, as accidents become increasingly rare, it is harder to identify the safety issues through traditional reactive analyses. Thus, an important element to this new approach is the development of a much broader database of events through voluntary self-reporting to identify possible aviation safety risks. Because these reports can involve possible noncompliance with FAA regulations, these programs provide incentives to encourage voluntary reports by resolving noncompliance through corrective action rather than through punishment or discipline. If the conditions set out in these programs are met, the enforcement action for individuals reporting the safety issue will be closed with no more than an administrative action. Several FAA programs encourage air carrier and repair station employees to make voluntary reports of safety information and provide data that will help identify precursors to accidents.

Organization Structure and Training

Structure

MMS was designed primarily along regional geographic lines, with vertical oversight provided between headquarters, regions, and districts. The structure had two effects: safety and leasing functions were combined under single supervisory authority, and safety and environmental personnel were pulled from district offices that handled day-to-day offshore permitting and review functions and placed, instead, at the regional level.

Throughout its existence, MMS faced some criticism that a functional organization structure would better ensure equal (and independent) focus on the three main functional areas. Notably, one major difference between U.S. and Norwegian management of offshore activities was in organization structures. In Norway, authorities for leasing or resource management and

for health, safety, and environmental regulation reside in two separate organizations. With Secretary of the Interior Ken Salazar's May 2010 secretarial order, U.S. offshore operations will resemble the Norwegian structure, in which safety and leasing operations are segregated into different organizations.

Training

Of seven elements identified as contributing to the Macondo well disaster by the Deepwater Horizon Study Group at the Center for Catastrophic Risk Management, five can be considered "failures in administrative controls—Human and Organization Factor (HOF) malfunctions." Administrative control failures include "deviation from standard operating procedures …, failure to follow accepted well completion procedures, failure to respond to trouble indicators, failure to maintain [emergency shutdown and disconnect] systems, and failure to fully test and activate the [blowout preventers]." MMS recently reviewed 310 OCS incidents (including fatalities, injuries, loss of well control, collisions, fires, pollution, and crane events) from 2003 and 2004 and found that 159, or more than half, involved failures to follow proper operating procedures; another 13 involved poor management of change. Together, these failures accounted for 51 percent of the incidents reviewed.

Despite improved results upon introduction of its performance-based training requirements, inadequacies in current training practices persist. Among the issues raised were:

- Lack of cross-training. One study in Australia showed that most oil rig workers who performed cementing tasks did not know that one-third of blowouts were due to cementing problems. Similar deficiencies in cross-training, according to former MMS officials, also exist in U.S. offshore oil and gas operations.
- Inadequate reinforcement of safety behavioral incentives.

EPA has developed training programs throughout the agency to maintain and upgrade the skills and knowledge of its staff. For example, the agency's in-house National Enforcement Training Institute serves as a clearinghouse for training information within the enforcement and compliance assurance program, exploring cost-effective means of delivering both classroom and distance training. It supports training of federal, state, local, and tribal attorneys, inspectors, civil and criminal investigators, and technical experts in all the various tools for environmental compliance and enforcement. It also conducts a range of activities, including (1) identification of strategic education and training needs that reflect priorities and important gaps in knowledge; (2) ensuring that needed education and training are identified and available; and 3) covering the full spectrum of the primary tools to promote compliance.

FAA has significant technical capacity, including use of certified engineers and others with special training and experience, to perform its regulatory oversight functions and airline certification program.

Inspections, Compliance, and Enforcement

In 2000—a decade before the Macondo well blowout—WEST Engineering Services surveyed 20 Gulf of Mexico rigs to determine compliance with recommended items or standards. They concluded that "in general, the rigs surveyed had a very high level of compliance with MMS and industry standards. Rigs surveyed had a total of 934 compliances with assessment points and 55 that were not in compliance." The WEST survey of MMS regulations, notices to lessees, and safety alerts noted that compliance of surveyed items was observed 84.8 percent of the time, and in some cases, practices recommended by the American Petroleum Institute (API) and developed through the voluntary consensus standards process were more stringent than MMS OCS regulations.

The purpose of MMS inspections is to ensure compliance with federal law, federal regulations, lease and right-of-way agreements, and approved exploration, development, and production plans. According to MMS regulations, these inspections are particularly concerned with verifying that equipment designed to prevent blowouts, spills, fires, and other accidents has been installed and is operating properly. Regulations specify that MMS conduct a scheduled inspection of each facility at least once a year and conduct unscheduled inspections "periodically."

Of the 49,903 noncompliance notices issued between 1998 and 2010, less than 1 percent resulted in civil penalties, for an average of 34 per year. Despite relatively high levels of compliance, several safety and small spill incidents prompted MMS several years ago to begin testing risk-based approaches to inspections. Under this approach, the agency developed criteria associated with higher risks—that is, noncompliance issues that were considered to hold the greatest potential to result in major accidents or environmental harm.

Both FAA and EPA include inspections and compliance as critical activities. FAA has established a formal enforcement decision tool for determining the appropriate responses to violations. The inspector identifying the violation makes the first judgment as to the appropriate response, and that judgment is reviewed by supervisors in the local FAA office. A decision to take "no action" or an administrative action (such as a warning notice) is not reviewed further within FAA. A recommendation for legal sanction by the local office is reviewed by the regional enforcement office and the Office of the General Council.

Enforcement of the environmental statutes it administers is a high priority for EPA. Roughly 20 percent of its workforce is engaged in enforcement activities. EPA sets national enforcement initiatives every three years to focus resources on the most significant

environmental problems and human health challenges identified by EPA staff, states, tribes, and the public.

Enforcement challenges for all three agencies include (1) how to best target inspection and enforcement resources, including use of tools to identify highest-risk activities and poor performers; (2) how to generate full reporting of compliance and safety incidents and issues, since agency inspectors cannot review all sites and equipment at all times; (3) how to foster corrective actions by the regulated entity; and (4) how to enhance overall accountability by regulated entities for their safety and environmental performance.

Recommendations

A comparative evaluation of regulatory structures and management practices can help illuminate effective practices and opportunities for improvement. We offer recommendations that result from this comparative evaluation. We underscore, however, that these recommendations must be accompanied by other changes pertaining to corporate culture, techniques, and operational incentives; emergency preparedness and response; and risk assessment and management to produce a composite set of improvements aimed at enhancing safety.

The Department of the Interior and BOEMRE have taken several actions to improve safety and reduce risks associated with offshore oil and gas activities. We consider two particularly important. The first is a reorganization that, when fully implemented, will segregate safety and leasing functions into two separate bureaus. The second is the October 15, 2010, release of the Final Rule on Safety and Environmental Management Systems, which incorporates by reference the entire API Recommended Practice 75, with its general procedures and all 12 specific elements. An important feature is the emphasis on the external auditing role of the federal agency. The new rule is an important step forward. Below, we offer some additional recommendations.

Agency Structure and Organization Oversight

On May 19, 2010, Secretary of the Interior Ken Salazar issued an executive order announcing a reorganization of the Minerals Management Service. The reorganization will place the leasing and safety functions of the agency in two separate organizations, with separate supervisors, to bring independent attention to safety considerations in budgeting and decisionmaking. The department has not yet completed the reorganization, pending an outside management review. We endorse the general outlines of the reorganization and offer two considerations as the Department considers how to fully implement the secretarial order. In designing the new bureaus consideration should be given to:

- Maintaining interbureau coordination on matters such as planning and leasing, expected levels of leasing and platform activity, and scientific research.
- Providing safety capacity down to the field level rather than providing that capacity only at the regional level and in headquarters.

Risk Assessment and Risk Management

The safety agency should develop specific guidance on risk assessment and risk management methods and practices. We suggest two methodologies:

- Setting quantitative thresholds or standards for acceptable, tolerable, and unacceptable risk. In reviews of particular rules, techniques, and practices, deviations from these standards should be based on rigorous analysis. Actual decisions about any deviations from the standards should be made at the highest levels of the agency. The practices of FAA, the United Kingdom's Health and Safety Executive, and other agencies that use quantitative thresholds should be evaluated as possible models.
- Using accident precursor analysis, if feasible, instead of historical spill data to develop risk assessments of low-probability major oil spills by identifying the failure probabilities of accident components.

Regulatory Processes and Best Practices

The agency should further emphasize safety and environmental performance-based approaches to risk management such as those used in Norway and the United Kingdom for offshore oil and gas development. We suggest four specifics:

- Ensuring that operator self-analysis and risk-based performance assessments include verifiable information and are subject to independent, third-party audits. In addition, the agency should periodically audit operators' self-assessments and performance at each site.
- Establishing clear risk thresholds. These should be used to evaluate alternative compliance options and develop specific guidance on implementation by regions and field offices. The agency can also apply these thresholds to determine whether compliance alternatives meet established performance goals.
- Establishing independent peer review to determine whether the regulations are adequate for achieving the standards. The peer review groups should include strong representation from outside the regulated community. Independent reviews and risk thresholds should become formal, regular requirements of the agency's oversight.

- Exploring the creation of a permanent, independent entity to investigate offshore oil spills that are greater than a specified magnitude. This independent body would identify probable causes and make recommendations on ways to prevent recurrences.

The People Factor

The agency's move toward performance-based training requirements would benefit from two actions:

- Requiring a higher degree of cross-training among skill sets, to ensure the safe operations of a platform and associated exploration and production equipment and processes.
- Using data concerning incidents of noncompliance to identify areas in which inspectors need additional or different training. Here, the agency could draw from the experience of EPA's compliance training program.

Enforcement and Compliance

We suggest two approaches:

- Creating a stronger incentive system for operators and contractors to report risks and problems without penalty (similar to programs developed by both FAA and EPA). The program would not apply to actions associated with criminal violations, fatal accidents, and major injuries.
- Continuing and strengthening the annual operator reviews, in which corrective actions are discussed. This process reinforces a focus on improvement, targeting poor performers and repeated incidents of noncompliance. The discussions do not replace continued use of penalties and legal sanctions, where warranted under regulations and based on the type of noncompliance. However, they enhance those traditional compliance tools by directing attention to corrective action, particularly for repeat instances of noncompliance.

1. Introduction

The ability of the federal government to manage current and future environmental, health and safety (EHS) risks associated with offshore energy exploration and production depends in part on the technical and procedural practices, accountability, and effectiveness of the responsible regulatory agency. These regulatory and management responsibilities have become increasingly challenging in a context of rapidly evolving technologies and new frontiers of energy production. A series of events over the past several years put the Minerals Management Service (MMS) under intense scrutiny. But it was the explosion on April 20, 2010, of the

deepwater Macondo oil well in the Gulf of Mexico that triggered a reconstituting of the agency as the new Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE). This reorganization, however, is the beginning rather than the end of a thorough reexamination of how the nation can reduce risks and enhance safety associated with offshore energy exploration and production.

That inquiry requires evaluating the capacity of MMS (now BOEMRE) to carry out its planning, regulatory and enforcement responsibilities. Comparing these practices and associated data with similar data, practices, and information from other federal agencies also managing low-probability but high-consequence EHS risks provides a basis for identifying opportunities for enhancing regulatory capacity and safety performance in the management of deepwater energy exploration and production activities. Though all aspects of EHS are relevant to improving the regulatory capacity of the newly formulated BOEMRE, we focus on the issues most relevant to human safety and environmental releases:

- the scope and depth of the analyses produced by the agency, including the breadth of the technical and regulatory options considered;
- the techniques and processes used to evaluate and manage risk;
- the processes for identifying best practices, including the role of voluntary consensus standards;
- the resources available to conduct EHS analyses;
- the types of peer review processes employed;
- the training and experience of the technical staff;
- the training and experience of consultants regularly used by the agency; and
- the character, frequency and extent of enforcement activities.

In this study, we compare and contrast the identified issues as performed by MMS and two other agencies—the Federal Aviation Administration (FAA) and the Environmental Protection Agency (EPA). All three agencies have responsibilities for oversight and regulation of some activities that involve potentially low-probability but high-consequence environmental, health, and safety risks. In addition to these interagency comparisons, we also describe some relevant practices of other nations that oversee and regulate offshore, deepwater oil and gas production activities.

2. Minerals Management Service

Background

Agency History

The mission of the former Minerals Management Service, established in 1982 by administrative action of the Secretary of the Interior, was "to manage the mineral resources on the outer continental shelf in an environmentally sound and safe manner and to timely collect, verify, and distribute mineral revenues from federal and Indian lands."[1] The new agency combined several functions that had been dispersed among several agencies and offices within the Department of the Interior. These functions included operation of offshore minerals leasing, minerals revenue collections and disbursements, and regulation of offshore energy exploration and production.

Before MMS was created, revenue collections, safety oversight and regulations, and offshore resource assessments had been undertaken by the U.S. Geological Survey (USGS) within the Department of the Interior. Offshore leasing was conducted by the Bureau of Land Management, which also conducted onshore oil and gas leasing on federal public lands.

Substantial problems in the management of minerals royalty collections and disbursements led to creation of the Commission on the Fiscal Accountability of the Nation's Energy Resources (Linowes Commission), which issued its report in January 1982. Among the commission's findings was a conclusion that "the scientifically oriented Geological Survey, which now manages royalties, has never been able to supply the active, sophisticated management that is needed. It is largely for this reason that the Commission recommends removing the royalty management function from the Geological Survey …"[2]

In part as a response to this recommendation and to other problems of coordinating royalty collections, safety oversight, and leasing activities associated with offshore energy production, the Secretary of the Interior established the Minerals Management Service, which took on responsibility for these functions. Initially, MMS used a regional structure, with each regional director having responsibility for all functions and reporting to an associate director at the Washington headquarters also responsible for all functions at the national level of program administration. Environmental safety functions were combined with leasing activities at the regional level. Environmental specialists at the field level under the earlier USGS structure were

[1] Minerals Management Service, Mission Statement, Strategic Plan, June 2, 1997.

[2] Commission on Fiscal Accountability of the Nation's Energy Resources (Linowes Commission), U.S. Government Printing Office, Washington, DC, January 1982, p. xvi.

moved into regional offices and combined with leasing operations. At the Washington headquarters level, a separate environmental office within MMS was established, and all offshore regulations were prepared and processed in the headquarters operations office.

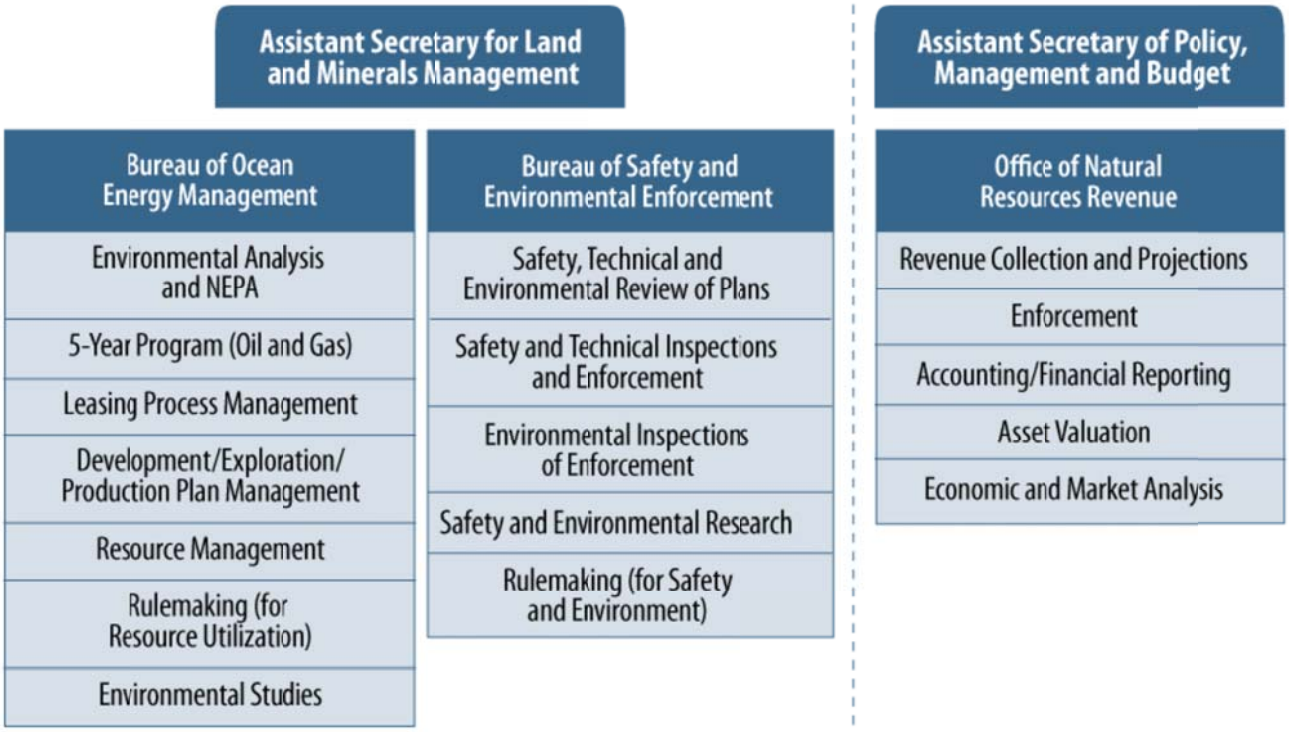
Just over a decade later, in 1994, MMS was restructured "to meet the objectives of the Clinton Administration's Reinventing Government effort and the National Performance Review (NPR) in its commitment to invent a leaner government …"[3] As part of that reorganization, several functions were consolidated at the headquarters level. However, these consolidations did not fundamentally restructure how MMS functioned. Throughout its existence, MMS generally did not use a function-based management structure, though several management reviews proposed such a structure.[4] Instead, the organization operated using a regional geographic structure, with most functions combined within the regions and falling under headquarters supervision.

On May 19, 2010, a month after the Macondo blowout, the secretary of the Interior reorganized offshore activities, shifting MMS functions into three organizations (see Figure 1). These include a new Bureau of Ocean Energy Management, Regulations, and Enforcement (BOEMRE) and, when the reorganization is complete, a Bureau of Safety and Environmental Enforcement, both reporting to the assistant secretary for Land and Minerals Management, plus an Office of Natural Resources Revenue (located under the assistant secretary for Policy, Management, and Budget). In the reorganization, safety functions will be segregated from offshore leasing functions and will no longer be managed under a single director within a single bureau.

[3] MMS Press Release, July 7, 1994.

[4] Interview with B. Danenberger, former MMS safety manager, October 11, 2010.

Figure 1. MMS Functions, May 2010



Source: H.B. Hogue, *Reorganization of the Minerals Management Service in the Aftermath of the Deepwater Horizon Oil Spill*, CRS Report for Congress R41485 (November 10, 2010): 14. http://www.fas.org/sgp/crs/misc/R41485.pdf

Offshore Oil and Gas Activity

As of October 2009, the Outer Continental Shelf (OCS) generates about 30 percent of all domestically produced crude oil and 11 percent of natural gas.[5] More than 95 percent of this production occurs in the Gulf of Mexico.[6] Production occurs in federal waters in the Gulf on

[5] See Z.-G. Ji, "Use of Physical Sciences in Support of Environmental Management," *Environmental Management* 34(2): 159-169; see also National Ocean Industries Association, "Basic Facts about Offshore Oil and Gas," 2004, available at www.noia.org (accessed September 20, 2010); and U.S. Department of the Interior, BOEMRE, "Outer Continental Shelf Oil and Gas Production," boemre.gov/stats/PDFs/OCSProductionTemplate2009.pdf (accessed December 4, 2010). The production percentages vary over time. Estimates in 2004 put total federal offshore natural gas production at 25 percent. The 2009 figure was 11 percent.

[6] U.S. Commission on Ocean Policy, "An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy," September 20, 2004, www.oceancommission.gov/documents/full_color_rpt/welcome.html.

around 3,500 platforms, of which 978 are manned.[7] Approximately 90 rigs, including 68 mobile offshore drilling units and 22 platform rigs, are active in the Gulf. In 2008, the last year for which complete data are available, federal offshore tracts generated some 1.7 million barrels of oil daily and 6.6 million cubic feet of natural gas, or about 446 million barrels of oil and 2.4 trillion cubic feet of natural gas annually.[8] Federal revenues collected annually come from bonus bids in the leasing process and from royalty revenues, which vary depending on resource prices and volumes produced. Total federal offshore royalty revenues have fluctuated throughout the last decade, from as low as $4.1 billion in fiscal year (FY) 2002 to as high as $18 billion in FY 2008.[9] Additional revenues from bonus bids from lease auctions have ranged from $85 million (nominal dollars) to $9.5 billion in 2008.[10]

Safety and Environmental Record

Environmental and safety performance offshore comprises two categories: (1) accidents and fatalities in the workforce; and (2) incidents resulting in oil spills and other pollutant releases into the environment.

Workplace safety. MMS tracks workplace safety in OCS oil and gas operations by recording the number of injuries and fatalities suffered by OCS workers annually, as well as two composite indices, the Operator Safety Index and the Annual Composite Accident Severity Ratio. MMS sets goals for each of these indicators each year. No clear trend in workplace safety performance is apparent in recent years. For example, in 2008 MMS recorded both an unusually low number of fatalities and an unusually high accident severity ratio.[11]

Oil spill record. Historically, oil spills have resulted from three types of incidents: platform events, pipeline events, and tanker spills. Overall, both the frequency of oil spill incidents and the volume of releases have declined over the past 20 years, excluding spills associated with the dramatic 2005 hurricanes, Katrina and Rita.[12]

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[7] American Petroleum Institute, Joint Industry Task Force, July 6, 2010.

[8] Energy Information Agency (see http://www.eia.gov/dnav/pet/PET_CRD_CRPDN_ADC_MBBL_A.htm and http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_rusf_a.htm).

[9] Office of Natural Resources Revenue, http://www.mrm.boemre.gov/MRMWebStats/.

[10] Department of the Interior, Office of Policy Analysis, "Economic Background on Interior's Oil and Gas Policy," February 17, 2010, 8.

[11] Program Assessment Rating Tool report, Outer Continental Shelf Minerals Regulation and Compliance, 2005, http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html.

[12] J.L. Ramseur, CRS Report for Congress, "Oil Spills in U.S. Coastal Waters: Background, Governance, and Issues for Congress," Updated September 2008; U.S. Coast Guard, Office of Investigations and Compliance Analysis, "Polluting Incidents In and Around U.S. Waters: A Spill/Release Compendium: 1969–2008," August 2010, 3–8.

In its August 2010 report, "Polluting Incidents in and around U.S. Waters," the U.S. Coast Guard reviewed 36 years and more than 354,000 investigation reports. The report found that "the majority of spills …involved discharges of between one and one hundred gallons," but that most spill volumes "can be attributed to a small number of incidents each year."[13] Nearly 70 percent of the volume of spills from 1973 to 2008 resulted from spills greater than 100,000 gallons.[14] Prior to the *Deepwater Horizon* oil spill, the Outer Continental Shelf area regulated by MMS had not suffered a platform or pipeline spill larger than 1 million gallons since 1970, according to records maintained by MMS/BOEMRE.

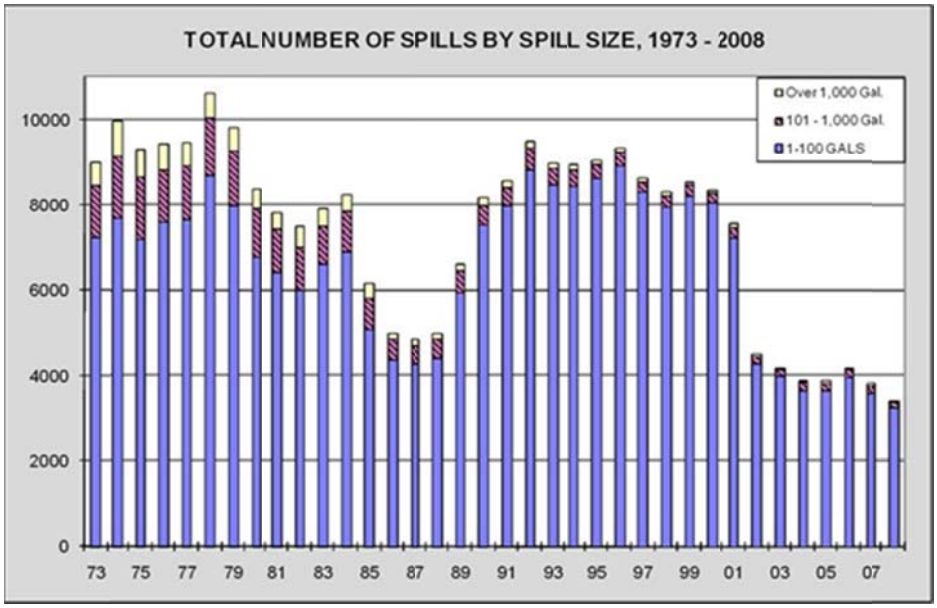
Historically, tankers have accounted for most spill volume, but since 1990 that distribution "has shifted toward non-tank vessel sources." Since the *Exxon Valdez* tanker spill in 1989, the frequency and volume of tanker spills have declined dramatically as stricter international regulations, threats of significant liability, and improved technologies and training have shaped the operating environment. Before the Macondo well blowout, offshore platforms were associated with no large spills over a 40-year period and, overall, had a good performance record.

Figures 2 through 5 include data from all U.S. waters regulated by the Coast Guard and are not limited to the OCS area regulated by BOEMRE. However, this information is included to illustrate general trends in the nature of oil spill incidents.

[13] U.S. Coast Guard, "Polluting Incidents In and Around U.S. Waters," August 2010, 3.

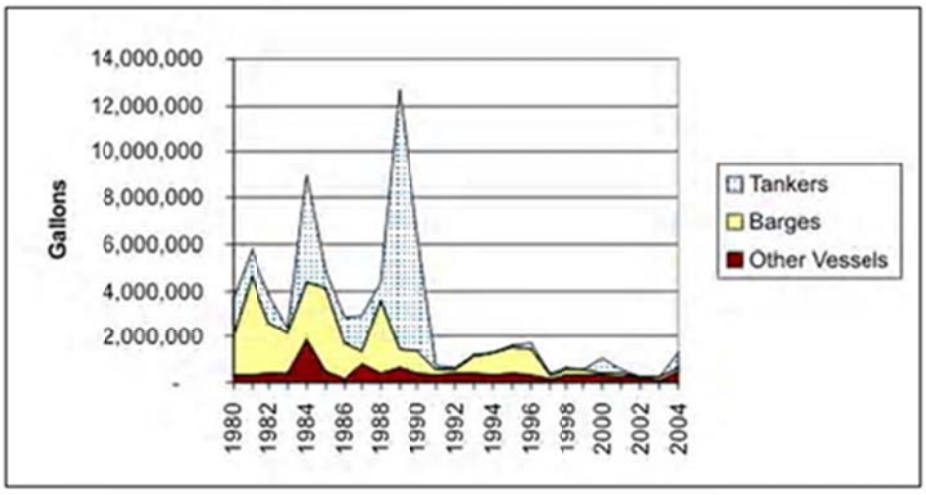
[14] Ibid., 8.

Figure 2.



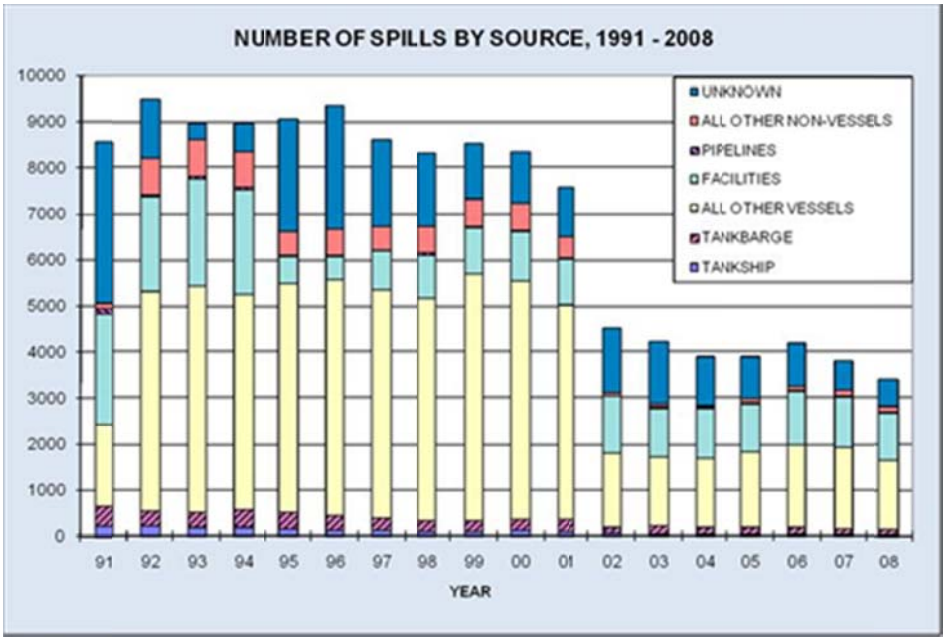
Source: U.S. Coast Guard, Office of Investigation and Compliance, "Polluting Incidents in and around U.S. Waters: A Spill Release Compendium: 1969-2008, August 2010.

Figure 3. Volume of Oil Spilled from Vessels into U.S. Coastal Waters, 1980–2004



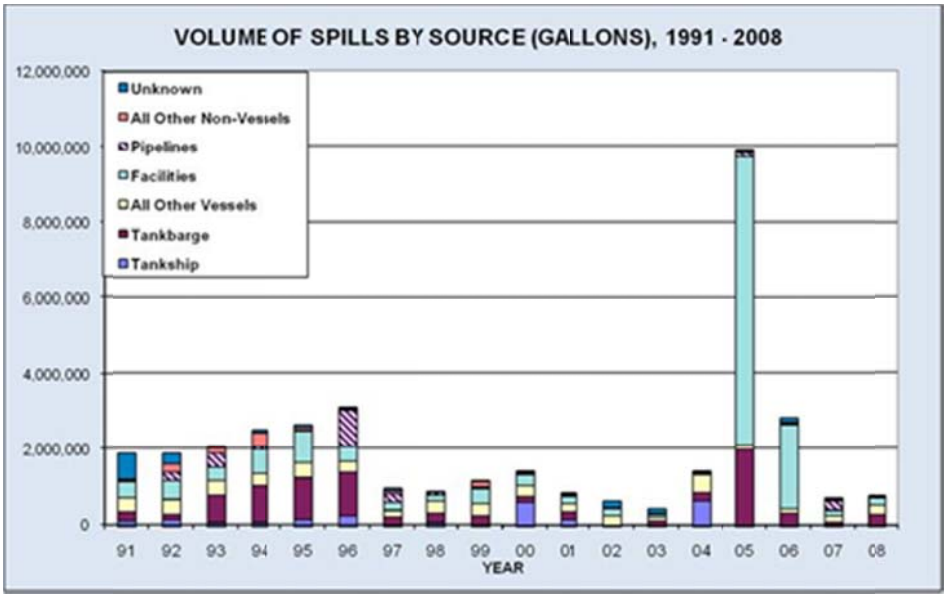
Source: Jonathan L. Ramseur, Congressional Research Report for Congress: Oil Spills in U.S. Coastal Waters, Updated Sept. 2, 2008.

Figure 4.



Source: U.S. Coast Guard, Office of Investigation and Compliance, "Polluting Incidents in and around U.S. Waters: A Spill Release Compendium: 1969-2008, August 2010.

Figure 5.



Source: U.S. Coast Guard, Office of Investigation and Compliance, "Polluting Incidents in and around U.S. Waters: A Spill Release Compendium: 1969-2008, August 2010.

One analysis of spills from platforms over a 15-year period (1985–1999) showed 0.13 spills greater than 1,000 barrels per billion barrels of oil and 0.05 spills greater than 10,000 barrels per billion barrels of oil (Table 1).[15]

Table 1. Oil Spill Rates Based on 1985–1999 Data

Spill Source	Spills ≥ 1,000 bbl	Spills ≥ 10,000
OCS Platform	0.13 per Bbbl	0.05 per Bbbl
OCS Pipelines	1.38 per Bbbl	0.34 per Bbbl
OCS Tankers	0.72 per Bbbl	0.25 per Bbbl

Sources: C.M. Anderson and R.P. LaBelle, 1990, Estimated Occurrence Rates for Accidental Oil Spills on the U.S. Outer Continental Shelf, *Oil and Chemical Pollution* 6:21-35 (cited in Zhen-Gang Ji, et al., "Oil-Spill Risk Analysis: Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales, Central Planning Area and Western Planning Area, 2003-2007, and Gulfwide OCS Program, 2003-2042," DOI, MMS, June 2002.

Reflecting this record, over the past two decades offshore oil and gas safety was not the focus of any reviews or reports by the Government Accountability Office (GAO), the Congressional Research Service, the National Research Council, or the National Academy of Public Administration. Nor was offshore oil and gas safety the primary focus of congressional oversight proceedings during this time. Rather, the focus has been largely on matters of royalties and revenue collections.

Offshore Planning and Regulatory Processes

Under MMS, planning, leasing, technical and other safety regulations, and compliance inspections and enforcement were all handled by the agency. By law, the planning process includes development of a five-year plan, which includes an oil spill risk analysis for the areas eligible for leasing under the plan. Subsequent to the five-year planning process, the agency develops plans for selling and issuing individual leases.

Once leases are issued, MMS (BOEMRE) reviews and, if satisfactory, approves exploration plans pursuant to issuing exploration drilling permits. In the final permitting step, the agency reviews production plans and, if approved, issues production drilling permits. For the exploration and production phases, MMS typically used either environmental assessments (EAs) or categorical exclusions (CXs), if no additional impacts beyond those identified in the five-year and one-year planning documents were identified. Under MMS, the decision to prepare an EA at the permitting phase (rather than a CX) was made by the regional supervisor for Leasing and Environment or by the chief of the Environment Division. Typically, outside the Gulf of Mexico,

[15] Z.-G. Ji et al., "Oil-Spill Risk Analysis: Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales, Central Planning Area and Western Planning Area, 2003–2007, and Gulfwide OCS Program, 2003–2042," U.S. Department of the Interior, Minerals Management Service, June 2002.

EAs were generally used in the exploration and development phases; in the Gulf, MMS often used categorical exclusions, with impact assessment essentially tiered back to the broader leasing and five-year planning environmental impact statement (EIS) documents.

Both the five-year planning and lease planning processes include oil spill risk assessment in the EIS analyses. As part of the National Environmental Policy Act (NEPA) process, MMS (BOEMRE) also provides the National Marine Fisheries Service (NMFS) and/or the Fish and Wildlife Service (FWS) with details on the proposed oil and gas activity, species listed under the Endangered Species Act (ESA) and designated critical habitat in the area, and related information on the proposed action's effects on these species. Also included are measures to reduce or eliminate effects on listed species. If MMS, NMFS, or FWS determined that an action might adversely affect listed species or designated critical habitat, MMS would undertake a formal consultation process and obtain a biological opinion on whether the action was likely to jeopardize a listed species or habitat. Other regulatory requirements under the Coastal Zone Management Act, Clean Air Act, Clean Water Act, Oil Pollution Act, and National Historic Preservation Act are also covered through the exploration and development permitting processes. Figures 6, 7, 8, and 9 summarize the regulatory process under MMS.

Figure 6. Overview of MMS Offshore Planning and Leasing Process

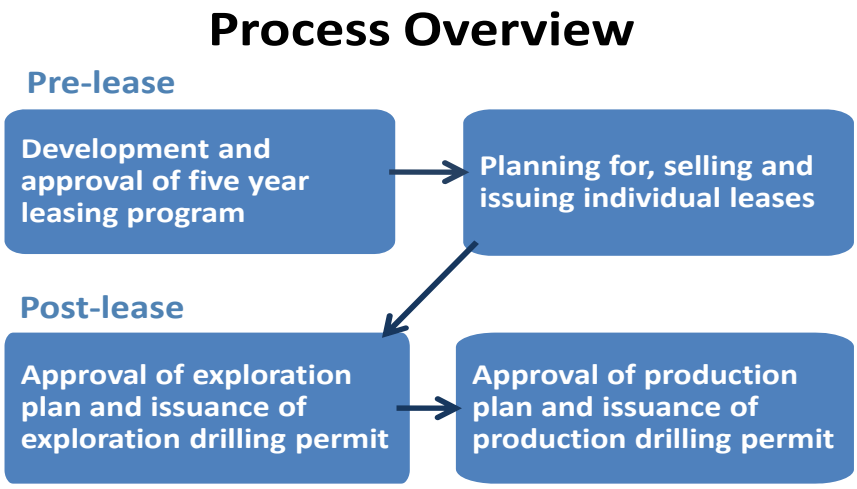


Figure 7. Process for Developing the 5-year Leasing Plan

Figure 8. Overview of Leasing Process

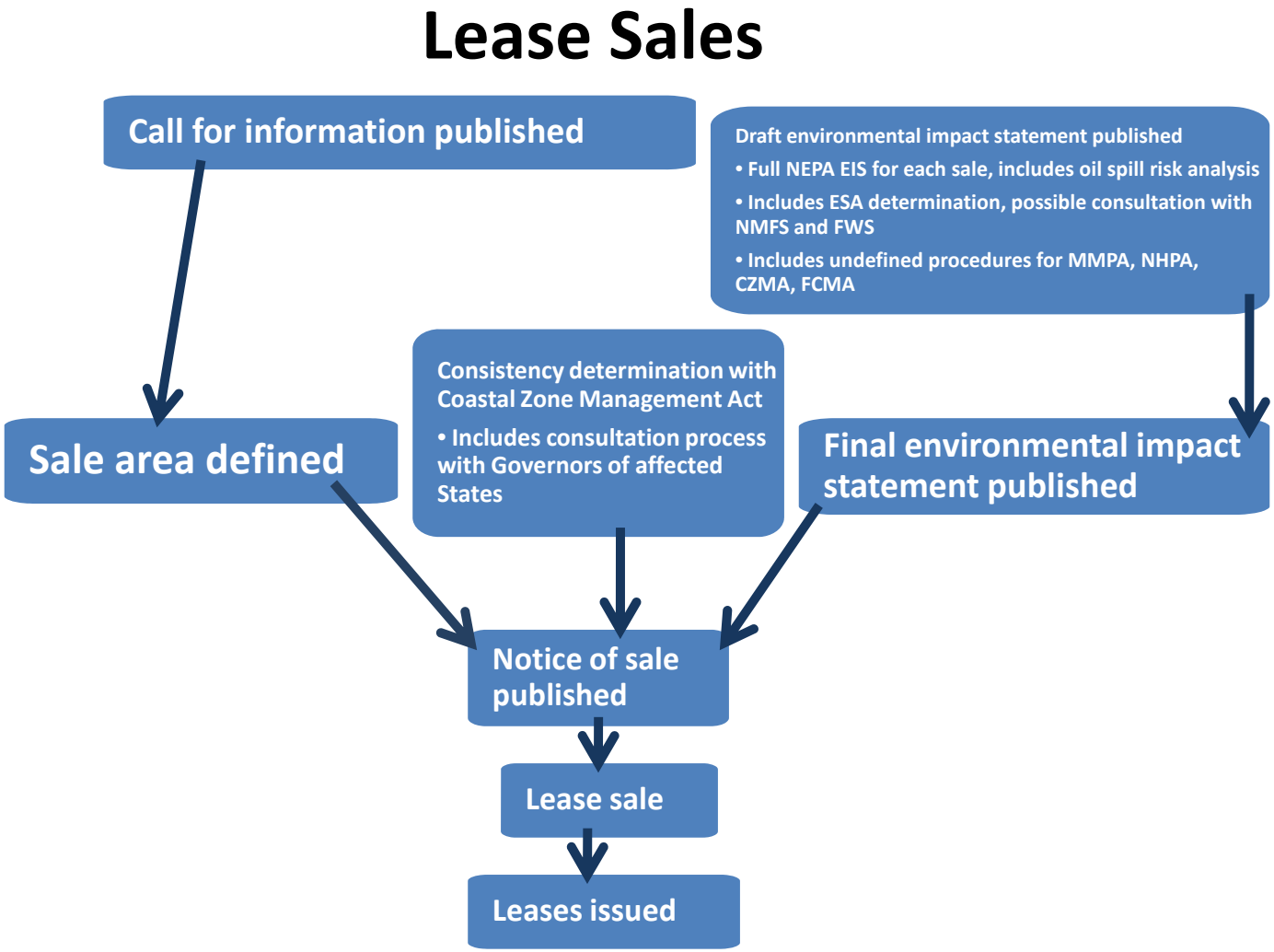
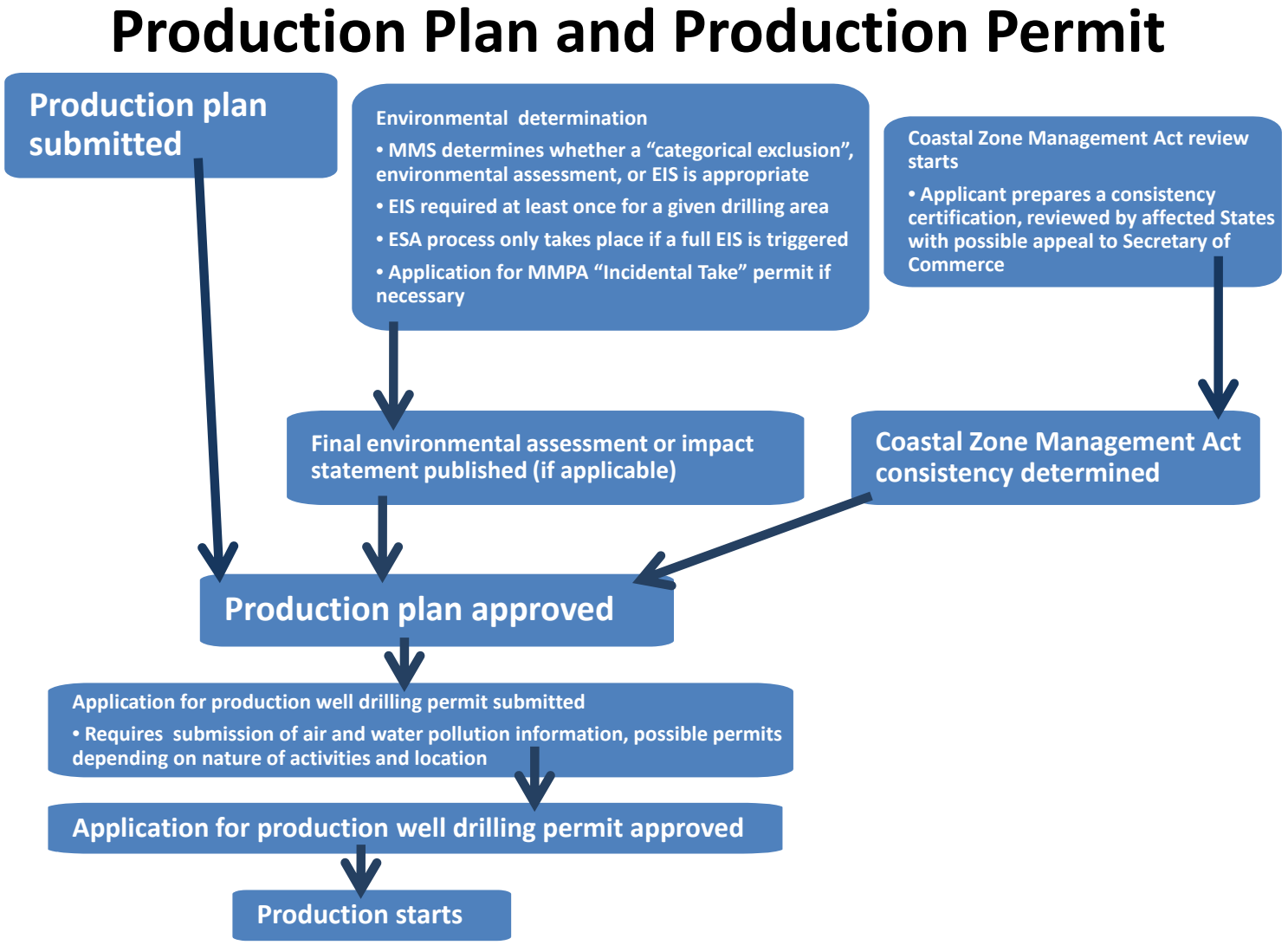


Figure 9. Overview of the Post-Lease Permitting Process



Regulatory Development: Decisionmaking Criteria and Analysis

MMS (now BOEMRE) planning, regulatory, and permitting processes constitute the framework within which companies and the agencies address environmental and safety issues. That framework includes four elements relevant to understanding how safety and environmental management might be improved: regulatory decisionmaking, risk assessment and planning processes; organization structure and capacity; and inspection and compliance processes.

Regulatory Decisionmaking, Risk Assessment, and Planning

Metrics and measurements of performance. MMS uses a variety of measures and metrics in three areas—safety, revenue, environmental effects—against which to evaluate overall regulatory and compliance performance of the offshore oil and gas program. Key measures relating to oil spills include barrels spilled per million barrels produced and compliance inspections completed (an output rather than outcome measure). Performance results have been reported annually in Government Performance and Results Act information and, more recently, in Program Assessment Ratings undertaken in conjunction with the Office of Management and Budget (OMB). Performance fell below targets for the oil spill metric in 2005, largely as a consequence of Hurricanes Katrina and Rita, and in 2008 (Table 2). Compliance inspections fell below targets in 2005–2007 (Table 3). Overall, MMS notes that offshore oil and gas activities, until the Macondo blowout, resulted in spills totaling less than 0.001 percent of the oil produced over the past 20 years.

Regulations and Rulemaking

Regulations are a formal statement of law; they are developed through a rulemaking process subject to the requirements of the Administrative Procedures Act of 1946. Many agencies use notice and comment rulemaking for its rule development. Agencies must first develop a "notice of proposed rulemaking". This notice is published in the Federal Register for comment. After the comment period has closed, agencies must review and respond to the comments in a final rule. If a rule is designated a significant rule under Executive Order 12866, the draft proposal and final rules must be submitted by the agency to BOEMRE to OMB for Executive Order 12866 review. Under EO 12866, agencies must complete a regulatory analysis for major rules—that is, rules with expected annual benefits or costs that exceed $100 million.

Table 2. Bbl Spilled per Million Bbl Produced

Year	*Target*	*Actual*
2002	<10	0.2
2003	<10	4.2
2004	<10	8.2
2005	<10	24.7
2006	< 5	3.0
2007	< 5	2.7
2008	< 5	13.7

Source: Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008. (Accessed Jan. 9, 2011). http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

Overall, MMS notes that offshore oil and gas activities, until the Macondo blowout disaster, result in spills of less than 0.001 percent of oil produced over the past 20 years.

Table 3. Compliance Inspections Completed

Year	*Target*	*Actual*
2002	17,000	22,547
2003	17,000	23,218
2004	21,000	24,938
2005	25,000	23,115
2006	23,000	20,172
2007	22,300	20,460
2008	20,000	25,560

Source: Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008. (Accessed Jan. 9, 2011). http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

MMS (BOEMRE) also tracks fatalities and serious injuries. Fatalities between 2002 and 2008, as reported in the Program Assessment Rating, averaged 5.8 fatalities per year, meeting targets in four of the six years measured (Table 4). The actual goal is 0; the targets listed in Table 4 reflect improvement goals. MMS asserts that U.S. offshore activities experienced fewer "major incidents" than other countries, though it does not cite a source for this assertion.[16] Overall, the MMS regulation and compliance program was rated "effective" by OMB in its 2008 review.[17]

[16] Program Assessment Rating Tool report, Outer Continental Shelf Minerals Regulation and Compliance, 2005, http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

[17] Program Assessment Rating Tool report, Outer Continental Shelf Minerals Regulation and Compliance, 2008.

Table 4. Fatalities

Year	*Target*	*Actual*
2002	N/A	7
2003	7	11
2004	7	3
2005	6	6
2006	6	9
2007	6	3
2008	6	2

Note: Actual goal is 0, but targets reflect improvement goals.

Source: Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008. (Accessed Jan. 9, 2011). http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

MMS also established metrics to assess operator performance, using two indices. The first is an operator safety index, which uses a ratio of the weighted "incident" value and the number of safety and pollution prevention components inspected during a year. The second is a ratio of the operator accident severity value and the component operator count, or number of safety components installed in MMS-regulated facilities. MMS then calculates its annual composite operator performance index (OPI) based on the number and severity of violations cited and accidents reported. Results from 2002 through 2008 are shown in Table 5.

Table 5. Operator Performance Index

Year	*Target*	*Actual*
2002	0.20	0.14
2003	0.20	0.21
2004	0.20	0.16
2005	0.20	0.11
2006	0.20	0.20
2007	0.20	0.15
2008	0.20	0.27

Source: Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008. (Accessed Jan. 9, 2011). http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

MMS also calculates an annual composite accident severity ratio based on the number and severity of accidents reported (Table 6). Accident data relate to the total number of safety and pollution prevention components installed in MMS-regulated facilities. The accident severity ratio is a subcomponent of the operator performance index. Reviewing this component separately distinguishes changes in the OPI due to decreased accidents versus changes due to changes in levels of enforcement activity.

Table 6. Annual Composite Accident Severity Ratio

Year	*Target*	*Actual*
2002	.08	.04
2003	.08	.08
2004	.08	.08
2005	.08	.03
2006	.08	.10
2007	.07	.075
2008	<.10	.20

Source: Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008. (Accessed Jan. 9, 2011). http://www.whitehouse.gov/omb/expectmore/detail/10003715.2005.html

In the same time period, MMS also tracked the number of serious injuries among workers in MMS-permitted activities. The target ranged from 25 to 27, with the upward adjusted goal reflecting expected changes in activity levels. Performance exceeded targets in four of seven years between 2002 and 2008. The Program Assessment Rating reports that:

> While no single cause for the increase in fatalities and serious injuries in FY 2006 from FY 2005 can be identified, the unusual offshore activity level during FY 2006 is most likely a significant contributing factor. During FY 2006, the offshore industry in the Gulf of Mexico [was] engaged in recovering from the record damage caused by hurricanes Katrina and Rita in August and September 2005. The number of repair operations and man-hours operating on the OCS [was] well above that of recent years, dramatically affecting the availability of equipment and qualified people to conduct recovery and repair operations.[18]

Despite reasonable performance, OMB's Program Assessment Rating Tool (known as PART) review and other reports note that MMS did not seek regular independent evaluations of its performance, including the adequacy of measures used or targets established. The PART review notes, "The [regulation and compliance] program has not undergone one comprehensive review, and could benefit from a regular-scheduled independent review."[19] MMS contracted periodically for independent reviews of portions of programs and undertook alternative management control reviews internally, but it did not systematically seek independent reviews of its overall program, performance measures, and program effectiveness.

The operator performance index shows that the agency met or exceeded the target level of performance for seven of nine years during which this measure has been tracked. Yet reviews

[18] Office of Management and Budget, MMS – Outer Continenal Shelf Minerals Regulation and Compliance, Program Assessment Rating, 2008.

[19] Ibid.

of events leading to the Macondo well blowout, including a report by the operator, British Petroleum, show layers of process and equipment failures. These failures suggest that MMS performance measures were missing critical qualitative and quantitative inspection and process information that might have pointed to problem performance. In its examination of onshore refinery and other workplace chemical incidents, the Occupational Safety and Health Administration (OSHA) notes that "having good numbers on the OSHA … injury logs does not correlate with having an effective chemical process safety program."[20] OSHA offers an example: BP–Texas City, where a refinery experienced a disastrous explosion in 2005, "had very good injury and illness numbers for its own employees prior to the 2005 explosion. That tragedy, of course, revealed serious problems with process safety and workplace culture at the facility."[21] Although OSHA's focus, in this particular assessment, targeted onshore refineries, the agency indicates similar challenges in other types of workplace.

In addition, in its 2009 proposed regulation on Safety and Environmental Management Systems (SEMS), MMS reviewed accident panel investigations, conducted a study of 1,443 incidents in OCS waters from 2001 to 2007, and reviewed incidents of noncompliance. The agency concluded that "the data indicate no discernible trend of improvement by industry over the past 7 years."[22] These data are summarized in Tables 7 and 8; E-INC stands for environmental incidents of noncompliance.

Table 7. Ratio of Total Production Operation E-INCs and Number of Components Inspected per Year

Year	*Total E-INCs*	*Components Inspected*	*Ratio (rounded)*
2001	156	66,065	0.0024
2002	173	68,355	0.0025
2003	134	66,056	0.0020
2004	141	67,267	0.0021
2005	122	61,520	0.0020
2006	133	56,930	0.0023
2006	111	46,384	0.0024

[20] J. Barab, U.S. Department of Labor, Occupational Safety and Health Administration, Testimony on worker safety in energy production industries before U.S. Senate Committee on Health, Education, Labor and Pensions, Subcommittee on Employment and Workplace Safety, June 10, 2010, press summary, http://www/dol.gov/opa/media/press/osha/OSHA20100819.htm (accessed October 9, 2010).

[21] Ibid.

[22] OMB, MMS Program Assessment Rating, 2008.

Table 8. Ratio of Total Drilling Operation E-INCs and Number of Wells Spud per Year

Year	*Total E-INCs*	*Wells Spud*	*Ratio*
2001	19	1,264	0.015
2002	4	941	0.004
2003	10	893	0.011
2004	11	915	0.012
2005	10	817	0.012
2006	8	763	0.010
2007	7	607	0.012

MMS recognized the limitations of its inspection and oversight practices in a 2006 advance notice of proposed rulemaking regarding Safety and Environmental Management Systems. In that advance notice, MMS stated that it had "limited methods to verify and document industry compliance with the regulatory performance standards."[23] Safety data and MMS conclusions about safety trends both indicated a need for additional or different tools to enhance safety practices within the offshore industry and better ways for MMS to assess performance. In addition to proposing a SEMS, MMS also strengthened its focus on risk-based inspections and on annual operating reviews, which were intended to focus on operators' compliance records and plans for improvement.

Performance trends, coupled with incident reports and selected safety assessments, have played some role in triggering and shaping regulations. For example, high levels of accidents associated with crane operations resulted in additional required procedures for their use on platforms. However, MMS did not establish a specific, quantitative safety threshold against which to develop and evaluate safety practices and standards. Establishing thresholds refers to the process of transforming "a variable which can vary in a continuous manner into one which varies in a binary, dichotomous manner."[24] In his evaluation of voluntary consensus standards, Mark Marpet notes that "thresholding is important because it gives decisionmakers a consistent, unambiguous means to decide on a course of action."[25] Reflecting this approach, both Norway and the United Kingdom require that companies specifically identify risks on an integrated basis and demonstrate how they are achieving specified safety standards. Both have some numerical, risk-based thresholds for use in these risk management processes.

Internal and external decision triggers. MMS decision criteria that have triggered regulatory action include both external and internal drivers. At the time of the Macondo spill, the agency had not established a specific, quantitative safety threshold against which to assess current practices and

[23] U.S. Department of the Interior, Minerals Management Service, Advance Notice of Proposed Rulemaking, "Oil and Gas and Sulphur in the Outer Continental Shelf (OCS)—Safety and Environmental Management Systems, Federal Register 71(98), May 22, 2006, 29277–78.

[24] M. Marpet, "An Ethical Issue in Voluntary-Consensus-Standards Development: A Decision-Science View," *Journal of Business* Ethics 1(15) (November 1998): 1708.

[25] Ibid., 1708.

determine the need for additional regulations. Instead, decisions to regulate appear to have resulted from iterative review of the following:

- safety issues, records, and incident reports;
- review of the American Petroleum Institute (API) Annual Standards Plan and ISO standard setting;
- issues relating to new exploration, production, and technology frontiers;
- equipment integrity and equipment failure;
- congressional and other external reviews and reports (until the Macondo blowout, these reviews and reports focused almost exclusively on royalty collections and not on safety issues); and
- international oil and gas regulators' forum discussions.

Through participation by MMS specialists in the API consensus standard-setting process, MMS gained some understanding of safety issues and options for addressing them.[26]

Risk assessment, planning, and safety criteria.[27] The National Research Council (NRC) defines risk assessment as a process that involves hazard identification, hazard characterization or dose-response assessment, exposure assessment, and risk characterization.[28]

The planning and regulatory context for offshore (especially deepwater) oil and gas exploration and production involves both workplace safety hazards and the possibility that oil spills will occur, including spills of sufficient scale to damage marine and coastal environments and human communities. Assessing and managing these risks are central responsibilities of MMS (and its successor bureaus). This risk management occurs in two main clusters of activity: (1) the planning and leasing process; and (2) the regulatory process for establishing safety and environmental regulations.

Risk management in planning and leasing process. Through its planning process, MMS (BOEMRE) identifies areas eligible for oil and gas leasing in five-year leasing plans and then undertakes planning for annual leasing. In both of these stages, MMS (BOEMRE) conducts full environmental impact statement analyses. These analyses must include an evaluation of potential environmental, social,

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[26] Danenberger, telephone interview, August 30, 2010.

[27] This discussion of risk is extracted from L. Scarlett, I. Linkov, and C. Kousky, "Risk-Management Cross-Agency Comparisons with the Minerals Management Service," Draft, November 15, 2010.

[28] National Research Council, *Risk Assessment in the Federal Government: Managing the Process*. Washington: National Academy Press, 1983.

and economic impacts. An OCS lease sale can involve "anywhere from 100 to 500 nine-square-mile tracts which have been identified as possible production areas by interested oil companies. Also at issue are as many as 20 or 30 specific resources which have been identified … as vulnerable to oil spills on the basis of research and communication with local authorities."[29]

Because of the uncertain nature of whether, when, and where an oil spill might occur and how significant it might be, the agency uses risk models. In the 1970s, as offshore oil and gas activity increased, the U.S. Geological Survey developed an Oil Spill Risk Assessment (OSRA) model to estimate probabilities of an oil spill and oil spill contact with important resources.[30] MMS notes,

> [T]he occurrence of oil spills is fundamentally a matter of probability. There is no certainty regarding the amount of oil that would be produced, or the size or likelihood of a spill that would occur during the estimated life of a given lease. Nor can the winds and ocean currents that transport oil spills be known for certain. A probabilistic event such as an oil-spill occurrence or oil-spill contact to an environmentally sensitive area cannot be predicted, only an estimate of its likelihood (its probability) can be quantified.[31]

The model that MMS (BOEMRE) uses to assess risk has three basic components: (1) estimates of the probability that a spill will occur; (2) simulated trajectories of spills to critical environmental resources; and (3) combined results of the first two elements to estimate the risk from potential oil development.[32] The model uses historical records of oil spills, ocean currents, and wind patterns and has been refined over the years, with periodic efforts to validate it by assessing its projections against actual spills. In essence, the model simulates thousands of spills at different locations of possible drilling and along pipeline and tanker routes. The model then plots the spill trajectory, calculating those trajectories over time and for different spill volumes.

In addition to its use in NEPA EISs, the OSRA model is used in environmental assessments (EAs), oil spill response plans, environmental reports completed by companies,

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[29] R.A. Smith, J.R. Slack, T. Wyant, and K.J. Lanfear, "The Oil Spill Risk Analysis Model of the U.S. Geological Survey," Geological Survey Professional Paper 1227, U.S. Government Printing Office, Washington, DC, 1982, 1.
[30] Ji, 2004, op. cit.

[31] Z.-G. Ji, W.R. Johnson, C.F. Marshall, and E.M. Lear, "Oil-Spill Risk Analysis: Contingency Planning Statistics for Gulf of Mexico OCS Activities," U.S. Department of the Interior, Minerals Management Service, April 2004.
[32] Z .-G. Ji et al., "Deepwater Oil-Spill Modeling for Assessing Environmental Impacts," in *Coastal Environment V: Incorporating Oil Spill Studies,* C.A. Brebbia et al., eds., WIT Press, Villacampa, Southampton, UK, 2004, 349–358.

biological opinions for ESA consultations, and other federal agency reports.[33] Any concerns about the model and its assumptions thus propagate through almost all oil spill analyses.

To estimate the probability of an oil spill occurrence, MMS (BOEMRE) maintains data on oil spills. Estimates are normalized by volume of oil handled and modeled as a Poisson process using historical data.[34] A Poisson process assumes that the number of spills in any time interval is not dependent on the number in a preceding interval. This assumption may, however, be incorrect if technological or regulatory changes cumulate, affecting spill probabilities. Moreover, each time interval must be stationary. A review of relevant data showed a decrease in spills over a certain time period, and intervals of relative stationarity were identified.[35] Smith et al. note that "while some of the uncertainty [in estimating oil spill risks) reflects incomplete or imperfect data, considerable uncertainty is simply inherent in the problem."[36]

Modeling of oil spill occurrences is challenging. Though small (less than 100 gallons) spills are common, high-volume, high-consequence spills are extremely infrequent. The paucity of observations of big events makes estimations using data problematic. Nonetheless, even though no platform spill of the magnitude of the Macondo blowout had occurred in the Gulf, the probability of such an occurrence was not zero. Moreover, oil spill data are "fat tailed": that is, spills greater than 1,000 barrels account for just 0.05 percent of spills but 79 percent of the total volume spilled.[37] In this sort of distribution, average spill probabilities have little use, yet they have been routinely used in risk assessments.

The OSRA model has been subject to various technical and analytical critiques. Such critiques are important for improving offshore oil and gas management both by companies and by regulatory agencies. However, for purposes of understanding risk management in the offshore oil and gas context, our focus here is on three broader institutional and decisionmaking issues: (1) what formal, regular, and transparent processes exist to periodically review, validate, and improve risk models used by the agency and industry; (2) how information is generated by models used to inform decisionmaking, including decisions about risk mitigation; and (3) what standards, if any, are used as the benchmark or goal for managing and mitigating risk.

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[33] Ji et al. 2004.

[34] K.J. Lanfear and D.E. Amstutz, "A Reexamination of Occurrence Rates for Accidental Oil Spill on the U.S. Outer Continental Shelf," Oil Spill Conference, American Petroleum Institute, Washington, DC 1983, 355–59; see also C.M. Anderson and R.P. LaBelle, "Update of Comparative Occurrence Rates for Offshore Oil Spills," *Spill Science & Technology Bulletin* 6(5/6) (2000): 303–21.

[35] Anderson and LaBelle, 2000.

[36] Smith et al., 1982, 2.

[37] Anderson and LaBelle, 2000.

The model has undergone numerous upgrades and periodic efforts to validate projections of spill trajectories and thus potential impacts from a spill.[38] Such efforts have been both regular and transparent. In 2003, MMS used satellite-tracked drifters to assess the efficacy of the model. Model enhancements occurred in 2004. The broader question is whether the model framework, which uses historical data to generate probabilities of a spill, is appropriate for managing offshore and coastal resources.

Concern has persisted in how the model is used to inform decisionmaking. In its comments on the 2010–2015 OCS draft five-year plan, for example, the National Oceanic and Atmospheric Administration recommended that "future project-specific NEPA documents should fully evaluate the potential impacts of worst-case scenarios, such as a spill event during the summer salmon fisheries or winter crab fisheries."[39] Because the model projected the probability of a high-consequence spill as extremely low, FWS determined that risk of harm to ESA-listed species associated with several deepwater oil and gas projects was so low that formal consultation under the act was not required. In effect, the initial estimate of extremely low probability of a spill has cascading effects on decisionmaking of resource managers. For the Macondo well, the risk model generated estimates of 4,600 barrels as the most likely size of a large spill and no more than 26,000 barrels of oil spilled over the entire 40-year life of production activity on six leases, including the Macondo well site.[40] These estimates resulted in an environmental assessment determination of "no significant impact" from the project.

One challenge of using a risk-based approach to analyze offshore risks is precisely this cascading effect. If a risk has very low probability (but potentially catastrophic consequences), the probability of adverse impacts may be deemed so low that they are not considered in planning and resource management processes. An alternative approach is hazard-based analysis of risk, which "examines possible events regardless of their low (or high) likelihood. For example, a potential impact would not lose significance because the risk has been reduced due to an increase in the level of control, such as engineering standards."[41] In its 2004 oil spill risk analysis, MMS used a hazards-based assessment to attempt to better understand the

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[38] See Smith et al. 1982; Ji et al. 2004; Lanfear and Amstutz, 1979.

[39] U.S. Department of Commerce, National Oceanic and Atmospheric Administration, "Comments on the U.S. Department of the Interior/Minerals Management Service Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program for 2010–2015," NOAA, Washington, DC, 2009.

[40] See http://energycommerce.house.gov/documents/20100719/Supplemental .Memo.Deepwater.07.19.2010.pdf.

[41] Z.-G. Ji et al., "Oil-Spill Risk Analysis: Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales, Central Planning Area and Western Planning Area, 2003–2007, and Gulfwide OCS Program, 2003–2042," U.S. Department of the Interior, Minerals Management Service, June 2002.

consequences of a spill. It is not clear, however, how this information was used in subsequent planning or ESA consultation documents.

How risk modeling and associated risk estimates are used raises an important issue. Even if the model is useful for estimating probabilities of a spill and projecting the likelihood that it will cause damage, a larger decisionmaking issue looms: how safe is safe enough? Risk models themselves do not establish what constitutes "acceptable" or "tolerable" risk. Acceptable risk can be defined in various ways, such as when the risk falls below a certain probability or falls below some already tolerated risk level, or when the benefits of reducing a risk exceed the costs.[42] A central challenge in determining safety policy is whether to set a quantitative risk standard and whether and how to use quantitative risk analysis.

Risk management in setting standards. This aspect of risk management applies both to the offshore planning process and to the regulatory processes for establishing safety and environmental regulations. According to former MMS officials, the agency looks at both quantitative and qualitative risk assessment but generally has favored qualitative approaches.

For many years, MMS required at least qualitative risk assessments for deepwater production facilities in accordance with API Recommended Practice 14j. In addition, API Recommended Practice 14c sets forth procedures for "failure analysis" for all production facilities. Such procedures, used for production facilities, have not been used for analyzing deepwater drilling. Instead, deepwater drilling reviews have traditionally been conducted by a single engineer to assess compliance with prescriptive rules rather than to provide any risk assessment.

The rationale for qualitative assessments relates, in part, to data quality. With poor data quality, quantitative assessments can be subject to significant manipulation. One MMS former manager notes that such manipulation occurred in the early years of using "safety cases" in the United Kingdom and elsewhere. For example, one risk assessment for a subsea gas project off Australia concluded, based on "failure data" and "consequence assessments," that use of subsurface safety valves was not necessary. According to a reviewer of that risk assessment, the operator's real concern was the cost of installing and maintaining these devices. However, it was difficult for the regulator to refute the data used in the assessment.

In one quantitative risk assessment comparing deepwater production systems, two of the five recommendations pertain to data. The report's second recommendation states,

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[42] P.R. Hunter and L. Fewtrell, "Acceptable Risk," in *Water Quality: Guidelines, Standards, and Health,* L. Fewtrell and J. Bartram (eds.), IWA Publishing, London, 2001.

> [T]he quality of existing data sets for the Gulf of Mexico should be improved so that they are of greater value in future risk analyses. First, the type and quality of data that are currently collected should be evaluated, and any changes recommended from this evaluation should be implemented in a timely manner. Second, single agencies should be responsible for tracking and compiling similar types of data. Third, all data records should be reviewed annually by the industry and regulators to improve the clarity, quality and usefulness of the information in these records. Finally, the data should be published annually in a clear and an easily accessible format.[43]

The report's third recommendation states,

> Additional information about the populations of offshore facilities and operations in the Gulf of Mexico should be collected on an annual basis. Specifically, the following information from federal and state waters in the Gulf of Mexico would be valuable: the length of active pipelines operating per year, the number of tanker on-loading and off-loading events in ports and lightering zones per year, and the number of man-hours in production-related activities, supply vessel operations and tanker operations per year.[44]

Nonetheless, both industry and MMS have, on occasion, strived to quantify risks and use quantified comparative risk assessments to evaluate equipment and procedures. For example, a 2006 study prepared for MMS assessed surface versus subsurface blowout preventers (BOPs) on mobile offshore drilling units and provided both quantitative and qualitative comparisons.[45] An earlier 2001 study prepared for MMS provided a quantitative risk analysis to assess and compare oil spill and fatality risks for four representative deepwater production systems in the Gulf of Mexico.[46]

Risk assessment framework. The questions of how safe is safe enough and whether and how to quantify, evaluate, or assess risk are recurrent themes among federal regulatory agencies. OMB, drawing on discussions of a multiagency Regulatory Working Group, set forth principles

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[43] R.B. Gilbert, E.G. Ward, and A. Wolford, "Comparative Risk Analysis for Deepwater Production Systems: Final Project Report for the Minerals Management Service," prepared by Offshore Technology Research Center, January 2001, v.

[44] Ibid.

[45] J. Melendez, J.J. Schubert, and M. Amani, "Risk Assessment of Surface vs. Subsurface BOPs on Mobile Offshore Drilling Units: Final Project Report," prepared for Minerals Management Service Project No. 540, August 2006.

[46] Gilbert et al. 2001.

for risk analysis in January 1995.[47] The principles were described as "aspirational rather than prescriptive." Agencies were not mandated to follow the principles but instead invited to apply them flexibly, using practical judgment. The cover memorandum accompanying the principles noted, "The science of risk assessment is rapidly changing and its use is a function of a number of factors—including legal mandates and available resources—that vary from one regulatory program to another. We therefore do not offer these principles as conclusive, complete or irrevocable."

The 1995 general principles noted the importance of distinguishing between risk identification and risk management policies. Other principles pertained to transparency of assumptions and analysis, peer review, consistency, distribution of risks, benefits, and costs, and policy criteria. In September 2007, the risk analysis principles were updated by OMB in a new memorandum.[48] The new memorandum retained the basic concepts of the 1995 memo but cast them as requirements to follow in risk management, consistent with the agencies' authorities and statutes, rather than as aspirational.

The Department of the Interior participated in the 1995 Regulatory Working Group and commented on the 2007 updating of the risk principles. Neither the 1995 principles nor the 2007 update appears to have prompted significant internal MMS review of its risk analysis and risk management.[49] However, because its risk model was developed by the U.S. Geological Survey, the model, its assumptions, and its use of data largely met the requirements of those principles.

The more central issue in MMS's risk management centers less on the model per se and more on is how risk information was used and whether a clear, quantitative safety goal would provide greater transparency in its decisionmaking in both planning and setting standards. The Environmental Protection Agency, Federal Aviation Administration, Food and Drug Administration, and Nuclear Regulatory Commission all have established numerical risk thresholds or ranges of tolerable risk. Although numerical thresholds are not essential to risk management, they provide a transparent goal against which to benchmark practices, equipment, standards, and facilities. Risk analyses can still be compromised by inadequate data and use of assumptions that render quantitative risk assessments subject to critique. Nevertheless, quantitative goals have the advantage of better enabling independent reviewers to evaluate whether a particular standard is likely to meet the specified safety threshold.

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[47] S. Katzen, "Memorandum for Regulatory Working Group," Executive Office of the President, Office of Management and Budget, January 12, 1995.

[48] S.E. Dudley and S.L. Hays, "Memorandum for the Heads of Executive Departments and Agencies M-07-24; Subject: Updated Principles for Risk Analysis," Executive Office of the President, Office of Management and Budget, September 19, 2007.

[49] Interview with W. Cruickshank, Deputy Director, BOEMRE, September 21, 2010.

Role of Costs. Some environmental statutes include specific prohibitions against considering costs in setting standards. The laws governing MMS (BOEMRE) do not include such provisions. In the API consensus standards process, costs and other commercial issues are not explicitly considered. However, because the process bases many standards on proven technologies and practices, cost is implicitly a consideration.

Best Practices. Offshore oil and gas exploration and production are evolving, with new development frontiers, materials, processes, and equipment emerging on an ongoing basis. The voluntary consensus standard-setting process, by convening energy companies, equipment manufacturers, regulators, and others, can enhance awareness of best practices and improved technologies. MMS participates in API standard-setting committees, giving agency officials access to information about these innovations. However, MMS also systematically contracted with outside engineering and other experts to review emergent technologies and undertake comparative risk assessments. In some instances, the outcome of these analyses resulted in MMS's opting for new regulations or, in its adoption of API standards, the agency made some modifications to those standards.

Voluntary Consensus Standards Process. Offshore energy exploration and production activities include a combination of technical standards for equipment and procedural requirements regarding operations and workplace safety. Standard setting varies along three dimensions.

- Type of regulation. The regulations range from prescriptive technological requirements to performance standards (in which levels of safety or other qualitative or quantitative measures are established and regulated entities then determine implementation).
- Process by which regulations are established. Whether the standards are performance based or prescriptive, the process can range from agency initiation to consensus procedures that involve technical experts from the regulated industry, other interested parties, and the regulatory agency (or agencies).
- Approach to regulatory compliance. Measures to assess compliance range from traditional agency inspections, used to assess presence of required equipment and procedures, to a proactive and risk-based approaches that make the operator accountable for ensuring overall safety and risk reduction by identifying hazards and risks, developing mitigation strategies and control measures, and demonstrating that the overall system meets the standards.

MMS (and BOEMRE) have relied on a combination of performance-based and prescriptive standards. MMS also used a mix of voluntary consensus standards and standards developed directly by the agency. The National Technical Transfer and Advancement Act

(Public Law 104-113, March 7, 1996) requires government agencies to use industry standards when available and when they meet the performance needs of the agencies. The act requires that agencies participate in the development of these standards. Consistent with this act, many offshore energy exploration and production technical standards are developed through a consensus process managed by a standard-setting group within the American Petroleum Institute.

API is accredited by the American National Standards Institute (ANSI), a private, nonprofit organization "that oversees development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States."[50] ANSI accredits more than 200 organizations as voluntary, consensus standard-setting organizations, with API serving as the lead organization in setting many oil and gas technical and process standards. Other standard-setting organizations, such as the America Society for Testing and Materials, develop some relevant standards, such as those pertaining to fuel.

API serves both as the petroleum industry's ANSI-certified voluntary standard-setting organization and, through separate activities, as its trade association and lobbying entity. A review of 50 organizations on ANSI's list of accredited standards organizations shows that this dual role is not uncommon. Of 50 standard-setting organizations reviewed, nearly half also have some form of government relations apparatus. Many, like API, are industry trade associations.

Accreditation as a voluntary standard-setting organization under ANSI requires adherence to various criteria, such as requirements that the standard-setting process be open to all interested parties, that non-API parties be eligible to participate, and that certain rules of voting and transparency be followed. Consensus does not require unanimity. Rather, consensus in API proceedings is defined as a two-thirds majority vote with two-thirds of eligible voters actually voting.

API's standards relating to drilling for oil and natural gas and production of these resources fall into two categories—equipment specifications and recommended practices. In addition, API's standard-setting body issues technical reports on research and other information. API standards are used voluntarily by industry except in cases where MMS incorporated the standard by reference into regulations. In addition, some companies supplement use of these standards with their own internal practices and procedures.

[50] See Wikipedia at http://en.wikipedia.org/wiki/National_Technology_and_Advancement_Act (accessed September 20, 2010).

Voluntary Consensus Standards

The National Technology Transfer and Advancement Act of 1995 (NTTAA) directs agencies to use voluntary consensus standards in place of government-unique standards in agency procurement and regulatory activities, except where inconsistent with law or otherwise impractical. The basic goals of the NTTAA include: (1) eliminating the cost to the government of developing government-unique standards, (2) providing incentives and opportunities to establish standards that serve national needs, and (3) encouraging long-term growth and promoting efficiency and economic competition through the harmonization of standards. Since the adoption of the NTTAA in 1996, it has been the policy of the U.S. government to use voluntary consensus standards as the basis for regulatory standards unless the regulating agency finds that it is inconsistent with law or otherwise impractical to do so. OMB Circular A-119 defines a voluntary consensus standards body as one having the following attributes: (1) openness, (2) balance of interest, (3) due process, (4) an appeals process, and (5) consensus (defined as general agreement, but does not require unanimity).

Under the NTTAA, agencies are required to provide an annual report to the National Institute of Standards and Technology (NIST) on the decisions by the agency to use government-unique standards in place of a voluntary consensus standard. In addition, Circular A-119 requires agencies to publish a request for comment as part of the Notice of Proposed Rulemaking on the proposed use of voluntary consensus standards, an explanation for the use of a proposed government-unique standard where a voluntary consensus standard exists, and an invitation for comment to identify a voluntary consensus standard where no such standard has been identified by the agency. In the final rule, the agency must summarize its discussion from the NPRM, provide a discussion of any comments received, and explain the agency's final decision.

Of approximately 262 specifications, recommended procedures, and bulletins in API's exploration and production list, 29 are included in whole or in part by reference in MMS's regulations. These cover such issues as design requirements of risers for floating production systems; specifications for wellhead equipment; specifications for subsurface safety valve equipment; verification tests of wellhead surface safety valves and underwater safety valves for offshore service; installation, maintenance, and repair requirements for surface and underwater safety valves; practices for design and hazards analysis for offshore production facilities; and recommended practices for blowout prevention equipment. In certain instances, MMS excluded part of an API standard or included additional requirements. Consider the following examples:

- API RP 53, Blowout Prevention Equipment Systems. Operators are required to follow only Sections 13.3, 17.10, 17.11, 17.12, 18.10, 18.11, and 18.12, which are incorporated into 30 CFR 250.442 and 250.446.

- API 14G, Fire Prevention and Control. MMS regulations included only Section 5.2, which addresses water pumps.
- API RP 90. MMS included the entire document by reference but added requirements, at 30 CFR 250.519–530.
- API Spec 14A. MMS included the entire document by reference but added requirements, at 30 CFR 250.806–807.[51]

API seeks balance on its standard-setting committees, striving for one-third of participants to be owners or operators, a third to be equipment manufacturers, and a third to represent general interests. The last category includes individuals from 10 government agencies, three national labs, academia, and other organizations.[52]

MMS (BOEMRE) provides technical specialists, such as production engineers, drilling engineers, and structural engineers, as participants in the API voluntary consensus standard-setting committees and processes. MMS officials note that they had insufficient personnel to participate in every standard-setting committee. Consequently, the agency tracks the activities of various API standard-setting committees and assigns MMS personnel to participate in those deemed significant.[53] Generally, to preserve their federal rulemaking independence, MMS participants did not actually vote on final standards.[54]

Participation in the standard-setting committees, according to MMS officials, helped MMS understand whether any particular proposed standard presented problems and become familiar with debates about performance or other issues. MMS took these issues into account when determining whether to adopt a voluntary consensus standard or develop its own standard. For example, in discussions regarding standards for subsurface safety values (which operate at high temperatures and high pressures), some participants argued for a lower safety factor because the equipment was difficult to design and develop. MMS, however, was not comfortable with this proposal and required, instead, a case-by-case review of the equipment.[55]

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[51] Email communication from W. Cruickshank, Deputy Director, BOEMRE, September 11, 2010.

[52] American Petroleum Institute, meeting with authors, August 27, 2010.

[53] Danenberger, personal communication, August 28, 2010.

[54] Danenberger, personal communication, August 28, 2010; Walter Cruickshank, personal communication, September 11, 2010.

[55] Ibid.

In 2000, WEST Engineering Services conducted an "Evaluation of the Suitability of Industry Standards as MMS Requirements."[56] The report compared API's recommended practices and the International Association of Drilling Contractors' deepwater guidelines with MMS requirements for safety and environmental performance.[57] In addition, the report surveyed 20 Gulf of Mexico rigs to assess compliance with recommended items or standards identified in the first task of the report. The WEST report found a high level of compliance with recommended practices but observed that in some cases operators either were not familiar with or did not fully understand the importance of certain safety procedures.[58]

In interviews, industry participants indicate that the consensus process has some element of compromise and inconsistent goals. Some goals, for example, are perceived as minimum standards; others "reach for the top." Some firms have pressed to make the voluntary standards "best practices." For example, in development of API Recommended Practice 6, on wellheads, some participants pressed to develop high standards that were risk-based, with performance tied to environmental conditions, pressure, and other factors: depending on risk conditions, control requirements would vary. Some participants in the consensus process believe that choices are influenced by who participates. Another observation is that major issues, according to some participants, receive greater attention and more emphasis on "best practices" standards.

Both MMS (BOEMRE) participants and industry participants view the agency's role as significant and reasonably effective. For example, MMS raised the issue of safety valves and cooperated through the API process to draw attention to it. The result was a new standard on control systems for safety values that requires proof testing and third-party verification of equipment. The independent testing was conducted by Southwest Research, which still offers testing services. According to several industry technical experts, independent testing is not often required, even though many standards require demonstration that the equipment performs according to API standards or specifications. Generally, MMS leaves it up to operators or purchasers to decide on how to assess whether certain equipment meets required specifications.

Performance-Based Approach. Though offshore performance for four decades was relatively good in terms of environmental releases, in the late 1990s MMS took up two conceptual issues regarding safety. First was whether and how to use a performance-based approach to safety regulations rather than a prescriptive approach. Second was how to shift more responsibility and accountability to companies for their safety and environmental performance.

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[56] West Engineering, "Evaluation of the Suitability of Industry Standards as MMS Requirements," Minerals Management Service Project 01-9-PO-17072, October 16, 2000.

[57] Ibid., 1.

[58] Ibid.

Increasingly, across many industry sectors, including oil and gas, regulatory frameworks are moving toward performance standards. The Petroleum Safety Authority Norway notes that the transition in Norway began in the late 1970s. Two disasters, a blowout in 1977 and the overturning of a mobile rig in 1980 that killed 123 people, led to performance rules that emphasized companies' responsibility to meet stated levels of safety. Norway now uses primarily performance-based standards, with some supplemental prescriptive requirements.[59]

As described in a report delineating differences between U.S. and Norwegian approaches to offshore regulation, performance-based regulations involve:

> specifying the performance or function which is to be attained or maintained by the industry. The regulatory role here involves defining the safety standards which companies must meet and checking that they have the management systems which permit such compliance. Through a performance-based regulation, the companies are given a relatively high degree of freedom in selecting good solutions which fulfill the official requirements.[60]

The performance approach emphasizes clear safety standards, audits, verification, investigations, and significant interaction between industry and the regulator to undertake joint safety studies and develop regulations.

In a prescriptive system, laws and regulations set specific structural, technical (engineering and equipment) and procedural requirements as the basis for minimizing environmental, health, and safety hazards. Compliance is achieved by installing specified structures and equipment, adhering to specified types of training, and following specified procedures. Regulatory codes for offshore oil and gas activity in the United States are listed in Table 9.

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[59] Det Norske Veritas, "Summary of differences between offshore drilling regulations in Norway and U.S. Gulf of Mexico," Report for Oljeindustriends Landsforening/Norsk Oljenvernforening For Operatorselskap, DNV Re. No. 12P3WF5-9, August 27, 2010, 2.
[60] Ibid.

Table 9. Primary Federal Regulatory Codes for Federal Offshore Oil and Gas Activities

Code of Federal Regulations	*Authority (Agency)*	*Departmental Head*	*Authorizing Legislation*
30 CFR 250 "Oil and gas..in the OCS"	Minerals Management Service (BOEMRE)	Secretary of the Interior	Outer Continental Shelf Lands Act
33 CFR 140-147 "Outer Continental Shelf Activities"	U.S. Coast Guard	Secretary of Homeland Security	Outer Continental Shelf Lands Act
46 CFR "Shipping"	U.S. Coast Guard	Secretary of Homeland Security	Homeland Security Act
40 CFR "Protection of the Environment"	Environmental Protection Agency, other	EPA administrator, other	Comprehensive Liability, Response, and Compensation Act; Oil Pollution Act

The prescriptive approach as applied to offshore oil and gas activities presents at least three challenges: (1) prescribed regulations may lag behind development of new, safer equipment and procedures; (2) prescriptions may not cover all relevant behavioral and other actions that result in safe performance; and (3) regulators shoulder the primary responsibility for inspecting facilities and affirming that they are safe.

For more than a decade, MMS participated in international and domestic discussions about how to enhance offshore regulations and develop a stronger performance rather than exclusively prescriptive focus. In 2000, through a new training rule, training requirements shifted away from prescribing required courses and hours of training to regulations requiring that workers demonstrate ability to perform certain skills.[61] In MMS interviews with 710 employee contractors conducted in 2007–2008, after the rule had been in effect for six years, the agency received 2 unfavorable and 14 poor ratings.[62] The agency also conducted 30 formal audits resulting in issuance of 30 citations for incidents of noncompliance.[63] Using these results, MMS clarified training requirements on March 31, 2008, to better specify (1) what contractors were covered by the rules; (2) the required frequency of training; (3) the required frequency of assessment and skill verification; and (4) the definition of production safety. Related to this growing interest in performance regulations was the discussion of how to shift more responsibility and accountability to companies for their safety and environmental performance. This discussion mirrored developments by other nations engaged in regulating offshore activities.

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[61] 30 CFR Part 250, Training of Lessee and Contractor Employees Engaged in Oil and Gas and Sulphur Operations in the Outer Continental Shelf (OCS), Final Rule, February 5, 1997.

[62] See http://www.boemre.gov/lesseetraining/ (accessed November 11, 2010).

[63] Ibid.

Though the details of their approaches differ, Norway and the United Kingdom both use a regulatory framework that places overall responsibility on the operator "to ensure a safe and prudent operation of the entire [set of] petroleum activities in line with regulations."[64] The approach, as described in a 2010 Norwegian report comparing its practices with those of MMS, "requires an active approach where the company needs to identify its own need for control based on relevant identified risks, and establish systematic and control measures to ensure compliance with those regulations."[65] The United Kingdom requires operators to develop a "safety case."

Sometimes described (somewhat misleadingly) as "self-regulation," the approach places responsibility on the operator (and contractor) to identify risks and hazards; develop controls, mitigation strategies, and systems to reduce risks to defined acceptance levels; and use identified risks as the basis for prioritizing decisionmaking.[66] The 2010 Norwegian report describes a risk-based system as one in which regulations are related to specific risks faced by a company or operator: "safety and contingency measures must be commensurate with the risk in each individual activity. The higher the risk, the more effort is required and the more wide-ranging measures must be implemented."[67] The approach is similar to that of the United Kingdom, which requires that each operator develop a "safety case" that identifies risks on an integrated, system-wide basis, including both technical and procedural (human behavior) issues and describes how the operator will address risks and achieve specified safety levels. For both Norway and the United Kingdom, risk assessment is a legislative requirement for all new and existing installations.

Although it has not been a U.S. regulatory requirement, some companies that operate in U.S. offshore waters use a safety case approach, comprising several practices. First, some firms use outside reviewers to examine their risk registries or hazards identification and associated control mechanisms to reduce risks. Second, some establish more stringent criteria for equipment design. Shell Oil, for example, uses a 1,000-year storm event to assess extension leg platforms, rather than a more typical 100-year storm event criterion.[68] Third, some firms verify equipment performance in their own labs rather than relying on manufacturer testing and certification.

A central question for MMS (BOEMRE), as a regulatory agency, is how to stimulate these kinds of best practices across all industry participants. In its 2009 proposed regulations on Safety and Environmental Management Systems, MMS notes that it cannot adequately ensure safety through inspections alone. Particularly in deepwater operations, direct inspections are not possible, and the agency

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64 Det Norske Veritas, 12.

65 Ibid., 16.

66 Ibid.

67 Ibid., 18.

68 Interview with C. Williams and K. Satterlee,, Shell Oil Company, October 4, 2010.

must rely on reviews of logs and monitored information. Moreover, even with expanded numbers of inspectors, the thousands of well sites, large number of components, and thousands of workers involved in offshore operations make primary reliance on inspections and traditional assessment of compliance with prescribed techniques and processes inadequate to ensure safety. There are simply not enough inspectors to be everywhere all at once and all the time. These observations have led MMS, the industry, and other nations to seek other ways to enhance safety practices and better reinforce self-regulation and stronger development of safety cultures within firms.

Safety and Environmental Management Programs. In the 1990s, MMS began moving toward a more performance-based regulatory approach, emphasizing industry adoption of environmental and safety management systems and industry accountability for its safety systems and safety performance. As early as 1991, MMS "introduced the concept of a Safety and Environmental Management Program (SEMP) with the goal of having operators in the offshore industry voluntarily adopt an active safety and environmental management approach in conducting operations."[69]

In response to this focus, API developed Recommended Practice 75, pertaining to Safety and Environmental Management Systems, which includes 12 elements:[70]

- safety and environmental information;
- hazards analysis;
- management of change;
- operating procedures;
- safe work practices;
- training;
- assurance of quality and mechanical integrity of critical equipment;
- pre-startup review;
- emergency response and control;
- investigation of incidents;
- audit of safety and environmental management program elements; and

[69] 30 CFR Part 250, "Oil and Gas and Sulphur in the Outer Continental Shelf—Safety and Environmental Management Systems," Federal Register 71(98), May 22, 2006, 29277.

[70] Ibid.

- documentation and recordkeeping.

After API Recommended Practice 75 was written, MMS worked with the offshore industry to develop a prototype Safety and Environmental Management Program and protocols for performance auditing. From 1994 through 1998, MMS monitored the industry's voluntary implementation of these systems to gauge the degree of adoption. In addition, MMS held annual performance reviews with operators to examine compliance history, reviewing results of MMS inspections, actions under civil penalty review, and actions that resulted in civil penalties. More than half of incidents reviewed pertained to behavioral issues associated with operating procedures and management of change. Results of these reviews and other industry discussions led to a rewriting of API Recommended Practice 75 "to incorporate concepts from the International Organization for Standardization (ISO) 14001—Environmental Management Systems."[71]

In 2006, MMS put forth an advance notice of a proposed rulemaking in which it announced an objective of improving the regulatory system and industry performance by mandating that operators use an integrated system for environmental management and performance. The announcement, and eventual proposed rule issued in June 2009, focused on 4 of the 12 elements of API Recommended Practice 75: hazards analysis, operating procedures, mechanical integrity, and management of change.

MMS focused on those four elements after reviewing panel investigation reports of incidents, analyzing incidents, and analyzing noncompliance (Table 10). These reviews showed the major performance weaknesses and causes contributing to accidents. In addition, analysis of accidents identified six contributing causes: (1) lack of communication between operator and contractor(s); (2) lack of understanding of job hazards analysis prior to beginning work or lack of hazards analysis written procedures; (3) onsite supervision not enforcing existing procedures or practices; (4) lack of written safe work procedural guidelines; (5) integrity of facilities and equipment not maintained according to recommended practices; and (6) workplace hazards not identified and corrected.[72] As in the incident panel reviews, three of these six issues related directly to workplace behavior; the other three at least indirectly also related to behavioral issues and practices. In a review of 310 incidents that occurred in OCS waters in 2003 and 2004, with 13 fatalities and 97 injuries, the majority involved at least one of the four elements MMS targeted in its proposed rulemaking on Safety and Environmental Programs.

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[71] Federal Register, May 22, 2006, 29278.
[72] Federal Register (71), May 22, 2006, 29279.

Table 10. Contributing Causes of Injuries and Fatalities

MMS Report	*Hazard Analysis*	*Operating Procedures*	*Mechanical Integrity*	*Management of Change*	*Injuries*	*Fatalities*
2005-027		X	X	X		
2005-007		X	X			
2004-078	X	X		X		1
2004-075	X	X	X			
2004-048						
2004-046	X	X		X	3	
2004-004	X					1
2003-068		X				
2003-046		X		X		
2003-023						
2002-076	X		X			1
2002-075	X			X		1
2002-062				X	2	1
2002-059	X		X	X	1	1
2002-040			X			
2001-084				X		
2001-045		X	X			1
2001-042	X		X	X		1
2001-010	X			X	1	
2001-009		X		X		
2001-005	X			X		
2000-089	X		X			1

The 2006 advance notice of proposed rulemaking and subsequent 2009 proposed rulemaking are illuminating. MMS notes in these documents that it issued hundreds of incident reports annually and that it perceived "no discernible trend of improvement by industry over the past 5 years. The number of notices of incidents issued concerning maintenance of pollution inspection records have continually increased from 2000–2005."[73] MMS concludes in the advance notice that "our current approach to environmental protection does not allow us to ascertain the level of industry compliance with all applicable environmental laws, regulations, and lease stipulations. We believe that industry's SEMS plan should contain processes and protocols for detailing their compliance with these requirements."[74] It was similar concerns that some years earlier had prompted Norway to shift to a performance-based environmental management approach.

The proposed SEMS rule issued in June 2009 included provisions requiring offshore operators to develop Safety and Environmental Management Systems consisting of the 4 elements identified earlier in the 2006 advance notice. Many comments on that advance notice

[73] Ibid.

[74] Ibid.

viewed the voluntary application of API Recommended Practice 75 as sufficient. Others commented on MMS's perceived lack of capacity to approve SEMS plans and argued for third-party certification. Some indicated that the 12 elements of Recommended Practice 75 were integrated parts of a total system and that requiring just 4 of the 12 could undermine fully integrated approaches to environmental and safety management. The rule, however, did not preclude use of all 12 elements; rather, the other 8 elements would remain part of any voluntary compliance with the recommended practice.

The proposed rule, addressing the issue of oversight, required that each lessee and operator have its SEMS audited at least every three years by an independent third party or by qualified personnel within the company. Under the proposed rule, MMS would provide additional oversight through periodic audits—announced or unannounced evaluations with MMS personnel and/or third parties. Poor performance was indicated as a potential trigger for an MMS evaluation of the SEMS.

In comments on the proposed rule, API stated support for the existing voluntary system. In the context of the Macondo well blowout, of particular note is that British Petroleum stated that it already had a system in place that included the four elements addressed in the new regulation and proposed revisions to the rule; its own system, it said, would give operators greater flexibility in administration, recordkeeping, and reporting requirements. BP also opposed requirements that equipment be maintained in conformity with manufacturers' requirements, stating instead that BP had adopted risk-based inspection and testing requirements.

On October 15, 2010, MMS issued the final SEMS rule, with one major change from the proposed rule: MMS incorporated by reference the entire API Recommended Practice 75, including the general procedures and 12 elements of the API Safety and Environmental Management System. The change occurred in part because many comments noted that the system needed to be viewed as an integrated whole.

International Practices: Information Exchanges. The offshore oil and gas industry operates in an international context. An International Regulators Forum periodically brings together MMS and regulators from other nations, along with the private sector, to evaluate technologies, regulatory practices, and related topics. In addition, the International Standardization Organization (ISO) develops some standards relevant to offshore oil and gas exploration and production. Around 70 percent of these ISO standards are the same as or equivalent to API standards. In many instances, the API standards are used as the base documents for establishing ISO standards, with modifications as appropriate to an international setting. In other areas, such as for LNG facilities, ISO plays the lead role in standards development.*Budget:* The MMS budget for revenue management and compliance (royalty collections) has grown much faster than either the budget for inspections or the budget for leasing and environment (Figures 10 and 11). In 1984 (the earliest year for which data are

available), the agency's budget for revenue management was 9 percent larger than the regulatory budget. By 2010 it was 48 percent larger, perhaps reflecting continual focus on the royalty program by congressional and other independent reviewers. The royalty program has been the subject of numerous criticisms by Interior's inspector general, Congress, the General Accountability Office, and other observers, even before it transitioned from USGS to the newly formed Minerals Management Service in 1982.

The size of the budget for revenue activity relative to regulatory activity grew steadily throughout the mid-80s, stabilized from about 1989 to 1994, and then grew again (Figures 10 and 11). The discrepancy between the two peaked in 1997, when the budget for revenue activities was more than twice that for regulatory activities. The gap then narrowed. Since 2005, the revenue management budget has been around 1.5 times the size of the regulatory budget. The budget for leasing and environment has fluctuated, too, but over time has more or less grown (in nominal terms) at a rate similar to the regulatory budget.

Additionally, the budget for oil spill research has actually shrunk by 22 percent in real dollars since oil spill research first appeared as a separate subactivity, in 1993.

Figure 10. Trends in MMS Budget Components, Nominal Dollars, 1984–2010

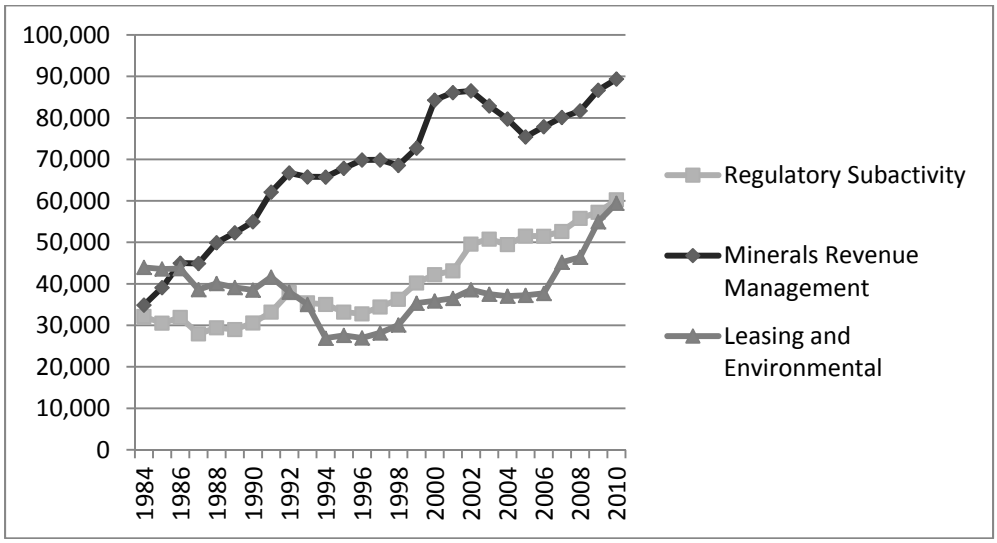
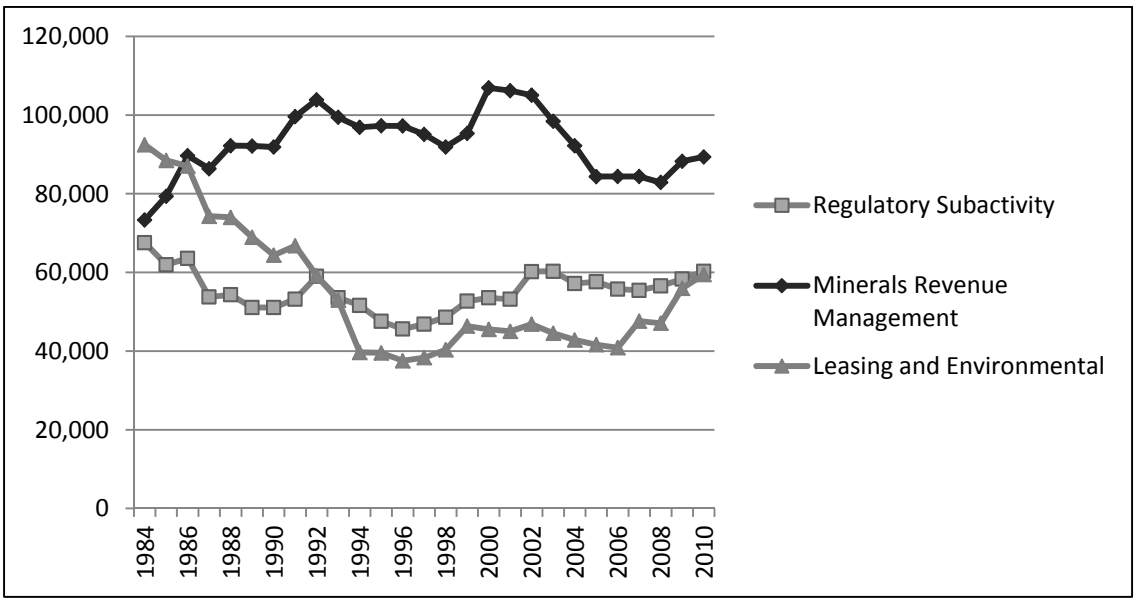


Figure 11. Trends in MMS Budget Components, 2010 Dollars, 1984–2010



Agency Structure and Capacity

Organization Structure. Structuring and coordinating the various activities associated with offshore oil and gas exploration and production have long been challenges for the Department of the Interior. Before 1982, when MMS was created, resource assessments, safety oversight, and royalty collection were handled by the U.S. Geological Survey. Leasing was handled by the Bureau of Land Management. Coordination problems prompted the temporary creation of a coordinating role in the Office of the Assistant Secretary for Policy, Management and Budget. Establishment of MMS was, in part, designed to overcome these coordination challenges, as well as to improve capacity for royalty assessment and collection. The newly created MMS was designed primarily along regional geographic lines, with vertical oversight provided between headquarters, regions, and districts. The structure had two effects: safety and leasing functions were combined under single supervisory authority, and safety and environmental personnel were pulled from district offices that handled day-to-day offshore permitting and review functions and placed, instead, at the regional level.

All organizational design structures involve trade-offs. Structuring along functional lines (e.g., safety, leasing, and royalty collections) can enhance focus on the individual functions and their independent requirements but present coordination challenges among interlinked activities. Throughout its existence, MMS faced some criticism that a functional organization structure would better ensure equal (and independent) focus on the three main areas. Notably, a major difference between U.S. and Norwegian management of offshore activities was in organization structures. In Norway, authorities for leasing and resource management are in one organization, and those for health, safety, and environmental are separate. With Secretary Salazar's Secretarial

Order 3299, U.S. offshore operations now resemble the Norwegian structure, in which safety and leasing operations are segregated into different organizations.

Peer Review and Analysis. MMS uses several organizations and processes to provide some outside advice, peer review, and assessment of its activities. However, MMS does not have regular and formal procedures for conducting peer review of its risk models, safety standards, and regulations. Advisory and review functions cluster into two main categories: use of advisory committees and contracting with outside academic or other experts to perform risk assessments and other reviews. In addition, MMS assembles incident panels to evaluate offshore accidents that result in fatalities or significant oil spills.

MMS (BOEMRE) maintains three advisory committees: the OCS Policy Committee, the OCS Scientific Committee, and the Royalty Policy Committee. All three committees are advisory and are not responsible for directly making or executing policy. Voting members of these committees are appointed by the secretary of the Interior. The committees also include *ex officio* nonvoting members (e.g., certain coastal state governors and heads of certain federal agencies participate on the policy committee, and BLM participates on the Royalty Policy Committee). Guidelines for selecting voting members appear in the committee charters, but these guidelines are not binding. The Policy Committee and Royalty Policy Committee include various stakeholders. The Policy Committee also is to have a representative from each state with offshore oil and gas leases, as well as representatives from other stakeholders, such as major oil producers, small oil companies, the environmental community, local government, and consumers. The Royalty Policy Committee is to have representatives from affected states, Native American groups, mineral and energy companies, and public interest groups. Criteria for members of the Science Committee concern scientific competence. The committees meet once or twice each year, receive informational presentations from MMS, and from time to time issue resolutions or recommendations to MMS.

Unlike EPA, MMS does not appear to have prescribed requirements for conducting peer review. The agency has contracted on numerous occasions with various academic experts and other consultants to undertake quantitative risk assessments of different technologies, review MMS regulations for adequacy, and other tasks. MMS conducts incident panels but manages these panels internally. The Outer Continental Shelf Lands Act requires MMS (BOEMRE) or the Coast Guard to investigate and report on all deaths, serious injuries, major fires, and major oil spills related to OCS exploration, development, and production.[75] Because of intersecting jurisdictions, in March 2009 MMS and the Coast Guard signed a memorandum of agreement

[75] See, for example, U.S.C. Section 1348 and implementing regulations at 33 CFR Section 140 and 30 CFR Section 250.189.

spelling out the circumstances under which each agency would take the lead in conducting an investigation.[76] Unlike FAA, for which the independent National Transportation Safety Board investigates airplane crashes and related safety incidents, both MMS and the Coast Guard undertake their own incident investigations.

Training Requirements and Practices. Industry analyst Paul Sonneman notes that "Serious well control problems in the field are more often the result of inappropriate human behavior than of any other single cause."[77] Of seven elements identified as contributing to the 2010 Macondo well disaster by the Deepwater Horizon Study Group at the Center for Catastrophic Risk Management, five can be considered "failures in administrative controls—Human and Organization Factor (HOF) malfunctions."[78] Administrative control failures include "deviation from standard operating procedures …, failure to follow accepted well completion procedures, failure to respond to trouble indicators, failure to maintain [emergency shutdown and disconnect] systems, and failure to fully test and activate the [blowout preventers]."[79]

Four years earlier, in its 2006 proposed rulemaking on Safety and Environmental Management Systems (SEMS), MMS's rationale seems to have anticipated these human failures. For that proposed rulemaking, MMS reviewed 310 OCS incidents (including fatalities, injuries, loss of well control, collisions, fires, pollution, and crane events) that occurred in 2003 and 2004. Of these incidents, 159, or more than half, involved failures to follow proper operating procedures; 13 involved poor management of change. Together, these failures accounted for 51 percent of the incidents reviewed.

Training and Performance Assessment. Although training alone cannot address those types of failure, workforce training, capacity, and competence of agency, contractor, and industry personnel contribute to the human factor in safety performance. MMS regulations require training of all personnel of the agency, lessees, operators, and contractors. Those requirements shifted from prescriptive requirements—number of hours of training, specific course requirements, and testing to performance standards—when MMS found that participation in specified training activities did not necessarily result in good performance.[80] Once

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[76] Memorandum of Agreement between the Minerals Management Service–U.S. Department of the Interior and the U.S. Coast Guard–U.S. Department of Homeland Security, MMS/USCG MOA: OCS-05, March 27, 2009.

[77] P. Sonneman, "The Psychology of Well Control," presented at the First Annual IADC Well Control of the Americas Well Control Conference, Houston, November 18–19, 1992. http://www/budsoffshoreenergy.files.wordpress.com/2010/06/psych-of-wc-paper-1992.pdf

[78] Center for Catastrophic Risk Management, Deepwater Horizon Study Group, Progress Report 2, University of California–Berkeley, July 15, 2010, 5.

[79] Ibid.

[80] Danenberger, interview, August 30, 2010.

performance requirements were instituted, operators became accountable for showing their employees' ability to perform. According to one former MMS safety official, the shift to performance standards yielded significant improvements in workers' performance. Under the performance-based approach to training, MMS intended to use random inspections, tests and drills, and incident analysis to validate workers' skills. Six years after implementing the new training rules, MMS interviewed the regulated community and undertook audits to assess the effectiveness of the new training rule and, as a result of those evaluations, issued clarifying information and definitions.

Interviews with both industry and agency personnel, as well as a review of training literature and reports, point to ongoing inadequacies in current training practices. Among the issues raised were:

- Lack of cross-training. One study in Australia showed that most oil rig workers who performed cementing tasks did not know that one-third of blowouts were due to cementing problems. Similar deficiencies in cross-training, according to former MMS officials, also exist in U.S. offshore oil and gas operations.
- Inadequate reinforcement of safety behavioral incentives. Many workers may know the technical procedures for well control but fail to respond to danger signals with work stoppages or other proper responses. "Year after year," writes one industry observer, "we hear of well control situations resulting from, or complicated by, a dramatic failure of trained rig personnel to perform [a] simple sequence of behaviors in a timely fashion."[81] Though this comment was written in 1992, recent interviews with agency and industry experts reveal that such problems continue.

A recent report on oceanographic professionals, including those working in offshore oil and gas operations, addressed licensing and certification programs.[82] Neither the oil and gas industry nor the agency requires certifications for engineers (though they do require bachelor's degrees). In the interview process for the report, some offshore oil and gas professionals expressed concern that certification would limit the pool of eligible applicants.

[81] Sonneman, 1992.

[82] L. Rosenfeld, D. Sullivan, and T. Murphree, "Certification for Oceanographic Professionals: A Needs Assessment Study: Final Project Report, prepared for NOAA, December 1, 2009.

Regulatory Enforcement

Compliance Record: In its 2000 survey of 20 Gulf of Mexico rigs to determine compliance with recommended items or standards, WEST Engineering Services concluded that "in general, the rigs surveyed had a very high level of compliance with MMS and industry standards. Rigs surveyed had a total of 934 compliances with assessment points and 55 that were not in compliance."[83] The report noted that some instances of noncompliance were in rigs built before a particular standard was developed. In other instances, rig operators were in the process of bringing their rigs into compliance but had not completed the work. However, the survey also showed instances in which noncompliance was associated with a rig contractor's incomplete knowledge. For example, "some drilling contractors had not fully considered the ramifications of a single BOP control hose between a shuttle value and the BOP. Failure would render the BOP control system inoperative, constituting a 'single point failure' and therefore a lack of compliance with this API RP."[84]

In summary, the WEST survey of MMS regulations, notices to lessees, and safety alerts noted that compliance of surveyed items was observed 84.8 percent of the time; and in some cases, API recommended practices were more stringent than MMS OCS regulations.

Inspections and Violations. MMS (BOEMRE) inspects OCS drilling and production activities to ensure compliance with federal law, federal regulations, lease and right-of-way agreements, and approved exploration, development, and production plans. According to MMS regulations, these inspections are particularly concerned with verifying that equipment designed to prevent blowouts, spills, fires, and other accidents has been installed and is operating properly.[85]

Regulations specify that both scheduled and unscheduled inspections are to be conducted.[86] MMS is required to conduct a scheduled inspection of each facility at least once a year and to conduct unscheduled inspections "periodically."[87] Recent reporting by the *Wall Street Journal* indicated that MMS rarely conducts unscheduled inspections.[88]

Inspections of offshore facilities are either "complete" inspections or "sample" inspections. A complete inspection scrutinizes all of a facility's safety system components and

[83] West Engineering, 2000, ES-2

[84] Ibid., ES-3.

[85] Code of Federal Regulations, Title 30, Part 250, Section 130.

[86] 30 CFR 250.131.

[87] MMS Manual 650.1: http://www.BOEMRE.gov/adm/PFD/rl278.pdf.

[88] *Wall Street Journal,* "Inspectors Rarely Surprised Oil Rigs," October 11, 2010.

also checks for compliance with "current plans, lease terms, and appropriate stipulations." A sample inspection examines a random sample of safety devices or components. MMS policy states that both quantitative and qualitative assessments are to be used to determine which facilities are subjected to unscheduled inspections and whether any scheduled or unscheduled inspection should be a complete or sample inspection. Some inspection data obtained from MMS list a third kind of inspection, a "partial" inspection, the nature of which is not detailed in the MMS manual.[89]

MMS inspection guidelines list 136 criteria for inspectors to examine.[90] These criteria are called potential incidents of noncompliance, or PINCs. Not every PINC is applicable to every offshore operation. Some apply only to specific types of operation (exploration, drilling, production, pipelines, or renewable energy development), and some are applicable only during certain phases of operation (such as initial drilling or decommissioning). Many aspects of the drilling and production operation (such as well tests and periodic operator-conducted safety inspections) are not directly observed by the inspector. In such cases, the inspector's job is to review the operator's logs and records to verify compliance with required procedures.[91]

If a component or procedure does not meet the standards specified in the PINC list, the operator can be issued a notice for an incident of noncompliance. An INC can take one of three forms: a warning, issued when a violation poses no immediate danger to personnel or equipment; a component INC, issued when a specific location or piece of equipment poses an immediate danger, and the location or equipment in question can be shut down without affecting the overall safety of the facility; or a structure INC, issued when an unsafe situation poses an immediate danger to the personnel or facility, and the location or equipment in question cannot be shut down without affecting the overall safety of the facility. Component or structure INCs can result in component or structure shut-ins, respectively, in which the unsafe component or facility is removed from service until the unsafe situation is remedied.[92]

In certain circumstances, an INC can lead to civil penalties (i.e., fines) and even criminal penalties. According to the MMS manual, a review for potential civil and criminal penalties is triggered by violations that cause injury, death, or environmental damage or pose a threat to human life or the environment. Examples of circumstances that trigger a review for civil and criminal penalties include unsafe and unworkmanlike conditions involving injury to humans or pollution; safety devices that are bypassed or removed without a valid reason; and inoperable

[89] MMS Manual 650.1: http://www.BOEMRE.gov/adm/PFD/rl278.pdf.

[90] MMS National Potential Incident of Noncompliance List, 2009.

[91] MMS National PINC List, http://www.BOEMRE.gov/regcompliance/PDFs/OFFICEPINCLIST.pdf.

[92] Ibid.

safety devices that are left in service without repair. Additionally, any violation that is not corrected within the timeframe specified by MMS, or any instance of an operator's failing to maintain evidence of financial responsibility up to its maximum legal liability, is to be reviewed for potential civil or criminal penalties. Note that each of these circumstances triggers a review for civil and criminal penalties, which may or may not result in actual assessment of a penalty.[93]

From 1998 to 2010, 64,173 inspection visits of offshore production facilities were conducted by MMS, or an average of 4,936 per year. Of those inspection visits, 37,842, or 59 percent, were full inspections; 10,360, or 16 percent, were partial inspections; and 15,971, or 25 percent, were sample inspections. A total of 46,977 INC notices were issued, or an average of 3,614 per year (multiple INCs can be issued in the course of a single inspection). Of those INC notices, 22,897, or 49 percent, were warning notices; 22,285, or 47 percent, were component shut-ins; and 1,795, or 4 percent, were structure shut-ins.[94]

From 1998 to 2010, 21,866 inspection visits of offshore drilling rigs were conducted by MMS, or an average of 1,682 per year. Data on whether these were full, partial, or sample inspections are not available. A total of 2,926 INCs were issued, or an average of 225 per year. Of those INC notices, 1,782, or 61 percent, were warning notices; 582, or 20 percent, were component shut-ins; and 562, or 19 percent, were structure shut-ins.[95]

Of the 49,903 INC notices that were issued between 1998 and 2010, only 443, or less than 1 percent, resulted in civil penalties, for an average of 34 per year. The smallest fine issued was $3,000, the largest was $810,000, and the median penalty was $20,000. Of penalties assessed, 360 (or 81 percent) were between $3,000 and $50,000, and 40 (or 9 percent) were for $100,000 or more. The most common penalty was $10,000.

The five largest fines assessed were for the following offenses: a firewater system was inoperable for 81 days ($810,000); a well was producing with casing pressure for 279 days after a request to do so was specifically denied by MMS ($697,500); an operator had multiple violations, including two missed annual crane inspections, a missed gas detection system test, several other missed equipment tests, failure to fix a leaking subsurface safety valve for 17 months, and failure to fix heliport skirting for 29 months ($525,000); an entire platform safety system was bypassed to keep production online, resulting in two pollution incidents, one of which caused a 12-square-mile oil slick ($505,000); and an operator failed to replace two leaking subsurface safety valves for 186 and 365 days, respectively ($467,950).

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[93] MMS Manual 650.2.

[94] MMS inspection data obtained by Resources for the Future.

[95] MMS inspection data obtained and analyzed by Muehlenbachs et al. (2011).

Examples of violations that were assessed the most common penalty, $10,000, included an open hole that led to mud tanks with no guardrails; bypass of the relief valve on a production water skimmer; and failure to secure a hatch, resulting in a falling accident.[96]

The figures reported in the agency's Program Assessment Rating (PART), discussed above, show a much higher number of compliance inspections conducted per year. This is because the PART figures include inspections of other types of facilities, such as pipelines, and also because more than one type of inspection may be conducted in the course of a single inspection visit. For example, on a single visit, inspectors may perform a water quality inspection for EPA; a full, partial, or component inspection of drilling equipment as discussed above; and a check of Coast Guard–mandated safety equipment such as life jackets. Each of those activities would be considered a separate inspection for the purposes of the Program Assessment Rating Tool.

Despite relatively high levels of compliance, safety incidents and small spills prompted MMS several years ago to begin testing risk-based approaches to inspections. Under this approach, the agency developed the following criteria, associated with higher risks[97]:

- manned (versus unmanned) platforms;
- gas production;
- volume of production;
- operator performance based on prior inspections;
- district reports on operators with compliance issues; and
- platforms with gathering of flow lines crossing the facility.

This risk-based inspection approach will evolve as the new agency hires additional inspectors and revises inspection protocols.

Main Points about MMS (BOEMRE)

Before it was reorganized in the aftermath of the Macondo blowout, the Minerals Management Service was responsible for three related but very different missions: (1) the leasing of offshore parcels for oil and gas exploration and production; (2) the regulation of offshore production and the enforcement of safety and environmental regulations; and (3) the distribution

[96] MMS Civil Penalty Data: http://www.BOEMRE.gov/civilpenalties/index.htm.

[97] W. Cruickshank, Deputy Director, BOEMRE, email to L. Scarlett, September 11, 2010.

of offshore leases and the collection and administration of royalties. Given the relatively low incidence of large oil spills since the founding of MMS, and given national policies focused on energy production and the resulting revenue, over time proportionately more financial resources were dedicated to lease administration and revenue enforcement than to safety and environmental enforcement. Royalty collection and management also drew the lion's share of oversight from both the executive and the legislative branches. The reorganization of these functions following the Macondo incident has segregated leasing, revenue collection, and safety and environmental enforcement into separate offices to give independent budget, planning, and management focus to each function. However, with the reorganization still in progress, several important issues remain unresolved, including how to ensure coordination across these intersecting functions and separate agencies, and how to strengthen on-the-ground safety management capacity.

As the newly formed bureaus work on reducing risks and enhancing safety, several areas merit particular focus. These include:

- use of peer review and independent analysis of risk management and standards;
- strengthening of operator accountability to articulate risk goals and detail how practices and technologies achieve those goals, both in general and at specific exploration and production sites;
- methods for enhancing safety performance of operators, including issues pertaining to types of training, identification of poor performance, and methods to ensure corrective action; and
- methods for reporting data on incidents, compliance, and performance.

3. Federal Aviation Administration

Background

The Federal Aviation Act of 1958 created the Federal Aviation Administration (FAA) as a separate entity to provide "for the regulation and promotion of civil aviation in such manner as to best foster its development and safety, and to provide for the safe and efficient use of the airspace by both civil and military aircraft."[98] According to its current mission statement, FAA seeks to provide "the safest, most efficient aerospace system in the world."[99] FAA's

[98] Federal Aviation Act of 1958, Public Law 85-726.

[99] www.faa.gov/about/mission/.

responsibilities include establishing regulations to protect safety for a wide range of aviation-related activities, including commercial aviation, air cargo, general civil aviation, and commercial aerospace. FAA's FY 2009 budget was $15 billion. Roughly $10 billion was authorized for the Air Traffic Organization and $2 billion was authorized for safety and operations. The total full-time equivalent (FTE) for FAA was roughly 41,000 positions.[100] This discussion will focus on FAA regulation of the commercial (regularly scheduled flights) aviation sector.

The commercial aviation industry experiences fatal accidents almost every year. The effects of a fatal accident are internalized within the industry in the sense that the companies involved in an accident are subject to tort liability and loss in market share—effects that may have a dramatic effect on their revenue and stock price and even their viability. There is also evidence that fatal accidents have spillover effects for the industry as a whole.[101] In addition, the air crew has a strong, personal interest in aviation safety.[102] The organizations representing the air crew provide an important, independent perspective in the regulatory process.[103]

As a consequence, this is an industry that is very sensitive to safety concerns. Industry concern with safety has implications for FAA regulation because it supports a high degree of cooperation between the regulated firm and the agency.

As one example of this cooperative approach, FAA and industry formed the Commercial Aviation Safety Team (CAST) in 1998 with the goal of reducing fatal commercial accidents by 80 percent by 2007.[104] CAST is a cooperative government-industry organization, co-chaired by an FAA associate administrator and an industry representative. Members include several U.S. government agencies, representatives of the employee organizations (e.g., Airline Pilots

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[100] www.faa.gov/office_org/headquarters_offices/aba/budgets_brief/media/2010_budget_highlights.pdf.

[101] J.C. Bosch, E.W. Eckard, and V. Singal, "The Competitive Impact of Air Crashes: Stock Market Evidence," *Journal of Law and Economics* 41(2) (October 1998), 503–19. See also D.A. Carter and B.J. Simkins, "The Market's Reaction to Unexpected Catastrophic Events: The Case of Airline Stock Returns and the September 11th Attacks," *The Quarterly Review of Economics and Finance* 44 (2004): 539–58.

[102] There is a long tradition within the industry of relying on the independent judgment of the pilot in determining whether it is safe to fly.

[103] As one indicator of the influence of the air crew on aviation safety, the FAA administrator—J. Randolph Babbitt—began his career as a pilot for Eastern Airlines. He has served as President and CEO for the U.S. Airlines Pilots Association, the world's largest professional organization of airline pilots. In fact, the administrators of the FAA have generally been pilots—with the exception of the two immediate predecessors to Administrator Babbitt. Administrators with experience as pilots bring their unique perspective to the importance of continuing to improve airline safety.

[104] www.cast-safety.org/about_background.cfm.

Association), aircraft manufacturers, and the air carriers.[105] Since 1998, CAST has analyzed data from hundreds of fatal accidents and thousands of incidents to identify and recommend safety enhancements. Although CAST has recommended a few changes in FAA regulations, it has primarily served an extraregulatory function, with most of its recommendations providing suggested changes to FAA guidance and procedure documents. Now in its second decade, CAST is shifting to a "proactive" approach—assessing emerging risks before accidents occur—rather than the "reactive" approach of reviewing data from accidents and incidents.[106]

As another indicator of the level of cooperation between FAA and the industry, FAA staff report that the industry generally does not challenge major FAA safety rules in the courts. A survey of the three major aviation safety rules issued by FAA in the past 10 years indicates that none of these rules were challenged in the D.C. Circuit.[107]

FAA also operates in a regulatory context with significant oversight by Congress and other federal agencies. Over the past five years, Congress has held more than 20 hearings on FAA safety issues and requested and received more than 10 reports by GAO on various safety issues.[108] In August, President Obama signed the Airline Safety and Federal Aviation Administration Extension Act of 2010, which requires FAA rulemaking in at least six areas concerned with flight personnel qualifications and training, crew pairing, and fatigue. Of particular importance, the act instructs FAA to require that commercial air carriers implement a safety management system (SMS, discussed further below).[109] It also requires FAA to report annually to Congress the status of its review of recommendations from the National Transportation Safety Board (NTSB).[110]

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[105] www.cast-safety.org/members.cfm.

[106] FAA, *The Federal Aviation Administration: A Historical Perspective, 1903–2008,* Chapter 9, 147, www.faa.gov/about/history/historical_perspective/.

[107] We did identify two challenges in the D.C. Circuit during this period, but neither involved a recently completed FAA safety rule. In one, a pilots group challenged a longstanding FAA rule—adopted in the 1950s—requiring pilots to retire at age 60. After the court upheld the FAA rule, the President signed legislation in 2007 changing the mandatory age for pilots to age 65. In the other case, a group of airlines filed suit in 2008 arguing that ultra-long-haul flight time and rest operational guidance issued by FAA should have been established through notice-and-comment rulemaking. FAA is now in the process of going through a notice-and-comment rulemaking that includes these flight time and rest requirements. 75 FR 55852 (September 14, 2010).

[108] House Committee on Transportation and Infrastructure, http://transportation.house.gov/hearings/; Senate Committee on Commerce, Science, and Transportation, http://commerce.senate.gov/public/index.cfm?p=AviationOperationsSafetyandSecurity.

[109] Airline Safety and Federal Aviation Administration Extension Act of 2010, Section 215. SMS is defined by the act as the program established by FAA in Advisory Circular No. 120-92 (June 22, 2006).

[110] Ibid., Section 202.

Congress established NTSB in 1967 as an independent agency with the mission of promoting a high level of safety within the transportation system. NTSB was originally placed in the Department of Transportation (DOT) for administrative purposes, but in 1974, Congress established NTSB as a completely separate entity to conduct accident investigations functions "totally separate and independent from any other … agency of the United States." NTSB investigates accidents and major incidents to determine probable causes and makes recommendations for changes in rules and procedures. It also conducts safety studies and evaluates the effectiveness of regulatory programs for the transportation agencies. Finally, it reviews the appeals of enforcement actions taken by FAA involving aviation certificates and appeals of FAA civil penalty actions.[111]

Regulatory Actions

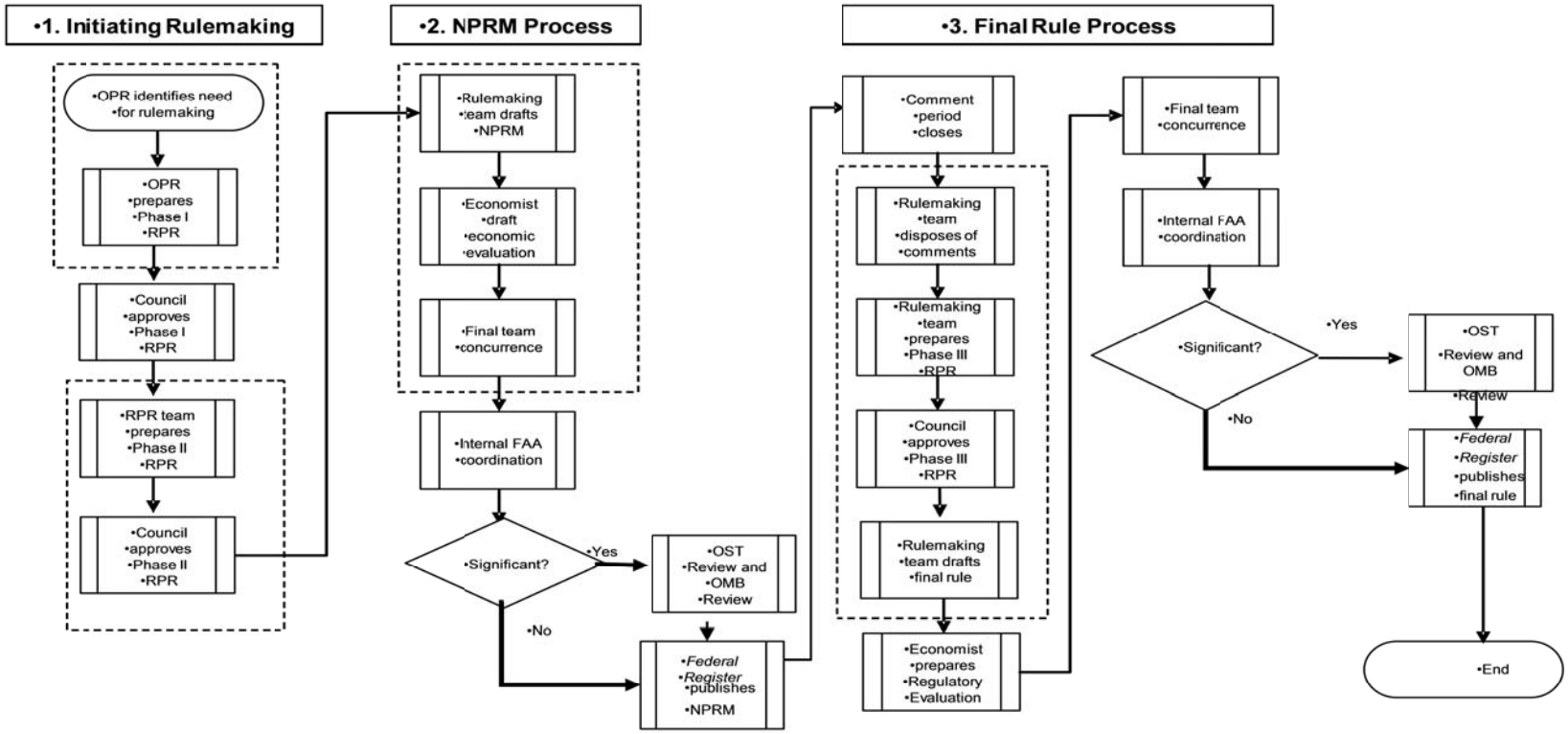
FAA is responsible for developing and maintaining regulations that promote aviation safety. Regulations are developed through a rulemaking process subject to the requirements of the Administrative Procedures Act of 1946. As discussed above, this process involves notice of a proposed rule, an opportunity for public comment, and publication of a final rule. Draft proposed and final rules that are designated "significant" must be submitted by FAA to the Office of the Secretary in DOT. After the Office of the Secretary completes its review, these draft proposed and final rules must be submitted to OMB for Executive Order 12866 review. Major rules—that is, rules with expected annual benefits or costs that exceed $100 million—also require a completed regulatory analysis.[112] (See Figure 12 for a schematic of the FAA regulatory development process.)

Over the past 10 years, FAA has published seven major rules; three directly address aviation safety (see Table 11). Of the remaining four rules, three are "economic" rules concerned with the allocation of slots at some of the nation's busiest airports. The Washington, DC Metropolitan Area Special Flight Rules Area is a security rule.

[111] www.ntsb.gov/Abt_NTSB/history.htm .

[112] The economic office begins the regulatory impact analysis early in the rule development process but only after options have been identified and sufficient information has been generated to prepare the analysis. The economic office has approximately 90 days to prepare the regulatory impact analysis. Generally, the preparation is done in-house.

Figure 12. FAA Rulemaking Process



Source: Cindy Nordlie, email message to the A. Fraas. September 20, 2010.

Table 11. Benefits and Costs of Major FAA Rules, 2003–2009

Year	Rule	Federal Register #	Annual Benefits	Annual Costs
2003	Reduced Vertical Separation Minimum (RVSM) in Domestic United States Airspace[1]	68 FR 61304	$295 - 360 million	$63 - 81 million
2006	Congestion and Delay Reduction at Chicago O'Hare International Airport[2]	71 FR 51382	$153 - 164 million	$0.3 million
2008	Transport Airplane Fuel Tank Flammability Reduction[2]	73 FR 42444	$21 - 66 million	$60 - 67 million
2008	Congestion Management Rule for John F. Kennedy International Airport and Newark Liberty International Airport[3]	73 FR 60544	$35 - 42 million at JFK $28 - 33 million at Newark	$3.9 - 4.6 million at JFK $2.3 - 2.7 million at Newark
2008	Congestion Management Rule for LaGuardia Airport[4]	73 FR 60574	$137 - 434 million	$2.7 - 3.2 million
2009	Part 121 Pilot Age Limit[2]	74 FR 34229	$30 - 35 million	$4 million
2009	Washington, DC Metropolitan Area Special Flight Rules Area[2]	73 FR 76195	$239 million ($10 - 839 million)	$92 million ($89 - 382 million)

Source: Annual benefits and costs figures are from Office of Management and Budget Reports to Congress unless otherwise noted. All other estimates are based on the Federal Register notices for the respective rulemaking and author calculations.

Notes:

[1] Estimated quantifiable benefits, based on fuel savings for the U.S. aircraft fleet over the years 2005 to 2016. Undiscounted benefits and costs are $5.3 billion and $869.2 million, respectively. Discounted benefits are $3 billion. Costs are based on 15 year period from 2002 to 2016. Discounted costs are $764.9 million. Annualized numbers based on author calculations using 3 and 7 percent discount rates.

[2] Benefits and costs are in 2001 dollars.

[3] Present value of benefits and costs over 2009 to 2019 are $306 million at JFK and $245 million at Newark (benefits) and $34 million at JFK and $20 million at Newark (costs). NPV of benefits was calculated by adding NPV of costs to NPV of net-benefits. Annual figures are based on author calculations using 3 and 7 percent discount rates.

[4] Present value of benefits and costs in 2008 dollars are $1.2 - 3.2 billion and $23.9 million, respectively. Annual figures are based on author calculations with 3 and 7 percent discount rates.

Overall, FAA published 16 final rules in 2008 and 17 in 2009. FAA staff report that the FAA is able to carry roughly 40 to 45 rulemaking projects at the same time.[113] The agency prioritizes its rulemaking initiatives and projects in the context of a four-year timeframe. Given the time required for rule development, this translates into roughly 15 final rules per year.

Many of FAA's rules are the result of initiatives generated internally by the agency's program offices. Some rules have been initiated in response to recommendations from CAST or other FAA advisory committees, NTSB recommendations, or occasionally statutory mandates adopted by Congress. A small fraction represents the FAA response to international agreements and efforts to address safety and harmonize requirements for equipment, personnel, and operations.

FAA also uses airworthiness directives as a regulatory instrument. Airworthiness directives, used only to address "unsafe conditions," constitute rulemaking and are enforceable;[114] they are prepared and published in the Federal Register by the program office. These directives are not subject to review by DOT, the Office of the Secretary of DOT, or Executive Order 12866. Although some go through notice-and-comment rulemaking, many are completed in "emergency" situations as direct final rules without notice and comment.

Because rulemaking is a cumbersome and complex process, FAA often uses guidelines—advisory circulars, service bulletins, or other written procedures—that interpret and augment its regulations without going through a formal rulemaking process. FAA staff report that their major objective is to change behavior to promote aviation safety, and the agency would prefer to change guidance, operational manuals, and written procedures rather than initiate a rulemaking.

Regulatory Development Process

FAA is organized into program offices like the Aircraft Certification Service and the Flight Standards Service. In developing a rulemaking, these program offices receive assistance from the Offices of Rulemaking, Chief Counsel, and Aviation Policy and Plans. (See organization chart in Appendix.) The Office of Rulemaking has the primary responsibility for the management of the regulatory process. The Office of Chief Counsel provides legal advice and assistance in drafting regulations. The Office of Aviation Policy and Plans provides the economic analysis that must accompany significant rulemakings, given DOT's requirements and the requirements of Executive Order 12866. Program offices provide technical expertise in drafting regulations.

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[113] Note that airworthiness directives and guidelines are prepared by the program offices and are not subject to this constraint on rule development.

[114] The directives are usually not incorporated in the CFR.

FAA uses a rulemaking council to decide which rules to undertake and to establish priorities for rulemaking. The directors of the Office of Rulemaking and the Office of Aviation Policy and Plans and the assistant chief counsel for Regulation form the core rulemaking council. They plus the directors of program offices with rulemaking responsibility form the full council and meet every other month to discuss rulemaking initiatives. Program offices—like the Aircraft Certification Service and the Flight Standards Service—are the main sources for identifying issues that may deserve regulatory action. The burden falls on the program office to make its case for initiating a rulemaking. NTSB also represents an important source of new regulations. Congressional mandates tend to pick up NTSB and FAA program office initiatives. As a result, these mandates operate primarily to affect FAA priorities and timing by accelerating the rulemaking process, rather than adding items to FAA's rulemaking agenda.

Safety Metrics

For its program assessment rating tool review, FAA has used a rolling three-year average of the accident rate per 100,000 departures as a safety metric[115] (Figure 13). These data suggest a roughly 70 to 80 percent reduction in fatal commercial aviation accidents over the 1990–2009 period[116] (Table 12), close to the goal CAST set of reducing fatal commercial accidents by 80 percent by 2007. Over this period, CAST helped identify a variety of safety problems that resulted in changes by FAA and the airlines, including an FAA airworthiness directive requiring inspection of engine components to address uncontained engine failure, a change by airlines in their automation policies and training to address inadequacies in pilot training, and the identification of airports that may require bird control.[117] FAA also took action in other areas to improve safety, including requiring the retrofit of commercial airplanes with fire detection and suppression systems, an airworthiness program to ensure continued safety of aircraft wiring systems over the life of the aircraft, and a program to reduce the risk of runway incursions.[118]

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[115] In FY 2008, FAA shifted to fatalities per 100 million persons on board as a new safety metric. The rationale offered for this new metric is that it better measures individual passenger risk. Fatalities include all fatalities—passengers, air crew, ground crew, and any others on the ground. U.S. DOT, Federal Aviation Administration, PART, www.whitehouse.gov/omb/expectmore/detail/10002246.2004.html.

[116] The increase in 2001–2003 includes the onboard fatalities associated with the September 11, 2001, terrorism-related crashes.

[117] GAO, Improved Data Quality and Analysis Capabilities Are Needed as FAA Plans a Risk-Based Approach to Safety Oversight (May 2010), GAO-10-414, 7. FAA reports that the work of CAST showed "great results. Since its creation ten years earlier, CAST analyzed data from approximately 500 accidents and thousands of safety incidents worldwide developing safety enhancements to reduce the leading cause of commercial aviation accidents in the United States." FAA, *Federal Aviation Administration: A Historical Perspective, 1903-2008,* 147.

[118] Ibid, 147.

Figure 13. Fatal Accidents per 100,000 Departures (3-year Moving Average), 1990–2009

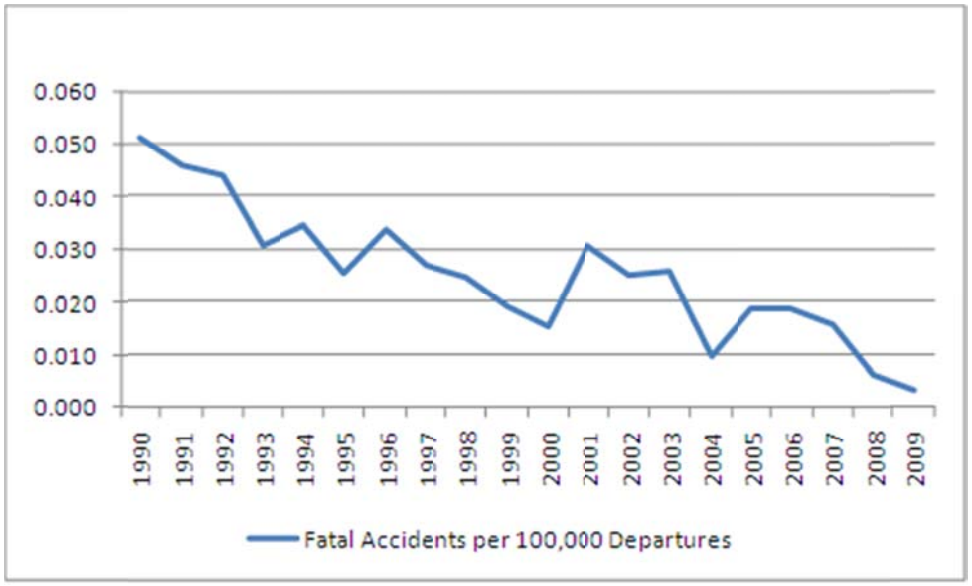

Table 12. Aviation Accident Trends, 1990–2009

	Fatal Accidents	Fatalities	100,000 Departures	Fatal Accidents per 100,000 Departures (3-Year Moving Average)
1990	4	11	78	0.051
1991	3	60	75	0.046
1992	3	29	75	0.044
1993	1	1	77	0.031
1994	4	239	78	0.035
1995	1	160	81	0.025
1996	3	342	79	0.034
1997	3	3	99	0.027
1998	1	1	105	0.025
1999	2	12	109	0.019
2000	2	89	111	0.015
2001	6	531	106	0.031
2002	0	0	103	0.025
2003	2	22	102	0.026
2004	1	13	108	0.010
2005	3	22	109	0.019
2006	2	50	106	0.019
2007	0	0	107	0.015
2008	0	0	103	0.006
2009	1	50	102	0.003

Source: Federal Aviation Administration's Aviation Accident Statistics.
Based on Table 6. Accidents, Fatalities, and Rates, 1990 - 2009, 14 CFR 121, Scheduled Service (Airlines)

Transition in Safety Review

The reduction in fatal accidents has been achieved through a "reactive" safety review process—that is, a review of accidents and incidents that have already happened to identify the underlying cause and appropriate corrective action by FAA and the air carriers. FAA is now moving to adopt a "proactive" approach that will identify precursors that could result in aviation safety risks. FAA views this shift as necessary because as accidents become rare, the data on accidents become increasingly sparse. The key to this new approach is the development of a much broader database of events through voluntary self-reporting to identify possible aviation safety risks. Because these reports can involve possible noncompliance with regulations, FAA provides incentives to encourage voluntary reports by resolving any noncompliance through corrective action rather than through punishment or discipline. FAA expects that the new approach will yield safety data that would otherwise be unobtainable.[119] Descriptions of the main FAA programs for the collection of voluntarily submitted information follow.

Aviation Safety Action Program. The purpose of the program is to encourage air carrier and repair station employees to volunteer data that will help identify precursors to accidents. Because these reports can involve possible noncompliance with FAA regulations, the program provides an incentive: individuals who report safety issues will incur no more than an administrative action, provided certain conditions are met[120]: (1) the employee must file a report in a timely manner; (2) the violation must be inadvertent; and (3) the event must not involve criminal activity, substance abuse, or intentional falsification.[121]

Flight Operational Quality Assurance. This program is designed to encourage the voluntary reporting of digital flight data generated during flight operations. These data provide objective information on flight operations that is not otherwise available. [122] Under the program, the airline routinely downloads the data stored by digital flight recorders—these are the same data recorded for accident investigation purposes—for analysis. The airlines and pilots share the aggregated data, without identifiers, with FAA to help the agency identify trends that, if uncorrected, could cause accidents.[123] FAA will not use data submitted under the program in an enforcement action against the airline or its employees (except in the case of violations that are criminal or deliberate acts).

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[119] GAO, Improved Data Quality and Analysis Capabilities are needed as FAA Plans a Risk-Based Approach to Safety Oversight, GAO-10-414 (May 2010), 18.

[120] DOT, FAA, Aviation Safety Action Program (ASAP), Advisory Circular No. 120-66b, 1–5.

[121] Ibid., 7–8.

[122] FAA, Flight Operational Quality Assurance (FOQA), ww.faa.gov/about/initiatives /atos/air_carrier/foqa/.

[123] Ibid. Also see FAA, Flight Operational Quality Assurance, Advisory Circular No. 120-82.

Voluntary Disclosure Reporting Program. The purpose of this program is to encourage certificate holders (e.g., air carriers) and similar entities to identify and correct instances of noncompliance and to take steps and commit resources to prevent their recurrence. Certificate holders that satisfy the conditions of the program will receive a letter of correction instead of a civil penalty action. In this way, FAA hopes to obtain safety data that would otherwise be unobtainable.[124] The conditions are that (1) the certificate holder notifies FAA immediately upon detecting the apparent violation; (2) the violation is inadvertent; and (3) the event does not involve criminal activity, substance abuse, or intentional falsification.[125]

Aviation Safety Reporting Program. FAA also has in place a longstanding program for anonymous reporting of safety-related issues. Beginning in 1975, FAA instituted the voluntary Aviation Safety Reporting Program to encourage pilots, controllers, flight attendants, maintenance personnel, and other aviation workers to report actual or potential safety issues. To ensure anonymity for all parties involved, pilots, controllers, and the like submit these reports directly to the National Aeronautics and Space Administration—an independent third party—and all processing, "de-identification," and analysis are conducted by NASA. FAA uses this information to take corrective action to remedy safety issues and plan for improvements. FAA regulations prohibit the use of these reports in any disciplinary action, except in cases of a criminal offense or accident. Further, if a violation comes to its attention, FAA does not impose a civil penalty or revoke a certificate in response, provided the following conditions are met[126]:

- the violation was inadvertent and not deliberate;
- the violation did not involve a criminal action or result in an accident;
- the person was not involved in any prior FAA enforcement action in the previous five years; and
- the person provides proof of a report of the violation to NASA within 10 days after the violation.

Mandatory reporting programs. There are also mandatory reporting programs requiring reports on such events as accidents, engine failures, and near midair collisions. Overall, FAA has more than 10 reporting programs (Table 13).

[124] DOT, FAA, Voluntary Disclosure Reporting Program, Advisory Circular No. 00-58B, 3.

[125] Ibid., 4.

[126]FAA Aviation Safety Reporting Program, Advisory Circular No. 00-46D, Section 9.

Table 13. Aviation Safety Databases

Database/date established	Responsible entity	Source of data	Data collected	Data format
Voluntary databases				
Aviation Safety Action Program/1997	FAA, air carriers	Members of participating aviation industry employee groups	All types of safety events	Narrative
Aviation Safety Reporting System /1987	NASA	Industry personnel in the air and on the ground (e.g., air traffic controllers, mechanics, flight attendants, and ground crews)	All types of safety events	Narrative, quantitative
Flight Operational Quality Assurance /1995	FAA, air carriers	Devices on specially equipped aircraft that collect data from the aircraft's flight data recorders	In-flight operations	Quantitative
Voluntary Disclosure Reporting Program /1990	FAA	Air carriers, repair stations, production approval holders, and fractional ownership programs operating under part 91[a]	All types of safety events	Narrative
Other databases				
Accident/Incident Data System (AIDS)/1978	FAA	FAA inspectors	Some aviation accidents and those incidents not investigated by NTSB[b]	Primarily narrative, some quantitative
Air Transportation Oversight System (ATOS)/1998	FAA	FAA inspectors	Inspection results	Narrative, quantitative
National Wildlife Strike Database (Wildlife)/1990	FAA, USDA	Pilots, air traffic control personnel, and others involved in civil aviation	Bird and other wildlife strikes	Narrative, quantitative
Near Midair Collision System (NMACS)/1987	FAA	Pilots and other flight crew members	Near midair collisions	Narrative, quantitative
National Transportation Safety Board Aviation Accident and Incident Database/1982	NTSB	NTSB investigators	Aviation accidents and major incidents	Primarily quantitative, some narrative
Operational Error/Deviation System (OEDS)/1985	FAA	Air traffic controllers and air traffic equipment	Air traffic control operational errors and pilot deviations[c]	Primarily quantitative, some narrative
Pilot Deviation System (PDS)/1987	FAA	Air traffic controllers and other FAA personnel	Pilot deviations	Primarily quantitative, some narrative
Service Difficulty Reports (SDRS)/1986	FAA	Pilots, mechanics, inspectors, and others	Aircraft equipment problems	Narrative, quantitative
Vehicle Pedestrian Deviation System (VPDS)/1988	FAA	Air traffic controllers, other FAA and industry personnel	Unauthorized entry on a runway by a vehicle, pedestrian, or aircraft	Narrative, quantitative

Sources: FAA, NASA, NTSB, USDA, and GAO.

[a]A production approval holder is an entity that holds a certificate, approval, or authorization from FAA to manufacture aircraft, aircraft engines, propellers, and related parts and articles. Fractional ownership refers to shared aircraft ownership.

[b]NTSB investigates all aviation accidents and major aviation incidents.

[c]An operational error/deviation is a violation of FAA separation standards that define minimum safe distances between aircraft, between aircraft and other physical structures, and between aircraft and otherwise restricted airspace. The event is classified as an operational error when an air traffic controller's actions cause the loss of minimum separation; the event is classified as a pilot deviation when a pilot's actions cause the loss, or both.

Source: GAO 2010. Aviation Safety: Improved Data Quality and Analysis Capabilities Are Needed as FAA Plans a Risk-Based Approach to Safety Oversight, GAO-10-414 (Washington, DC: May 2010): 5.

The Aviation Safety Information Analysis and Sharing program combines information from the various databases to help provide insights into potential safety issues. FAA developed this program to promote the open exchange of safety information to improve aviation safety.

Users can search across multiple databases and display pertinent information in a variety of formats.[127]

Safety Management System

FAA's safety management approach also includes the adoption of a safety management system within the organizational structures in aviation (e.g., the airlines and air traffic control). A safety management system is essentially a quality management approach to controlling risk that provides managers with a detailed roadmap for monitoring safety-related processes.[128] It emphasizes safety management as a fundamental business process to be incorporated within the organization and provides the organizational framework to support a sound safety culture.[129]

Over the past five years, FAA has encouraged the voluntary development of SMS by aviation service providers and has taken several initial steps for rulemaking in this area. A joint industry-FAA committee to develop recommendations for SMS was established in February 2009, and FAA issued an advance notice of proposed rulemaking on July 23, 2009. As noted above, the Airline Safety and Federal Aviation Administration Extension Act (August 2010) instructs FAA to conduct a rulemaking that would require commercial air carriers to implement safety management systems. The act requires that FAA consider including each of the following as elements of an SMS: the Aviation Safety Action Program, the Flight Operational Quality Assurance Program, a line operations safety audit, and an advanced qualification program.[130] On November 5, 2010, the FAA published an NPRM regarding SMS.[131]

The full benefits of the SMS program may be years in the future. The program will require not only access to existing databases (and the development and/or enhancement of databases for information that has previously not been obtainable) but also technical advancements in methods to identify precursors so that FAA can conduct risk-based analysis.[132] In a recent report on the risk-based approach, GAO reported, [133]

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[127] www.asias.faa.gov/portal/page/portal/ASIAS_PAGES/ASIAS_HOME.

[128] FAA, Introduction to Safety Management Systems for Air Operators, Advisory Circular No. 120-92 (June 22, 2006), 2.

[129] Ibid., 2. See also FAA, Safety Management System: SMS Explained, www.faa.gov/about/initiatives/sms/explained/.

[130] Act, Section 215.

[131] 75 FR 68224.

[132] GAO, Improved Data Quality and Analysis Capabilities Are Needed as FAA Plans a Risk-Based Approach to Safety Oversight (May 2010), 12.

[133] Ibid., 12.

> While FAA has issued agencywide guidance on implementing SMS and has some efforts such as ASIAS under way, it does not have a way to measure or specific times to indicate full implementation. FAA officials told us that the current efforts would provide a foundation for the full implementation of SMS. But without a clear description of the activities to be completed and time frames for their completion, it may be years before SMS is fully implemented and its benefits are realized. In commenting on a draft of this report, FAA officials noted that even with a clear description of the activities to be completed and time frames for their completion, it will be years before SMS is fully implemented and its benefits are realized. We agree with FAA and note that specific time frames establish expectations for FAA's implementation of SMS and provide a means of accountability for meeting those expectations.

Triggers for Regulatory Action

FAA has adopted a structural approach to ensuring safety. FAA's *System Safety Handbook* sets out a matrix of severity and likelihood of an incident as a basis for establishing priorities for agency response.[134] Table 14 presents categories of incident severity; Table 15 presents the definitions for likelihood of occurrence. Table 15 has both qualitative and quantitative definitions because current FAA risk assessments may be either qualitative (reflecting subjective judgments by the analyst) or quantitative. Thus, a "probable" event is anticipated to occur one or more times during the operational life of a component or, quantitatively, has a probability per operational hour that is greater than 1 in 100,000. If the likelihood of occurrence is "probable," any event in the major, hazardous, or catastrophic severity class would require tracking in the FAA hazard tracking system until the risk is reduced to an acceptable level. "Extremely improbable" events—that is, events that are not anticipated to occur during the entire operational life of an entire system or fleet or, quantitatively, a probability of occurrence less than 1 in 1 billion—do not require regulatory attention.[135]

The quantitative approach is necessary for a system-level fault tree analysis, required as a part of the aircraft certification process.[136] FAA is continuing to develop a quantitative assessment process for its evaluation of other operational safety requirements, such as airworthiness directives.

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[134] FAA, Safety System Handbook. www.faa.gov/library/manuals/aviation/risk_management/ss_handbook/ (last updated May 21, 2008).

[135] FAA, Certification Maintenance Requirements, Advisory Circular No.: 25-19. www.faa.gov/documentLibrary/media/advisory_Circular/AC%2025-19.pdf

[136] 14 CFR 25.1309 (Part 25).

Table 14. Definitions of Severity in FAA's Acquisition Management System Process

Catastrophic	Results in multiple fatalities and/or loss of the system
Hazardous	Reduces the capability of the system or the operator ability to cope with adverse conditions to the extent that there would be: Large reduction in safety margin or functional capability Crew physical distress/excessive workload such that operators cannot be relied upon to perform required tasks accurately or completely (1) Serious or fatal injury to small number of occupants of aircraft (except operators) Fatal injury to ground personnel and/or general public
Major	Reduces the capability of the system or the operators to cope with adverse operating condition to the extent that there would be – Significant reduction in safety margin or functional capability Significant increase in operator workload Conditions impairing operator efficiency or creating significant discomfort Physical distress to occupants of aircraft (except operator) including injuries Major occupational illness and/or major environmental damage, and/or major property damage
Minor	Does not significantly reduce system safety. Actions required by operators are well within their capabilities. Include Slight reduction in safety margin or functional capabilities Slight increase in workload such as routine flight plan changes Some physical discomfort to occupants or aircraft (except operators) Minor occupational illness and/or minor environmental damage, and/or minor property damage
No Safety Effect	Has no effect on safety

Source: Federal Aviation Administration, FAA System Safety Handbook, Chapter 3: Principles of System Safety (December 30, 2000): 3–6.

Table 15. Definitions of Likelihood of Occurrence

Probable	Qualitative: Anticipated to occur one or more times during the entire system/operational life of an item. Quantitative: Probability of occurrence per operational hour is greater that 1 x 10-5
Remote	Qualitative: Unlikely to occur to each item during its total life. May occur several time in the life of an entire system or fleet. Quantitative: Probability of occurrence per operational hour is less than 1 x 10-5, but greater than 1 x 10-7
Extremely Remote	Qualitative: Not anticipated to occur to each item during its total life. May occur a few times in the life of an entire system or fleet. Quantitative: Probability of occurrence per operational hour is less than 1 x 10-7 but greater than 1 x 10-9
Extremely Improbable	Qualitative: So unlikely that it is not anticipated to occur during the entire operational life of an entire system or fleet. Quantitative: Probability of occurrence per operational hour is less than 1 x 10-9

Source: Federal Aviation Administration, FAA System Safety Handbook, Chapter 3: Principles of System Safety (December 30, 2000): 3–6.

Best Practices

Once FAA has identified an area of concern and begins its investigation for rulemaking, it may use joint industry-FAA committees to develop recommendations on the appropriate regulatory response. These committees are the Aviation Rulemaking Advisory Committee(ARAC) and the Aviation Rulemaking Committees(ARCs) which provide recommendations on regulatory issues as tasked by the FAA.. The ARAC is a standing committee chartered under the Federal Advisory Committee Act (FACA). The ARCs are chartered by the FAA administrator under special authority to address specific regulatory issues[137] and are not subject to FACA. They provide a forum that allows FAA to work with a broad range of interested parties in the aviation industry (aircraft manufacturers, airlines, pilots, etc.) and with international aviation groups to identify approaches to safety issues. If a rulemaking committee is addressing a general topic, consumer groups may also be included;

[137] Title 49 USC Section 106(p)(5).

however, if it is addressing technical subject matter, it probably would not include consumer groups. None of the committees provide a venue for regulatory negotiation; FAA is not bound by the recommendations of either the advisory or the rulemaking committees. Often, no consensus emerges from the rulemaking process; instead, the committees identify a range of practices and options for consideration by FAA in rulemaking.

Role of Costs

FAA seeks to balance the likelihood and severity of a possible incident with the cost of implementing corrective action. Thus, where it can reasonably quantify the consequences of safety hazards, FAA uses benefit-cost and cost-effectiveness analysis to inform its regulatory decisions. FAA staff also report that where the costs are disproportionate relative to the benefits (including the benefits of reduced mortality and injury), FAA reviews the various requirements in the draft rule and may adjust rule requirements to achieve a better balance. As noted above, significant rules are subject to OMB review under Executive Order 12866, and FAA must complete a regulatory analysis assessing the benefits and costs for these rules.

In January 1993, the Department of Transportation adopted a guidance memorandum, "Treatment of Value of Life and Injuries in Preparing Economic Evaluations," which set forth recommended economic values to be used in departmental regulatory analysis[138]. In the most recent update of that memorandum, dated March 18, 2009, DOT increased the value of a statistical life (VSL) to $6.0 million.[139] FAA recently published an NPRM that used a $6.0 million VSL and an $8.4 million VSL.[140] In the Regulatory Impact Analysis for the NPRM, the FAA stated that a VSL value of $8.4 million is consistent with recent literature and requested public comment on whether decision-makers should consider using a VSL higher or lower than $6 million to evaluate commercial aviation safety proposals.[141]

Voluntary Consensus Standards

FAA uses voluntary consensus standards to establish minimum operational performance standards for equipment or specifications for procurement. However, agency staff report that FAA does not use voluntary consensus standards for its aviation safety standards. To confirm

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[138] See: http://ostpxweb.dot.gov/policy/Data/VSL93guid.pdf

[139] The $6 million value was raised from a value of $5.8 million adopted in 2007; the increase was based on changes to the wages and salaries component of the Employment Cost Index and the Consumer Price Index (CPI-U). http://ostpxweb.dot.gov/policy/reports/VSL%20Guidance%20031809%20a.pdf

[140] Flightcrew Member Duty and Rest Requirements proposed rule (75 FR 55852; September 14, 2010).

[141] www.regulations.gov, FAA-2009-1093. The notice also reports that the present value of the benefits would equal the present value of the costs at a value per averted fatality of $12.6 million.

this, we reviewed FAAs major rules over the past 10 years and a sampling of its aviation safety regulations for 2008 and 2009. None of these rules used voluntary consensus standards.

Role of Peer Review

FAA staff report only limited use of peer review; however, FAA uses the Aviation Rulemaking Advisory Committee and its ARCs to provide outside input for rulemaking. As discussed above, the former is a standing committee chartered under FACA; the latter are chartered by the FAA administrator to address a specific regulatory issue. The membership of these committees brings a variety of interests to the table to discuss rulemaking issues—including representatives of the pilots and air crews.

FAA has an arrangement with the William J. Hughes Technical Center (comprising several university aeronautical engineering departments) for studies and consultation on specific areas of interest. This arrangement provides a national scientific technical base for FAA. Congress may mandate a National Academy of Sciences study for specific issues, but agency staff report that FAA itself does not typically request such reviews.

Although FAA typically does not rely on peer review of its regulations, its regulations are under the continuing scrutiny of NTSB, which tracks and grades the FAA response (as well as the response of other entities) to its recommendations. A recent GAO report examined the response to NTSB recommendations (beginning with August 1996) addressing icing and weather-related operational conditions.[142] GAO reports that of the 89 recommendation, 82 were directed to FAA. NTSB has closed 41 of the 82 recommendations as implemented (50 percent) and classified an additional 22 (27 percent) as cases where FAA has made acceptable progress. GAO reports that the combined 77 percent acceptance rate on NTSB recommendations is consistent with the rate for all NTSB recommendations. For this subset of 82, FAA responded within two years in an acceptable way (including acceptable but still unfinished and open actions) to 30 percent of NTSB recommendations and responded favorably to more than 50 percent within three years (Table 16). FAA rejected—sometimes with a long lag—about 17 percent of the recommendations (and still counting).

[142] GAO issued a report on July 29, 2010, assessing the FAA response to NTSB recommendations related to winter weather and icing incidents in 1996– 2008; see GAO-10-679SP.

Table 16. Adoption of Voluntary Standards by DOI, DOT, and EPA

Federal Agency Information on Participation/Adoption of Voluntary Standards Activities Required by OMB Circular A-119

Agency	Year	Government Unique Standards used in Lieu of Voluntary Consensus Standards	Voluntary Consensus Standards Substituted for Government Unique Standards	Voluntary Consensus Standards Used This Year (new uses)	Employee Participation in Voluntary Consensus Standards Bodies	Change from Previous Year (Column G)	Voluntary Consensus Standards Bodies with Agency Participation	Change from Previous Year (Column I)
DOI	2007	0	0	4	300	186	63	30
DOI	2006	0	2	0	114	40	33	7
DOI	2005	0	2	768	74	-195	26	7
DOI	2004	0	0	788	269	-376	19	-6
DOI	2003	0	0	242	645	345	25	6
DOI	2002	2	0	616	300	231	19	14
DOI	2001	2	-	-	69	-12	5	-24
DOI	2000	0	0	1569	81	-3	29	-25
DOI	1999	0	0	144	84	0	54	0
DOI	1998	0	0	144	84	-25	54	16
DOI	1997	0	0	205	109	-	38	-
DOT	2007	3	0	4	198	-8	48	0
DOT	2006	3	0	12	206	-3	48	1
DOT	2005	3	0	381	209	42	47	6
DOT	2004	3	0	343	167	0	41	11
DOT	2003	3	0	323	167	-9	30	-24
DOT	2002	1	0	212	176	-1	54	-114
DOT	2001	0	8	246	177	-34	168	22
DOT	2000	0	11	153	211	-18	146	26
DOT	1999	0	28	238	229	-63	120	14
DOT	1998	1	7	197	292	0	106	-27
DOT	1997	2	-	54	292	-	133	-
EPA	2007	23	0	3	44	0	25	0
EPA	2006	50	0	38	44	-8	25	-1
EPA	2005	50	0	50	52	7	26	3
EPA	2004	50	0	67	45	1	23	2
EPA	2003	50	0	109	44	2	21	-1
EPA	2002	38	2	9	42	-4	22	2
EPA	2001	36	2	64	46	23	20	5
EPA	2000	2	0	229	23	-174	15	0
EPA	1999	83	0	34	197	-3	15	1
EPA	1998	3	0	157	200	0	14	3
EPA	1997	0	4	31	200	-	11	-

*Source:*National Institute of Standards and Technology (NIST), Annual Reports on Federal Agency Use of Voluntary Consensus Standards and Conformity Assessment, https://standards.gov/NTTAA/agency/index.cfm?fuseaction=NTTAAReports.main.

Role of Peer Review

FAA staff report only limited use of peer review; however, FAA uses the Aviation Rulemaking Advisory Committee and its ARCs to provide outside input for rulemaking. As discussed above, the former is a standing committee chartered under FACA; the latter are chartered by the FAA administrator to address a specific regulatory issue. The membership of these committees brings a variety of interests to the table to discuss rulemaking issues—including representatives of the pilots and air crews.

FAA has an arrangement with the William J. Hughes Technical Center (comprising several university aeronautical engineering departments) for studies and consultation on specific areas of interest. This arrangement provides a national scientific technical base for FAA. Congress may mandate a National Academy of Sciences study for specific issues, but agency staff report that FAA itself does not typically request such reviews.

Although FAA typically does not rely on peer review of its regulations, its regulations are under the continuing scrutiny of NTSB, which tracks and grades the FAA response (as well as the response of other entities) to its recommendations. A recent GAO report examined the response to NTSB recommendations (beginning with August 1996) addressing icing and weather-related operational conditions.[143] GAO reports that of the 89 recommendation, 82 were directed to FAA. NTSB has closed 41 of the 82 recommendations as implemented (50 percent) and classified an additional 22 (27 percent) as cases where FAA has made acceptable progress. GAO reports that the combined 77 percent acceptance rate on NTSB recommendations is consistent with the rate for all NTSB recommendations. For this subset of 82, FAA responded within two years in an acceptable way (including acceptable but still unfinished and open actions) to 30 percent of NTSB recommendations and responded favorably to more than 50 percent within three years (Table 16). FAA rejected—sometimes with a long lag—about 17 percent of the recommendations (and still counting).

In addition, in response to requests from the U.S. Congress, especially the House Committee on Transportation and Infrastructure and the Senate Committee on Commerce, Science, and Transportation, GAO has continued to evaluate FAA's actions in addressing safety concerns within the commercial aviation industry. As noted above, the GAO has completed more than 10 reports on FAA regulation of safety in the commercial aviation industry since 2005.

[143] GAO issued a report on July 29, 2010, assessing the FAA response to NTSB recommendations related to winter weather and icing incidents in 1996– 2008; see GAO-10-679SP.

Inspections, Enforcement, and Compliance

Once FAA has identified a violation, its response can range from no action to administrative action to formal legal sanctions—that is, a monetary fine or the revocation of certification. FAA staff report that for key elements of the commercial aviation sector roughly 90 percent of identified violations are resolved without legal sanctions—either as no action or through administrative action (Tables 17 and 18). This is consistent with FAA's initiative (discussed above) to encourage voluntary reporting of events and incidents. Where legal sanctions were imposed the final monetary penalty was often lower than the amount initially proposed (Table 19).

Table 17. FAA Response Time, by Action Type

	Years for Response - FAA							
Type	**1**	**2**	**3**	**4**	**5**	**6-7**	**8-9**	**>10**
Closed - Exceed Recommended Action	2	-	-	-	-	-	-	-
Closed - Acceptable Action	11	8	1	2	6	-	3	2
Closed - Acceptable Alternative Action	-	-	1	-	1	1	-	2
Open-Acceptable Response	-	4	12	1	1	2	-	3
Action Unacceptable - Open	-	1	3	1	-	-	-	2
Action Unacceptable - Closed	-	1	3	-	-	2	-	2

Source: Government Accountability Office (GAO) Report GAO-10-679SP. Note: residual categories include Open - No Response, Closed - Suspended, Closed - Reconsidered, and Closed - No Response.

Over the 2008–2009 period, FAA reported that it imposed monetary fines for roughly 600 violations (for air carriers, commercial operations, and repair stations). The average fine was $34,000; the lowest was $300 and the highest was $7.5 million

Table 18. Cases Closed With Administrative vs. Legal Action

Large Air Carriers - Part 121					
	Administrative Actions[1]			Legal Actions[2]	
2005	743	84%		144	16%
2006	636	84%		123	16%
2007	632	87%		96	13%
2008	1077	90%		123	10%
Small Air Carriers - Part 135					
	Administrative Actions[1]			Legal Actions[2]	
2005	761	87%		109	13%
2006	547	88%		78	12%
2007	487	89%		58	11%
2008	728	*90%*		82	10%
Certificated Repair Stations					
	Administrative Actions[1]			Legal Actions[2]	
2005	732	91%		73	9%
2006	887	90%		100	10%
2007	795	92%		70	8%
2008	1023	93%		72	7%

1. Warning notices or letters of correction.

2. Legal actions involving the imposition of a monetary penalty or the temporary or permanent revocation of a certificate.

Source: Peter Lynch, email message to the author, December 17, 2010.

Table 19. Proposed and Final FAA Fines, by Category Type, 2005–2008

Category	Status	Overall	2005	2006	2007	2008
121 Carrier	Proposed	$22,184,016	$5,091,249	$6,460,747	$5,871,520	$4,760,500
	Final	$13,905,466	$3,010,325	$3,967,833	$3,818,483	$3,108,825
135 Carrier	Proposed	$5,080,350	$1,445,550	$1,087,600	$1,219,900	$1,327,300
	Final	$1,976,707	$650,390	$425,233	$456,635	$444,449
Repair Station	Proposed	$3,943,603	$689,593	$1,152,650	$742,450	$1,358,910
	Final	$2,236,083	$387,345	$686,527	$358,175	$804,036

Source: Peter Lynch, email message to the A. Fraas, October 29, 2010.

Revocation of certification is the most severe penalty at FAA's disposal. Over the 2008–2009 period FAA also suspended the certificate for 10 air carriers and commercial operators and for 7 repair stations.[144]

FAA has established a formal enforcement decision tool for determining the appropriate response to a violation.[145] The level of response to a violation is based in part on an assessment of the risk associated with the violation. As defined in the enforcement decision tool, *safety risk* means the level (high, moderate, or low) of potential injury or property damage from a violation, considering the hazard severity and the likelihood of its occurring. *Likelihood* means the probability (frequent, occasional, or remote) of the worst type of injury or damage that could realistically occur in the specific case.

The inspector identifying the violation makes the first judgment as to the appropriate response, and that judgment is reviewed by supervisors in the local FAA office. A decision to take no action or an administrative action (such as a warning notice) is not reviewed further within FAA. A recommendation for legal sanction by the local office is reviewed by the regional enforcement office and Chief Counsel's Office. Major legal sanctions—large monetary fines or the revocation of certification—are reviewed by the FAA headquarters Chief Counsel's Office and the associate administrator for the program office with jurisdiction for the area in which the violation occurred.

If the sanctioned party does not accept the legal penalty, its recourse depends on the nature and magnitude of the sanction. Large monetary fines—greater than $400,000 for large carriers and greater than $50,000 for small carriers—can be appealed in a U.S. district court. Smaller fines would be appealed to a DOT administrative law judge with appeal to the FAA administrator. The appeal of a revocation of a certificate goes to an NTSB administrative law judge with appeals to NTSB (with the commissioners serving as the review panel). Appeals of FAA administrator or NTSB decisions go to the U.S. appeals court for the principal place of residence or to the D.C. Circuit.

Training Requirements and Practices

Because human error continues to be the leading cause of accidents, improving human performance is central to enhancing safety. To reduce human error, the industry has adopted performance-based training in place of prescriptive training. FAA administrator has described performance-based training as follows:[146]

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144 FAA also revoked the certificates for 40 air carriers and commercial operators—probably all commercial operators—and 16 approved repair stations.

145 www.faa.gov/documentLibrary/media/Order/2150.3B%20Ch%@)!%20only.pdf.

146 www.faa.gov/news/testimony/news_story.cfm?newsId=10601.

> New technology, particularly simulators, allows high-fidelity training for events that we never could have trained to in the past using an aircraft, e.g., stall recovery.

Thus, FAA can determine proficiency based on actual performance with training simulators, not just meeting course requirements or taking hours of training. Although the major airlines have already largely embraced this training approach, FAA recently issued a proposed rule upgrading the training requirements for the air crew.[147] This proposal was developed working with an aviation rulemaking committee that included pilots, flight attendants, and representatives of airlines and training centers.

Personnel Management

To provide greater flexibility in such important personnel matters as compensation and hiring, Congress has exempted FAA from certain federal personnel requirements.[148] FAA has responded by adopting a performance-based compensation program that provides a wider range of pay and greater management flexibility to hire and retain employees. FAA's hiring flexibilities include on-the-spot hiring and monetary incentives for the recruitment and retention of personnel.[149]

As a part of FAA's exercise of this flexibility, it conducts an annual comparability analysis to determine the competitiveness of its pay structure with the GS salary tables and the private market. The upper end of the highest FAA pay band for technical and engineering career levels appears to be roughly 5 percent greater than the upper end of the GS-15 level. In general, GS-15 levels in federal agencies have typically been reserved for management-level positions, rather than for technical staff. FAA believes that the increases it adopted at the beginning of 2010 bring its pay band structure into closer alignment with the GS salary tables and the external market.[150]

In the Aircraft Certification Service, engineers (e.g., aeronautical engineers) constitute roughly half of the staff of 400. The engineers typically come to FAA with 5 to 10 years of experience—often with an aircraft manufacturer. The aircraft certification office also uses inspectors, typically from skilled blue-collar crafts with experience in quality assurance and quality control in manufacturing. There are a small number of slots at the GS-15 level (or above) for specialists (e.g., an engineer with specialized experience in composite materials or in metal fatigue).

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147 Federal Register, January 12, 2009 (74 FR 1280).

148 GAO, CIA, Federal Courts, FBI, Treasury, FDIC, Federal Reserve, and SEC have also received exemptions from Title 5 U.S.C. requirements and have adopted broad-banding and pay-for-performance approaches.

149 GAO.

150 FAA, Administrator's Message, www.faa.gov/news/updates/index.cfm?newsId=60098&print=go

The economists are in Aviation Policy and Planning. There are currently nine economists (not all of the 13 to 14 positions are filled). Roughly half have Ph.D.s; the rest have master's degrees. Experience prior to FAA varies.

Main Points about FAA

FAA is responsible for administering the Federal Aviation Act to provide a safe, efficient aviation system. The Act allows the use of economics and benefit–cost analysis in making regulatory decisions.

Because carriers, manufacturers, air crew, and the public all have a substantial interest in the safety of commercial aviation, there is a high degree of cooperation between the regulated industry and the FAA. Thus, the FAA makes extensive use of joint industry-FAA advisory committees (e.g., ARAC and the ARCs) in developing its safety regulations. FAA uses voluntary consensus standards to establish minimum operational performance standards for equipment or specifications for procurement; but it does not use such standards for aviation safety regulations. Finally, FAA regulation takes place in the context of a significant measure of oversight by NTSB and Congress.

In the past, the FAA has relied on review by the NTSB, joint industry-FAA review, and internal FAA review of past accidents and incidents to identify potential problems for aviation safety. The FAA is now moving to a "proactive" approach that would evaluate a much broader array of events as a way of identifying potential safety issues. To implement this new approach, the FAA is promoting the development of an extensive database of aircraft activity and events. In addition, the FAA is developing new regulations requiring carriers to adopt safety management systems.

4. Environmental Protection Agency

Background

Established in 1970, the U.S. Environmental Protection Agency now administers all or part of 32 statutes, including 10 major ones covering air, water, and land pollution and pesticide and chemical regulation.[151] Unlike MMS and FAA, EPA does not focus on a single industry. The regulatory authorities of EPA cut across virtually all domestic industries and some consumer practices as well. Most of these responsibilities cover the management of continuous emissions or releases of pollutants, although the agency is also involved in oil spill prevention and response, certain types of chemical and accidental releases, and cleanup activities on both land and water. Most programs are implemented by the states, with funding from and oversight by EPA. Lacking a single,

[151] See Appendix A.

overarching statute, the individual laws EPA implements are integrated by the agency's broad mandate to protect human health and the environment. Naturally, in the absence of an organic statute, there are major differences among the agency's programs.

Compared with MMS and FAA, where lawsuits are relatively rare, EPA is regularly challenged in the courts. This may reflect the broad reach and relatively high cost of its regulations, estimated at about 2 percent of GDP. Whatever the cause of the litigious environment in which EPA operates, the threat of legal challenge has probably contributed to the agency's emphasis on science and quantitative risk assessment.

EPA's FY 2011 operating budget, which supports research, regulation, and enforcement, is $3.9 billion. EPA also administers state and tribal assistance grant programs ($4.8 billion) to support environmental management activities across the United States, and infrastructure financing for water treatment and related projects ($3.8 billion). The agency employs approximately 17,400 people across the country—at its headquarters office in Washington, D.C., in 10 regional offices, and at more than a dozen laboratories and field sites. The agency also funds substantial extramural grants and contracts in support of its mission. More than 3,000 staff members are involved in compliance and enforcement activities.

In this section, we discuss EPA's handling of the same issues facing MMS and FAA. Most of the data are drawn directly from EPA sources, although some academic studies and anecdotal sources are also used.

Regulatory Development: Decisionmaking Criteria and Analysis

Rulemaking

EPA's regulatory activities are dictated by specific decisionmaking criteria contained in the multiple statutes it administers. In some cases, the statutory criteria are quite specific. For example, although the most recent round of auto standards does require extensive technical and policy judgments by the agency, historically, most tailpipe regulations have had formalized numeric criteria established in statute. In other cases, however, the statutory criteria are relatively broad and, arguably, require extensive technical and policy judgments by the agency to set numeric standards. For example, the Clean Air Act (CAA) directs the EPA administrator to set primary ambient air quality standards that "… allowing an adequate margin of safety … protect the public health."[Clean Air Act, Section 109 (b) (1)] Similarly, the Clean Water Act (CWA) states, "… it is the national goal that the discharge of pollutants into navigable waters … and … the discharge of toxic pollutants in toxic amounts be eliminated."[Clean Water Act, Section 101 9a)]

The opportunity to use economic analyses under each of the major laws the agency administers varies considerably by statute. As shown in Table 20, several statutes allow or even mandate benefit-cost analysis, such as certain sections of the Toxic Substances Control Act (TSCA),

the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Safe Drinking Water Act, and the new source standards under the Clean Air Act. At the same time, other provisions provide for more limited use of economic criteria. Section 108 of the CAA provides that National Ambient Air Quality Standards be based strictly on health criteria without consideration of costs, an interpretation reaffirmed by a 2001 Supreme Court ruling.[152] Most statutes do allow at least some consideration of cost-related factors—for example, the use of cost-effectiveness analysis—but not the comprehensive comparison of costs and benefits.

Table 20. Analysis Allowable Under Environmental Statutes

	Benefit-related factors			*Cost-related factors*			
	Pollution reduction	*Health*	*Welfare*	*Technical feasibility*	*Affordability*	*Cost-effectiveness*	*Benefit /cost*
Clean Air Act (CAA)							
NAAQS/primary		X					
NAAQS/secondary			X				?
Hazardous air pollution		a	a	b	b	b	b
Automobile engines	c	c	c	c	c	c	c
Fuel standards	c	c	c			c	c
New source standards	X			X	X	X	X
Clean Water Act (CWA)							
Effluent guidelines, industrial sources	X	X	X	X	X	X	?
Safe Drinking Water Act (SDWA)							
Maximum contaminant levels		X	X	X	X	X	X
Toxic Substances Control Act (TSCA)		X	X	X	X	X	X
Resource Conservation and Recovery Act (RCRA)		X	X	X	?	?	?
Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)		X	X		X	X	X

?: Uncertain if allowable under this statute.
a: Only marginally relevant in the initial MACT (maximum available control technology) phase; principally relevant for residual risk phase.
b: Affordability, etc. are relevant only within a narrow framework for MACT determinations.
c: Statute contains many specific directives limiting considerations of costs, health, and welfare.

Source: Morgenstern, R. *Economic Analyses at EPA: Assessing Regulatory Impact* (Washington, DC: Resources for the Future Press), 1997.

Across the set of environmental problems it addresses, EPA issues many types of regulations:

- ambient media standards, used as benchmarks for subsequent, more narrowly defined requirements (e.g., ambient air or water quality standards)
- emissions and effluent standards, which focus on pollution at the point of release into the environment and can themselves be defined in a variety of ways, such as limits on total amounts released, limits on concentrations discharged to effluent streams, percentage

[152] *Whitman v. American Trucking Associations*, 121 S. Ct. 903 (2001).

reduction from uncontrolled levels, and rate of emission per unit of output (such as CWA effluent limits);

- controls on the sale and use of products that have environmental effects when used or disposed of (e.g., mobile source regulations under the CAA, controls on materials affecting stratospheric ozone, and pesticide regulation under FIFRA);
- controls on contaminants in products directly consumed, such those regulated by the SDWA;
- controls on operations of activities that manage or use hazardous materials, such as Resource Conservation and Recovery Act (RCRA) requirements for management, disposal, and transportation of hazardous waste;
- targets for remediation of past releases, such as RCRA corrective action;
- controls to prevent degradation of targeted areas or resources, such as prevention of significant deterioration requirements under the CAA or nondegradation requirements under the CWA;
- requirements for public reporting of information, such as the Emergency Planning and Community Right-to-Know Act and the SDWA;
- protection of workers from exposure during employment, such as FIFRA worker protection standards; and
- decision processes, procedures, and certification training requirements for private abatement of hazards, such as the TSCA lead abatement program.

In support of that wide array of regulatory actions, EPA has developed extensive procedures and policies for data collection, risk assessment, economic analysis, research, and peer review. For example, the agency has extensive guidelines for technical analyses covering risk and economic issues.[153] To determine best practices, EPA often conducts surveys of pollution control technologies used in different industries.

[153] For a list of the agency's guidelines, see http://nlquery.epa.gov/epasearch/epasearch?querytext=epa+guidelines+&fld=&areaname=&typeofsearch=epa&areacontacts=http%3A%2F%2Fwww.epa.gov%2Fepahome%2Fcomments.htm&areasearchurl=&result_template=epafiles_default.xsl&filter=sample4filt.hts

Although EPA has its share of critics regarding the quality of its science, many observers see it as a leader among federal regulatory agencies in its emphasis on science and quantitative analysis. In fact, more than $800 million, roughly 20 percent of the agency's FY 2011 total operating budget, is categorized as science and technology (EPA 2009). A large portion of this funding is used to support the agency's regulatory agenda. In addition, substantial portions of its $2.9 billion program and management budget are devoted to quantitative risk assessments, as well as to technology and economic assessments, including regulatory impact analyses (RIAs).

EPA measures its overall performance in terms of five long-term goals:

- clean air and global climate change;
- clean and safe water;
- land preservation and restoration;
- healthy communities and ecosystems; and
- compliance and environmental stewardship.

The agency has established a total of 20 measurable objectives in support of those goals, each of which is based on a dozen or more specific metrics. Progress on all the agency metrics has been substantial in recent years. In most cases, progress extends over several decades. For example, under the clean air and global climate change goal, in the "healthier outdoor air" objective, EPA reports major reductions in unhealthy levels of exposure to fine and ultrafine particulate matter (both PM_{10} and $PM_{2.5}$), lead, nitrogen oxides, carbon monoxide, and ozone. Similarly, emissions of sulfur dioxide and both stationary and mobile sources of toxics have also declined.

Other clean air and global climate change categories are protection of the ozone layer, radiation, greenhouse gas intensity, and the enhancement of science and research, all of which also demonstrate substantial progress over the years. The agency also reports gains in its other long-term goals. A further area in which EPA reports progress is the recently established category of homeland security and emergency response. For details, see EPA's "Performance and Accountability Report FY2009."[154]

A total of 53 evaluations of EPA programs using the program assessment rating tool were conducted by OMB over 2003–2006.[155] Ninety percent of EPA programs were rated as performing, and the remaining 10 percent were judged as nonperforming. These scores are somewhat above OMB's government-wide average level of 80 percent performing and 20 percent nonperforming.

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[154] http://www.epa.gov/ocfo/par/

[155] See ExpectMore website, http://financingstimulus.org/index.html.

Among those in the performing category, two-thirds were deemed adequate and the other one-third were considered moderately effective, a higher rating. None of the agency's programs were rated effective, OMB's highest category.

EPA has a relatively strong track record in quantifying the benefits and costs of its actions. Despite statutory provisions limiting or even precluding the use of economic analyses in decisionmaking, the agency conducts extensive economic studies on pending regulations. In a recent report to Congress, OMB presents estimates of the total annual benefits and costs of major federal rules, by agency. For the 10-year period ending September 30, 2009, OMB reports that EPA issued 30 major rules, with total benefits of $81.9 billion to $533.1 billion. The cost of these rules is estimated to range from $25.9 billion to $29.2 billion. In several cases, the rules were issued on the basis of particular statutory provisions even though the estimated cost exceeded the quantified benefits. Interestingly, compared with the 95 major rules issued by all federal agencies over the same 10-year period, the 30 EPA regulations were responsible for 82.6 percent of the total benefits and 56.3 percent of the total costs.[156]

Voluntary Consensus Standards

Unlike MMS, EPA does not rely heavily on voluntary consensus standards. Based on a recent report by the National Institute of Standards and Technology (NIST) in compliance with OMB Circular A-119, covering FY 2007, EPA adopted 3 of the 350 voluntary consensus standards used that year throughout the government, or less than 1 percent. Similarly, only 1.3 percent of the 3,370 employees participating in voluntary consensus standards bodies on a government-wide basis were from EPA. The same report indicates that EPA regulations constituted almost half of the cases where government unique standards were used in lieu of voluntary consensus standards. [157]

EPA offered the following rationales for developing its own standards: the voluntary consensus standard was "too broad to be useful in a regulatory sense," lacked "quality control and quality assurance requirements," was "too general, too broad, or not sufficiently detailed to assure compliance with EPA regulatory requirements," had "applicability specifications [that were] not clearly defined," could "detect leaks but not classify the leak as [a volatile organic compound]," and was "not a complete weighting procedure because it does not include a pretest procedure."[158] Clearly,

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[156] U.S. Office of Management and Budget, *Report to Congress on the Benefits and Costs of Federal Reugaltions and Unfunded Mandates on State, Local, and Tribal Entities* (Washington, DC: Office of Information and Regulatory Affairs), 2010.

[157] National Institute of Standards and Technology, *Eleventh Annual Report on Federal Agency Use of Voluntary Consensus Standards and Conformity Assessment,* NISTIR 7503 (Washington, DC: U.S. Department of Commerce, May), 2008.

[158] Ibid.

the agency does not readily accept standards established by industry but rather, in almost all cases, uses its expertise and the authority granted to it by Congress to establish its own standards.[159]

International Practices: Information Exchanges

EPA is involved in information exchanges with many foreign governments and international organizations on matters of science, technology, and policy. For example, the agency participates in numerous groups and committees of the Organization for Economic Cooperation and Development. EPA has also established bilateral agreements with foreign governments, especially developing countries. These agreements involve information exchanges on a range of issues, including air and water pollution, waste management, chemical regulation, and climate change. For example, in FY 2008, the agency developed a program with China to establish human health and environmental training and programs on exported and imported products.

The agency also participates in international enforcement activities. For example, EPA works with state, federal, and international governments to secure compliance along the U.S. borders with Canada and Mexico to ensure that imported goods and hazardous waste shipments comply with U.S. environmental laws. Further, EPA shares information and techniques for compliance assurance with other countries and provides technical assistance and training to increase enforcement and compliance capacity. For example, in FY 2008, EPA helped establish the International Network of Environmental and Compliance Training Professionals to support international sharing of information and techniques for training environmental professionals, including inspectors.

Metrics and Measurements of Performance

EPA uses a range of metrics to assess risks to human health and the environment. The agency has issued scientific documents outlining principles and concepts that guide risk assessment for carcinogenicity, mutagenicity, developmental toxicity, exposure, chemical mixtures, and other hazards. In the area of cancer risks, the agency has established a lifetime risk range of 1 in 10,000 to 1 in 1,000,000 as generally acceptable for regulatory decisions and for site cleanup. For noncancer health risks, the agency has developed extensive guidance on the use of reference doses for different

[159] One might argue that because EPA tends to deal with nonmarket externalities, private parties don't have much incentive to develop voluntary standards until the government determines how much health or environmental damage constitutes a violation. FAA and, to some extent, MMS deal with problems for which markets generally exist, and for which private parties can seek recovery. Thus, at least some of the externalities are internalized without the government's having to referee. Of course, because some oil spill damages also involve nonmarket externalities, these distinctions are not clearcut.

toxicants. EPA's integrated risk information system represents a compendium of chemical toxicity values that incorporate the agency's latest research and approved methodologies.[160]

Beyond the consideration of individual pollutants and individual environmental problems, EPA has also considered the relative risks posed by the different problem areas it manages. In a 1987 study entitled "Unfinished Business: A Comparative Assessment of Environmental Problems," the agency compared the relative risks posed by 31 problems within four broad risk categories—human cancer risk, human noncancer risk, ecological risk, and welfare risk—focusing on the risks that remain after currently required controls have been applied, i.e., residual risks. Among other findings, the report noted the disparity between residual risks and EPA's resource allocations to individual programs.

In its regulatory impact analyses, the agency uses $6 million as the value of a statistical life. However, this metric is not rigidly adhered to in decisionmaking. Largely because the statutes are not uniformly governed by economic criteria, in numerous instances the cost per life saved has exceeded $6 million, sometimes by a large margin, as has been documented in the academic literature.[161]

The agency typically devotes considerable resources to quantifying and monetizing the environmental, health, and safety risks and benefits of taking action. EPA's Office of Air and Radiation is an agency leader in this area. For example, recent RIAs involving sulfur dioxide, nitrogen oxides, and mercury have quantified the following endpoints: premature mortality long-term exposure for adults (>30 years) and children (<1 year) PM, chronic bronchitis (adults, 26 and older), nonfatal myocardial infarctions PM, hospital admissions from respiratory causes O3 and PM, hospital admissions from cardiovascular causes PM, emergency room visits for asthma O3 and PM, acute bronchitis (children, aged 8–12) PM, lower respiratory symptoms (children, aged 7–14) PM, upper respiratory symptoms (asthmatic children, aged 9–11) PM, asthma exacerbations PM, work loss days (adults aged 18–65) PM, minor restricted-activity days (adults, aged 18–65) O3 and PM, school absence days (children aged 6–11) O3, worker productivity (outdoor workers aged 18–65) O3, recreational visibility (81 Class I areas), mercury poisoning episodes, neurologic effects, cardiovascular impacts, genotoxic effects, immunotoxic effects, other human toxicity data, and ecological effects.[162]

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[160] http://www.epa.gov/IRIS/

[161] See, for example, Tengs, T.O., M.E. Adams, J.S. Pliskin, D.G. Safran, J.E. Siegel, M.C. Weinstein, and J.D. Graham. 1995. Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness, *Risk Analysis* 15(3): 369–90, .

[162] For more information, see http://www.epa.gov/cair/pdfs/finaltech08.pdf and http://www.epa.gov/ttnecas1/regdata/RIAs/mercury_ria_final.pdf.

Resources Available for Regulatory Analysis

As noted, more than half of EPA employees are engineers, scientists, and policy analysts. Table 21 shows the distribution of EPA employees with graduate degrees (in 27 academic disciplines) as recorded in the EPA personnel records as of November 1996 (the most recent available). The disciplines, in descending order, are law (18 percent), biological or life sciences (16 percent), engineering (16 percent), physical science (14 percent), business management and administrative services (7 percent), public administration, including public policy (7 percent), social science other than economics (5 percent), health sciences (3 percent), conservation and natural resources (3 percent), and economics (2 percent). Although comparable data for other agencies are not publicly available, most observers agree that EPA has one of the most highly educated workforces among federal regulatory agencies.

Despite the high degree of training of its employees, an issue of possible concern is the extent to which EPA attracts and retains the "best and brightest." The evidence on this issue is not very strong, but the agency does have a good track record of attracting graduates of prestigious schools. Further, EPA has pioneered in the efforts to expand eligibility for high grade levels to highly skilled employees outside management.

With its highly educated workforce, large network of consultants and university experts, and substantial extramural budget to support research and analysis, EPA is able to conduct extensive research and analysis in support of its agenda. For example, the agency reported spending $150 million in FY 2009 on science and research in support of its clean air and global climate change goal, including on the issues of air toxics, global protection, the National Ambient Air Quality Standards, and others. Comparable activities are underway to enhance science and research in support of the agency's other long-term goals.

In the area of economic analysis, the agency has issued detailed guidelines and routinely develops 8 to 10 RIAs per year at an estimated cost of $1 million (1997$) each.[163] EPA also conducts economic and regulatory analyses for dozens of rules that do not meet the threshold requirements for a formal RIA.

[163] Morgenstern, R. *Economic Analyses at EPA: Assessing Regulatory Impact* (Washington, DC: Resources for the Future Press), 1997.

Table 21. Graduate Degrees of EPA Employees

Discipline	*Doctorate*	*Master's or J.D.*	*Total number*	*Total percent**
Law	50	1,201	1,251	18.1
Biological science/life science	500	624	1,124	16.2
Engineering	104	992	1,096	15.8
Physical science	323	613	936	13.5
Business management and administrative services	6	463	469	6.8
Public administration	9	442	451	6.5
Social sciences and history/not including economics	52	294	346	5.0
Health professional and related sciences	31	157	188	2.7
Conservation/renewable natural resources	23	154	177	2.6
Economics	31	85	116	1.7
Agriculture	34	76	110	1.6
Architecture	2	101	103	1.5
Education	5	91	96	1.4
Multi/interdisciplinary studies	11	76	87	1.3
Psychology	25	28	53	0.8
Computer/information science	4	45	49	0.7
English language and literature	5	40	45	0.7
Communications	2	34	36	0.5
Library science	0	30	30	0.4
Philosophy and religion	21	9	30	0.4
Liberal arts and sciences, general studies and humanities	0	23	23	0.3
Foreign language/literature	2	11	13	0.2
Visual and performing arts	0	10	10	0.1
Home economics	5	4	9	0.1
Ethnic/cultural studies	1	7	8	0.1
Theological studies/religious vocations	2	6	8	0.1
Other	25	86	111	1.6
Total**	1,248	5,674	6,922	100*

* As percent of total employees at EPA with graduate degrees

** Totals may not add due to double-counting of employees with more than one graduate degree.

Source: Morgenstern, R., Table 2 in "Legal and Institutional Settings," *Economic Analyses at EPA: Assessing Regulatory Impact* (Washington, DC: Resources for the Future Press), 1997.

Role of Peer Review

Although a common refrain from agency defenders is that the science drives regulatory decisions, critics make routine claims of poor quality studies and/or overinterpretation of the results. Over the years, agency analyses and regulatory decisions have been reviewed by numerous panels of the National Academy of Sciences and others, which sometimes fault the agency and other times hail it as a leader in the field. A 2001 report noted that the "risk assessment process is bogged down … decision-making based on risk assessment is also bogged down … uncertainty, an inherent property of scientific data, continues to lead to multiple interpretations and contribute to decisionmaking gridlock."[164] The report recommended improvements in agency practices in several areas:

- design of risk assessment;
- uncertainty and variability;
- selection and use of defaults;
- development of a unified approach to dose-response assessment;
- cumulative risk assessment; and
- mechanisms for improving the utility of risk assessment.

In response to that and other reviews, and following issuance of 2004 OMB guidance on information quality, in 2006 EPA established a formal policy for conducting peer review of scientifically and technically based agency outputs, including economic and social science products, that are intended to inform agency decisions. EPA deems peer review to occur when the designated work products are evaluated by relevant experts who were not involved in creating the product itself.

On January 31, 2006, the EPA administrator issued the agency's most recent policy statement on peer review:

> Peer review of all scientific and technical information that is intended to inform or support Agency decisions is encouraged and expected. Influential scientific information, including highly influential scientific assessments, should be peer reviewed in accordance with the Agency's Peer Review Handbook. All Agency managers are accountable for ensuring that Agency policy and guidance are

[164] National Research Council, *Science and Decisions: Advancing Risk Assessment.* Committee on Improving Risk Analysis Approaches Used by the U.S. E.P.A., Board on Environmental Studies and Toxicology (Washington, DC: National Academy Press), 2001: 3-4.

> appropriately applied in determining if their work products are influential or highly influential, and for deciding the nature, scope, and timing of their peer review. For highly influential scientific assessments, external peer review is the expected procedure. For influential scientific information intended to support important decisions, or for work products that have special importance in their own right, external peer review is the approach of choice. Peer review is not restricted to the nearly final version of work products; in fact, peer review at the planning stage can often be extremely beneficial.[165]

EPA's Science Policy Council is responsible for overseeing agency-wide implementation of the peer review policy, including promoting consistent interpretation, assessing agency-wide progress, developing recommendations for revisions of the policy, and issuing the *Peer Review Handbook*, which provides additional information and procedures on implementation.[166]

EPA also relies on committees established under the authority of the Federal Advisory Committee Act of 1972 to obtain advice on a wide range of environmental issues. FACA committees can be created by the President, Congress, or federal departments or agencies but must meet these basic requirements:

- Meeting must be open to the public, and the public must be permitted to present their views.
- All meeting minutes and reports must be available for public access.
- The public must be notified of meetings by advertisement in the Federal Register.
- Committee membership must be balanced by points of view.

EPA's Office of Federal Advisory Committee Management and Outreach operates the agency's FACA committees and has responsibility for the oversight and policy of all EPA federal advisory committees. Currently, EPA operates four FACA committees:

- Advisory Council on Clean Air Compliance Analysis. This committee provides advice on technical and economic aspects of reports EPA prepares on the effects of the Clean Air Act.
- Clean Air Scientific Advisory Committee. The committee advises EPA on the technical bases for the agency's national ambient air quality standards program.

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[165] U.S. Environmental Protection Agency (EPA) Peer Review Advisory Group, *Peer Review Handbook*, 3rd edition, prepared for EPA's Science Policy Council (Washington, DC: U.S. EPA), 2006. http://www.epa.gov/peerreview/pdfs/peer_review_handbook_2006.pdf.

[166] Ibid.

- National Advisory Council for Environmental Policy and Technology. This committee advises the EPA administrator on a broad range of environmental policy, technology, and management issues.
- Science Advisory Board. The board provides peer review and other types of expert advice on a wide range of topics in science and technology.

In addition, there is a Science Advisory Panel, established by Congress in 1975 through FIFRA. The panel is composed of seven members representing a breadth of scientific disciplines and focuses on the risks that pesticides pose to wildlife, farm workers, pesticide applicators, and the general public through diet and exposure in homes, schools, parks, pools, and golf courses. Like the Science Advisory Board, it operates in accordance with FACA. Its scientists neither make nor recommend policy but provide advice on the science used in policymaking.

The FACA committees include scientists, public health officials, businesses, citizens, community representatives, and members from all levels of government—approximately 800 individuals altogether. On its website, the agency touts its "open, transparent, and peer reviewed research planning, competitively awarded extramural research grants; independent peer review of EPA science publications, assessments, and documents; and rigorous peer review of EPA's research laboratories and centers."[167]

Inspections, Compliance, and Enforcement

Training Requirements and Practices

EPA has developed training programs to maintain and upgrade the skills and knowledge of its staff throughout the agency. For example, in the area of enforcement, the agency's in-house National Enforcement Training Institute (NETI) serves as a clearinghouse for training information within the enforcement and compliance assurance program, exploring cost-effective means of delivering both classroom and distance training. NETI supports training of federal, state, local, and tribal attorneys, as well as inspectors, civil and criminal investigators, and technical experts, in all the tools for environmental compliance and enforcement. NETI conducts a range of activities:

- identifying strategic education and training needs that reflect priorities and gaps in knowledge and skills of those engaged in ensuring compliance with federal environmental laws;

[167] U.S. Environmental Protection Agency, Role of Science at EPA. 2010. http://www.epa.gov/epahome/science.htm, Accessed October 5, 2010.

- providing education and training through quality courses and materials, offered through a variety of delivery mechanisms, to build and maintain competency and professionalism;
- providing training in compliance monitoring, compliance assistance, compliance incentives, and civil and criminal enforcement; and
- promoting a culture of continuous learning among environmental compliance professionals in federal, state, tribal and local governments.

Further information is available on the EPA website.[168]

Regulatory Enforcement

Enforcement of the environmental statutes it administers is a high priority for EPA. As noted, more than 3,000 people, roughly 20 percent of its workforce, are engaged in enforcement activities. An important part of the agency's effort is aimed at the oversight of state government agencies and others delegated to carry out frontline enforcement efforts. The overall goal of the enforcement program is to maximize compliance with the federal environmental statutes through compliance assistance, monitoring, and enforcement. The agency implements a total of 28 separate program areas dealing with prevention and control of air pollution, water pollution, hazardous waste, toxic substances, and pesticides. The statutory and regulatory requirements of these programs apply to a diverse universe of regulated entities and include the use of incentive policies, which reduce or waive penalties under certain conditions for facilities that voluntarily discover, promptly disclose, and correct environmental problems.

Monitoring of state and regional activities is done at varying frequencies, depending on the nature of the project. At a minimum, an evaluation is done at midyear and at the end of a fiscal year based on regional and state results entered in agency databases and data for national priorities. The performance expectations and activities outlined in the agency's guidance documents are the starting point from which headquarters and the regional offices discuss the management of program activities and the distribution of resources. These discussions result in regional commitments for a specific level of activity for the fiscal year. The commitments constitute the agreed-upon approach between the regions and the national program managers for achieving performance expectations in the core program and national priority focus areas for the fiscal year.

EPA sets national enforcement initiatives every three years to focus resources toward the most significant environmental problems and human health challenges identified by EPA staff, states, tribes, and the public. Many of the annual commitments in the agency's guidance documents, as well

[168] http://www.epa.gov/compliance/training/neti/.

as the activities associated with the core enforcement and compliance assurance program, support the priorities for EPA regions. For example, in FY 2009, annual commitments for inspections and assistance to concentrated animal feeding operations support Northeast and Great American West regional agriculture priorities. The air toxics national priority and accompanying commitment supports the regional Great South, Midwest, and U.S.-Mexico border priorities for air toxics. Core program implementation and results for TSCA lead enforcement support the Midwest regional priority for lead poisoning. The national priority for RCRA mineral processing supports the Great American West regional priority for mining. Implementation of national priorities and associated annual commitments on stormwater, combined sewer overflows, and sanitary sewer overflows support U.S.-Mexico Border, Islands, Northeast, Great South, and Midwest regional priorities for wastewater, drinking water quality, nutrients, and sedimentation.

Although private firms can audit themselves more cheaply and effectively than regulators can, firms may be deterred by fear that information they uncover will be used against them. To reduce this disincentive, the EPA audit policy, formally titled "Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations," provides incentives for regulated entities to voluntarily come into compliance with federal environmental laws and regulations. The policy was introduced in 1995 and revised in 2004. The regulated entity must voluntarily discover, promptly disclose to EPA, expeditiously correct, and prevent recurrence of the environmental violation. Disclosures are often preceded by consultation between EPA and the regulated entity, during which mutually acceptable disclosure details, compliance, and audit schedules are discussed.

Civil penalties under the environmental laws generally have two components, an amount assessed based upon the severity, or "gravity," of the violation, and the amount of economic benefit a violator received from failing to comply with the law. The policy includes the following two provisions:

- No gravity-based penalties are assessed if all nine of the policy's conditions are met. EPA retains its discretion to collect any economic benefit that may have been realized as a result of noncompliance.
- Gravity-based penalties are reduced by 75 percent if the disclosing entity meets all of the policy's conditions except detection of the violation through a systematic discovery process.

Further, entities that disclose criminal violations are not recommended for prosecution if all of the applicable conditions are met. "Systematic discovery" is not a requirement for eligibility for this provision, although the entity must act in good faith and adopt a systematic approach to preventing future violations.

Entities that satisfy the following conditions are eligible for audit policy benefits:

- The violation was detected in "systematic discovery"—that is, through an environmental audit or the implementation of a compliance management system. Discovery occurs when any officer, director, employee, or agent of the facility has an objectively reasonable basis for believing that a violation has or may have occurred.
- The violation was not detected as a result of a legally required monitoring, sampling, or auditing procedure.
- The violation is promptly disclosed in writing to EPA—within 21 days of discovery or such shorter time as may be required by law.
- Independent discovery and disclosure take place before EPA or another regulator would likely have identified the violation through its own investigation or based on information provided by a third party.
- Correction and remediation occur within 60 calendar days—in most cases, from the date of discovery.
- The facility prevents recurrence of the violation.
- Repeat violations—that is, the specific (or closely related) violations at the same facility within the past three years or those that have occurred as part of a pattern at multiple facilities owned or operated by the same entity within the past five years—are ineligible. If the facility has been newly acquired, the existence of a violation prior to acquisition does not trigger the repeat violations exclusion.
- Certain types of violations are ineligible, such as those that result in serious actual harm, those that may have presented an imminent and substantial endangerment, and those that violate the specific terms of an administrative or judicial order or consent agreement.
- Cooperation by the disclosing entity is required.[169]

Even if the entity fails to meet the first condition, systematic discovery, it may still be eligible for 75 percent penalty mitigation and a recommendation for no criminal prosecution.

Although the audit policy is widely touted by the agency and by some in the enforcement community, there are few independent analyses. One recent study[170] compared the self-reported

[169] For more information see: http://www.epa.gov/oecaerth/incentives/auditing/auditpolicy.html

[170] Pfaff, A., and C.W. Sanchirico. 2004. Big Field, Small Potatoes: An Empirical Assessment of EPA's Self-Audit Policy, *Journal of Policy Analysis and Management* 23(3): 415–432.

violations with those detected by standard EPA enforcement and found that the typical self-audited violation was relatively minor. Cases arising under the policy were more likely to concern reporting violations and less likely to concern emissions.

Table 22 displays detailed information on the accomplishments of EPA's enforcement activities for FY 2007 and FY 2008. The agency conducted 20,000 inspections and evaluations of facilities in FY 2008, slightly fewer than in the prior year. Apart from its Superfund-related enforcement activities, in FY 2008 the agency concluded civil and criminal enforcement actions requiring polluters to spend an estimated $11.7 billion on pollution controls, cleanup, and environmental projects plus an additional $39 million on environmentally beneficial projects, up slightly from the prior year. In addition to these pollution reductions, the agency assessed more than $125 million in civil penalties, and courts sentenced defendants to pay more than $60 million in criminal fines and an additional $12 million in court-ordered environmental projects, up substantially from the prior year.

Table 22. EPA Enforcement Data, 2007–2008

	2008	2007
Investments in Pollution Control and Clean-up (Injunctive Relief)	$11,700,000,000	$10,550,000,000
Investments in Environmentally Beneficial Projects (SEPs)	$39,000,000	$30,000,000
Civil Penalties Assessed		
Administrative Penalties Assessed	$38,200,000	$30,700,000
Judicial Penalties Assessed	$88,400,000	$39,800,000
Stipulated Penalties Assessed	$5,500,000	$12,400,000
EPA Civil Enforcement and Compliance Activities		
Referrals of Civil Judicial Enforcement Cases to Department of Justice (DOJ)	280	278
Supplemental Referrals of Civil Judicial Enforcement Cases to DOJ	35	19
Civil Judicial Complaints Filed with Court	164	127
Civil Judicial Enforcement Case Conclusions	192	180
Administrative Penalty Order Complaints	2,056	2,237
Final Administrative Penalty Orders	2,084	2,255
Administrative Compliance Orders	1,390	1,247
Cases with SEPs	188	184
EPA Compliance Monitoring Activities		
Inspections/Evaluations	20,000	22,000
Civil Investigations	222	346
Number of Regulated Entities Taking Complying Actions during EPA Inspections/Evaluations	1,100	1,350
Number of Regulated Entities Receiving Compliance Assistance during EPA Inspections/Evaluations	11,600	13,500
Inspections Conducted by Tribal Inspectors Using Federal Credentials[1]	334	-
EPA Superfund Cleanup Enforcement		
Percent of non-Federal Superfund Sites with Viable, Liable Parties where an Enforcement Action was Taken Prior to the Start of the Remedial Action	100%	100%
Private Party Commitments for Site Study and Cleanup (including cash outs)	$1,575,000,000	$688,000,000
Private Party Commitments for Oversight	$76,000,000	$62,000,000
Private Party Commitments for Cost Recovery	$232,000,000	$252,000,000
Percent of Cost Recovery Cases Greater Than or Equal to $200,000 that were Addressed before the Statute of Limitations Expired	100%	98%
EPA Criminal Enforcement Program		
Years of Incarceration	57	64
Fines and Restitution	$63,500,000	$63,000,000
Value of Court Ordered Environmental Projects	$12,000,000	$135,000,000
Environmental Crime Cases Initiated	319	340
Defendants Charged	176	226
Estimated Pollution Reduced, Treated or Eliminated Commitments (Pounds)[2]	1,600,000	18,000,000
EPA Compliance Assistance		
Total Entities Reached by Compliance Assistance	361,000	1,228,000
Number of User Visits to Web-Based Compliance Assistance Centers	2,220,000	1,958,000

Source: EPA's OECA Accomplishment Reports (2007-2008).

[1] In FY 2008, for the first time, OECA is creating a separate reporting category to count the number of tribal inspections conducted by tribal inspections using federal credentials. Inspections conducted by tribal inspectors using federal credentials are done "on behalf" of the Agency, but are not an EPA activity.

[2] Projected reductions to be achieved during the one year period after all actions required to attain full compliance have been completed.

EPA involves the public in its enforcement efforts. For example, EPA has a website where individuals can report potential environmental violations in their communities and workplaces. On its main site, the agency reports that information provided by the public has led to state and federal enforcement cases and "ultimately served environmental protection well."[171] As another sign of its desire to engage the public, in 2008 EPA set up a most-wanted list for defendants charged with environmental crimes or violations of the U.S. Federal Criminal Code. It encourages the public to report information to the local police or the nearest U.S. Embassy for those outside the United States.[172]

Of the 53 reviews of EPA activities conducted by OMB in 2003–2006, 3 focused on enforcement programs. OMB rated the civil enforcement and criminal enforcement programs as effective but found the agency's pesticide enforcement grant program ineffective.[173]

Most academic research on EPA's enforcement activities supports the view that the agency has strong and effective enforcement programs. A 1997 paper by Nadeau finds that EPA is effective at reducing the time plants are in violation of standards.[174] They estimate that a 10 percent increase in enforcement activity results in a 4–4.7 percent reduction in violation time.[175] Based on a sample of 1990–1997 air, water and waste penalties, in a 2002 study, Firestone finds that EPA's decision of which individuals to pursue penalty actions against—whether for administrative, civil judicial, or criminal actions—is consistent with the goal of minimizing environmental harm.[176] Using data on EPA's enforcement and compliance by steel plants during the 1980s, Deily and Gray find evidence that the agency was influenced by the productivity of its abatement activities and not by the costs that would be imposed on the plant or by the expectation of resistance from politically powerful firms or those in financial distress.[177]

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[171] See http://www.epa.gov/compliance/complaints/index.html.

[172] See http://www.epa.gov/compliance/complaints/index.html.

[173] This program was rated ineffective for the following reasons: (1) States do not collect sufficient outcome measures to assess the program's effectiveness. (2) EPA's oversight of grant performance focuses only on reviewing output measures collected by states (number of inspections and investigations) and the states' financial management of their grant funds. The oversight does not evaluate whether a state is using its funds in the most effective way. (3) The higher the percentage of EPA funding for a state's total program, the higher the average cost of conducting enforcement actions, which suggests an ineffective use of federal funds. See http://www.financingstimulus.org/summary/10002286.2004.htmo

[174] Nadeau, L.W. 1997. EPA Effectiveness at Reducing the Duration of Plant-Level Noncompliance. *Journal of Environmental Economics and Management* 34(1): 54–78.

[175] Ibid.

[176] Firestone, J. 2002. Agency Governance and Enforcement: The Influence of Mission on Environmental Decisionmaking. *Journal of Policy Analysis and Management* 21(3): 409–26.

[177] Deily, M.E., and W.B. Gray. 2008. Agency Structure and Firm Culture: OSHA, EPA, and the Steel Industry. *Journal of Law, Economics, and Organization* 23(3): 685–709.

A somewhat more critical view is provided by Rosenberg, who examined trends in EPA's enforcement practices over 1999–2004.[178] His central conclusion is that administrative enforcement, with an emphasis on settlement, increasingly dominates the agency's enforcement practices, dwarfing judicially supervised enforcement. Further, he finds that the civil penalties imposed are relatively small and, interestingly, tend to be adjusted downward in the course of the negotiation process. Although this may be efficient for the agency, he argues that this practice "may provide the regulated community with the idea that environmental enforcement does not present a serious threat to court enforcement, and so may not deter noncompliant conduct."[179]

Main Points about EPA

EPA is responsible for the administration of numerous statutes related to pollution and environmental quality, which leads to substantial variation in its approach to regulation. Some statutes grant EPA leeway in setting regulations, while others give very specific criteria for regulatory decisions. Some statutes allow economic and cost-benefit analysis, while others allow little or no use of such analysis. When possible, EPA makes extensive use of quantitative cost-benefit analysis, and its regulations were recognized by OMB for resulting in high levels of benefits relative to costs incurred.

EPA generally does not employ voluntary consensus standards because it considers such standards inadequate. It does make extensive use of scientific peer review in developing and evaluating its regulations.

EPA has a much more adversarial relationship with the industries it regulates than does MMS or FAA. Its regulations are routinely challenged in court, and litigation has led EPA to rely heavily on quantitative methods and scientific peer review.

5. Recommendations for Enhancing Safety in Offshore Energy Activities

In the wake of the *Deepwater Horizon* oil spill disaster, improving safety and reducing risks associated with offshore oil and gas exploration and production require understanding (1) the historical and current performance context; (2) the particular sequence of events that contributed to the recent disaster; (3) private sector safety cultures, practices, and incentives; (4) risk assessment and risk management goals and practices; (5) regulatory and oversight methods, roles, responsibilities, and management practices; and (6) emergency preparedness and response capacities and practices.

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[178] Rosenberg, R.H. 2008. Doing More or Doing Less for the Environment: Shedding Light on EPA's *Stealth* Method of Environmental Enforcement. *Boston College Environmental Affairs Law Review* 35(175): 175–216.

[179] Ibid., 215.

In this paper, we have reviewed regulatory and oversight issues first by examining how MMS, the regulatory agency with offshore oil and gas oversight responsibilities, has fulfilled its regulatory role, and then by looking at the practices of two other agencies, FAA and EPA. The agency parallels are not perfect, since MMS (before its reorganization) was both a regulatory agency and manager of access to ocean resources through its leasing and planning processes. One would, as a consequence of mission differences among these agencies, expect some differences in approaches to their regulatory responsibilities.

Nonetheless, a comparative evaluation of regulatory structures and management can help illuminate effective practices and opportunities for improvement. We emphasize that to be effective, the following recommendations must be accompanied by other changes in corporate culture, techniques, and operational incentives; emergency preparedness and response; and risk assessment.

The Department of the Interior and its new Bureau of Ocean Energy Management, Regulation, and Enforcement have undertaken several actions to improve the safety and reduce risks associated with offshore oil and gas activities. We consider two particularly important. The first is the reorganization, which when fully implemented will segregate safety and leasing functions into two separate bureaus. The second is the October 15, 2010, Final Rule on Safety and Environmental Management Systems, which incorporates by reference the entire API Recommended Practice 75, with its general procedures and all 12 specific elements. We consider this a clear improvement over the proposed rule, which would have required only 4 of the 12 elements. The final rule also emphasizes the external auditing role of the federal agency by requiring that firms undertake mandatory and periodic audits by independent third parties or by qualified internal personnel. In addition to these self-auditing requirements, the rule establishes conditions for the regulating agency to order independent third-party audits or directly undertake audits itself. Through the required auditing processes, the rule also emphasizes corrective action. In sum, this new rule is an important step forward. Below, we offer some additional recommendations.

Agency Structure and Organization Oversight

On May 19, 2010, Secretary of the Interior Ken Salazar issued an executive order announcing a reorganization of the Minerals Management Service. The reorganization places the leasing and safety functions of the agency in distinct organizations with separate supervisors to ensure independent attention to safety considerations in budgeting and decisionmaking. Through many years, various management reviews have suggested the benefits of a functional rather than primarily geographic organization structure for MMS. Separating the leasing and safety functions into two organizations takes this concept one step further. Interior has not yet completed the reorganization, pending an outside management review. We endorse the general outlines of the reorganization and offer two considerations for designing the new bureaus:

- Maintaining interbureau coordination on matters such as planning and leasing, expected levels of leasing and platform activity, and scientific research.
- Providing safety capacity down to the field level rather than providing that capacity only at the regional level and in headquarters.

Risk Assessment and Risk Management

The safety agency should develop specific guidance on risk assessment and risk management methods and practices. We suggest two methodologies:

- Setting quantitative thresholds or standards for acceptable, tolerable, and unacceptable risk. In reviews of particular rules, techniques, and practices, deviations from these standards should be based on rigorous analysis. Actual decisions about any deviations from the standards should be made at the highest levels of the agency. The practices of FAA, the United Kingdom's Health and Safety Executive, and other agencies that use quantitative thresholds should be evaluated as possible models.
- Using accident precursor analysis instead of historical spill data to develop risk assessments of low-probability major oil spills by identifying the failure probabilities of accident components.

Regulatory Processes and Best Practices

The agency should emphasize safety and environmental performance-based approaches to risk management, such as those used in Norway and the United Kingdom for offshore oil and gas development. Norway requires that each firm identify site-specific risks and hazards, articulate specific safety (risk reduction) performance goals, and show how those goals will be achieved through the techniques, practices, and mitigation measures they deploy at the site. The United Kingdom requires firms to produce a safety case that evaluates hazards on a systematic and holistic basis and shows how the required levels of risk reduction will be achieved. We suggest four specifics:

- In requiring this kind of operator accountability at each site, guidance should be developed to better assure that such operator self-analysis and risk-based performance assessments include key types of information in ways that are verifiable and capable of validation. Some form of independent, third-party audit of performance-based operator assessments should be used to help assure that these assessments or safety cases are relevant, complete, and utilized in operator implementation practices and decisions. BOEMRE (or new safety bureau) should also periodically audit operator self-assessments, adherence to assessment requirements, and overall performance at each site.
- Consistent with our recommendation on establishing clear risk thresholds, the safety agency should apply these thresholds in evaluating alternative compliance options. The safety agency

should develop specific guidance to regions and field offices on how to implement alternative compliance mechanisms (where relevant), including evidence to establish whether alternatives are likely to meet established performance goals.

- In identifying best practices, the agency should establish an independent peer review group (or groups) outside the ANSI (API Voluntary Standards) committees, including strong representation from outside the regulated community, to evaluate the adequacy of regulations for achieving the stated environmental health and safety standards and/or tolerable risk thresholds. In the past, MMS has contracted for independent risk assessments of particular equipment or structures and has periodically contracted for independent reviews of API voluntary consensus standards and their adequacy as the basis for MMS regulations. We propose that such independent review become formal and regular requirements of the agency's regulatory oversight function.
- The agency should consider establishing a permanent independent entity to investigate offshore oil spill accidents that meet certain criteria in order to determine the probable cause of the accident and to offer recommendations on how to prevent reoccurrences. One approach that should be considered is an independent body like the National Transportation Safety Board (NTSB). A more recently created entity, the Chemical Safety and Hazard Investigation Board, offers another model. Both are independent agencies, though they operate in close cooperation with the federal agencies with relevant regulatory responsibilities. As an alternative, FAA has also established the Civilian Aviation Safety Team (CAST) as a cooperative government-industry organization, co-chaired by FAA, to review safety incidents and recommend safety enhancements.

The People Factor

The agency's move toward performance-based training requirements would benefit from two actions:

- Encouraging a higher degree of cross-training among skill sets, to ensure the safe operations of a platform and associated exploration and production equipment and processes.
- Using data concerning incidents of noncompliance to identify areas in which inspectors need additional or different training. Here, the agency could draw from the experiences of EPA's compliance training program.

Enforcement and Compliance

We suggest two approaches:

- Continuing and strengthening the annual operator reviews, in which corrective actions are discussed. This process reinforces a focus on improvement, targeting poor performers and repeated incidents of noncompliance.
- Creating a stronger incentive system for operators and contractors to report risks and problems without penalty (similar to programs developed by both FAA and EPA). The program would not apply to actions associated with criminal violations, fatal accidents, and major injuries.

Appendix A. Laws That Influence Environmental Protection

The following laws and executive orders help protect human health and the environment. EPA is charged with administering all or a part of each.

- Atomic Energy Act (AEA)
- Chemical Safety Information, Site Security and Fuels Regulatory Relief Act
- Clean Air Act (CAA)
- Clean Water Act (CWA) (original title: Federal Water Pollution Control Amendments of 1972)
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, or Superfund)
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Endangered Species Act (ESA)
- Energy Independence and Security Act (EISA)
- Energy Policy Act
- EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045: Protection of Children From Environmental Health Risks and Safety Risks
- EO 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use
- Federal Food, Drug, and Cosmetic Act (FFDCA)
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

- Federal Water Pollution Control Amendments (see Clean Water Act)
- Food Quality Protection Act (FQPA) (see FFDCA and FIFRA)
- Marine Protection, Research, and Sanctuaries Act (MPRSA, also known as the Ocean Dumping Act)
- National Environmental Policy Act (NEPA)
- National Technology Transfer and Advancement Act (NTTAA)
- Noise Control Act
- Nuclear Waste Policy Act (NWPA)
- Occupational Safety and Health (OSHA)
- Ocean Dumping Act (see Marine Protection, Research, and Sanctuaries Act)
- Oil Pollution Act (OPA)
- Pesticide Registration Improvement Act (PRIA) (see FIFRA)
- Pollution Prevention Act (PPA)
- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)
- Shore Protection Act (SPA)
- Superfund (see Comprehensive Environmental Response, Compensation and Liability Act)
- Superfund Amendments and Reauthorization Act (SARA) (see Comprehensive Environmental Response, Compensation and Liability Act)
- Toxic Substances Control Act (TSCA)