COLLABORATIVE APPROACHES IN DEVELOPING ENVIRONMENTAL AND SAFETY MANAGEMENT SYSTEMS FOR COMMERCIAL SPACE TRANSPORTATION

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ABSTRACT

The Federal Aviation Administration (FAA), Office of Commercial Space Transportation (AST) licenses and permits U.S. commercial space launch and reentry activities, and licenses the operation of non-federal launch and reentry sites. AST's mission is to ensure the protection of the public, property, and the national security and foreign policy interests of the United States during commercial space transportation activities and to encourage, facilitate, and promote U.S. commercial space transportation. AST faces unique challenges of ensuring the protection of public health and safety while facilitating and promoting U.S. commercial space transportation.

AST has developed an Environmental Management System (EMS) and a Safety Management System (SMS) to help meet its mission. Although the EMS and SMS were developed independently, the systems share similar elements. Both systems follow a "Plan-Do-Act-Check" model in identifying potential environmental aspects or public safety hazards, assessing significance in terms of severity and likelihood of occurrence, developing approaches to reduce risk, and verifying that the risk is reduced. This paper will describe the similarities between AST's EMS and SMS elements and how AST is building a collaborative approach in environmental and safety management to reduce impacts to the environment and risks to the public.

Introduction

The Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST) regulates United States commercial space launch and reentry activities, and licenses the operation of non-federal launch and reentry sites. AST's mission is to ensure protection of the public, property, and the national security and foreign policy interests of the United States, in the event of a commercial launch or reentry activity, and to encourage, facilitate, and promote U.S. commercial space transportation.

FAA/AST is responsible for regulating commercial space transportation operations only to the extent necessary to ensure public health and safety and the safety of property. In fulfilling its responsibilities, AST issues licenses for expendable launch vehicle, reusable launch vehicle, and reentry vehicle launch and reentry activities, and the operation of commercial launch and reentry sites. AST also issues experimental permits for the launch and reentry of reusable suborbital rockets. AST has met the responsibility to protect public health and safety by licensing several sites and more than 175 commercial launches without injury to a single member of the public.

The commercial space activities proposed in license and permit applications have the potential to create environmental impacts and hazards to public safety. Accordingly, AST will only grant licenses and permits to applicants once they have successfully demonstrated that the proposed operations can be conducted in compliance with all applicable safety and environmental regulations. AST faces this unique challenge of ensuring the protection of public health and safety while facilitating and promoting U.S. commercial space transportation. Therefore, AST has developed an Environmental Management System (EMS) and a Safety Management System (SMS) to organize, administer, and ensure accountability for its oversight of these potentially risky activities while facilitating the industry.

An EMS is a systematic approach to identifying and managing an organization's environmental obligations and issues. Likewise, an SMS is an integrated set of work practices, beliefs, and procedures for monitoring and improving safety practices in an organization. Together, these two systems form a collection of processes, procedures, policies, and programs within AST that are used to assess, define, and manage environmental impacts and safety risks in the conduct of commercial space transportation operations. Because these systems share similar elements, AST is investigating a collaborative approach in implementing formal procedures to identify safety hazards and environmental aspects associated with issuing licenses and permits and to ensure consistent procedures across the organization.

This paper describes how the two management systems are designed to enhance AST's ability to systematically identify environmental and safety obligations and to integrate these into normal organizational processes. The management systems are not creating new obligations; rather, EMS and SMS provide the structure to enhance AST's existing environmental and safety approaches and the ability to proactively meet requirements.

Finally, the paper will identify some challenges for AST in managing its environmental and safety management systems.

Background

AST's license and permit application process is divided into the following activities:
- Pre-Application Consultation
- Policy Review and Approval
- Safety Review and Approval
- Environmental Review
- Compliance Monitoring (post-issuance of license)

During the Pre-Application Consultation and Application Evaluation periods, the FAA works with the applicant to ensure that sufficient information is supplied from the applicant to the FAA to support a review of the proposed action. The Policy Review and Approval process determines whether the information in the license or permit application presents any issues affecting U.S. national security or foreign policy interests, or international obligations of the U.S. The Safety Review and Approval process determines whether a license or permit applicant has satisfied each of the requirements set forth to demonstrate that the proposed activity can be conducted safely.

The Financial Responsibility Determination process ensures that all commercial license and permit holder demonstrate financial responsibility to compensate for the maximum probable loss resulting from claims by a third party for death, bodily injury, or property damage or loss resulting from an activity carried out under the license; and the U.S. Government against a person for damage or loss to government property resulting from an activity carried out under the license. The Environmental Review component of the licensing process ensures that potentially significant environmental impacts of licensed or permitted activities on the natural and human environment are fully considered in decision making. An applicant must provide information sufficient to enable the FAA to comply with all the requirements of such standards. Compliance Monitoring ensures that a licensee complies with the terms and conditions set forth in the license or permit issued by the FAA. Compliance Monitoring also involves oversight conducted by the FAA during licensed and permitted activities. All of these processes, except for Compliance Monitoring, are completed prior to the FAA issuing a license or permit to an applicant. All FAA safety analyses and requirements are included in the terms and conditions of the license or permit.

AST is divided into three divisions within the organization. The responsibilities of a license or permit application review are split between the divisions as follows.

The Space Systems Development Division is responsible for:
- Pre-application consultation
- Environmental management and review
- Development of concepts and operations for space and air traffic management

- Research and developing activities into safety methods

The Licensing and Safety Division is responsible for:
- Licensing and associated safety analyses and procedures documents
- License compliance monitoring and safety inspections
- New safety rulemaking efforts
- Common safety standards
- Failure, anomaly, and waiver databases

The Systems Engineering and Training Division is responsible for:
- Experimental permits and associated safety analyses and procedural documents
- Safety approvals and associated safety analyses and procedures documents
- Systems engineering efforts, including coordination of safety issues and recommendations
- Permit and safety approval compliance monitoring and safety inspections

Management Systems Development - EMS

Several mandates required the FAA to develop and implement an EMS. Executive Order 13148, *Greening the Government through Leadership in Environmental Management*, required that Federal agencies implement an EMS by December 2005. In accordance with DOT Order 5641.1A, the FAA was designated as one of seven "appropriate facilities" to implement individual EMSs. Consequently, in August of 2005, the FAA announced its environmental management policy statement, formalizing the FAA's commitment to excellence and leadership in protecting the environment and the health and safety of its employees and neighbors and establishing an EMS. Since a goal for EMS within FAA is to provide standardized programs, procedures and controls to reduce operational costs and improve overall environmental performance throughout the agency, each line of business was instructed to develop its own EMS. Accordingly, the Associate Administrator for the Office of Commercial Space Transportation signed an environmental policy in August 2005 and AST successfully established its EMS by December 2005.

The policy statement is the fundamental building block in the development of a management system. AST's policy statement notes that it will strive to:
- Ensure that environmental activities at AST are streamlined, as appropriate,
- Maintain and continually improve an environmental management system (EMS),
- Prevent pollution where possible,
- Comply with applicable environmental laws, regulations, and other requirements,
- Ensure that all authorizations issued for launches, reentries, and the operation of launch and reentry sites meet or exceed all safety and environmental requirements,
- Ensure that any required environmental studies are adequate and protective of the environment, and

- Ensure that required environmental monitoring activities are conducted as appropriate.

Management Systems Development - SMS

There are currently no similar requirements on the FAA to implement an SMS. However, in 2000, the FAA Administrator instructed an FAA team to study SMS concepts in preparation for potential future implementation. This study showed that the SMS is an internationally proven model for effectively and efficiently managing safety in a number of industries, including the maritime and energy industries. Since then, the International Civil Aviation Organization (ICAO) has issued requirements that all member states must establish an SMS for air traffic services by 2003.

At the same time, the FAA is examining other potential opportunities for SMS implementation. In the Commercial Space Launch Amendments Act of 2004, the United States Congress stated that space transportation is inherently complex and risky, and the future of the commercial human space flight industry will depend on its ability to continually improve its safety performance. Therefore, AST is currently developing its own SMS to provide a systematic approach in performing its regulatory functions to reduce the risk to the public from commercial space launch operations.

Benefits of a Management System

The EMS and SMS are continuous improvement systems that use and enhance existing environmental and safety approaches. Both systems provide a formal, structured methodology to identify aspects of operations that pose a risk to the safety, security, or efficiency of the commercial space industry and the environment. The management systems are based on the International Organization for Standardization (ISO) standards that use the "Plan-Do-Act-Check" model as described below.

- Plan – The organization identifies how its operations might harm the environment or public safety and develops measures to reduce this harm.
- Do – The organization implements measures to assess levels and functions of its operations.
- Check – The organization assesses the effectiveness of the measures for managing environmental impacts and public safety risks.
- Act – Based on its assessment of the implemented measures, the organization makes systems adjustments to promote continuous improvement.

The benefits of this type of model include developing a planned approach to accomplishing goals, which includes assigning qualified personnel and providing appropriate funding to accomplish tasks. In addition, this type of system promotes accountability and record keeping, meaning that individuals are responsible for ensuring that a task is complete and efforts are documented. Finally, the check portion promotes

anomaly reporting while the corrective action system determines ways to fix any problems that are found. The continuous improvement of the system allows it to adapt to the dynamic nature of the organization's operations and to remain relevant and viable for its intended purposes.

Key Elements of AST's EMS

An EMS is a "set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency." AST's EMS assigns certain duties with clear roles and responsibilities to each of its key elements. The key elements of an EMS include the policy, procedures, implementation, maintenance, checking and corrective actions, and management review.

Policy. AST's EMS is based on the ISO 14001, which requires an Environmental Policy to be in place that outlines the environmental goals of the organization and is fully supported by senior management. The policy clarifies compliance with environmental laws and regulations and stresses a commitment to continuous improvement. The policy also provides the direction for the remainder of the Management System.

Procedures. AST's EMS includes procedures that provide prescribed methods for conducting an activity or process. AST maintains procedures for identifying significant environmental aspects, legal and other requirements; setting objectives and targets; creating and documenting environmental managements plans and operational controls; training; emergency preparedness and response; monitoring and measurement; communication; document control; records management; non-conformance and corrective actions; and internal audits and management review. The purpose of these procedures is to enable individuals within AST to understand the requirements of the EMS and to ensure a consistent execution of those requirements.

Implementation – Annually, AST reviews its activities and identifies how they interact with the environment. The activities include issuing licenses and permits. Those interactions with the environment are termed environmental aspects. Objectives, targets, and performance indicators are established to address AST's significant environmental aspects. An objective is an overall environmental goal and a target is a detailed performance requirement that arises from an objective and that must be set and met to achieve the objective. Legal and other requirements, views of interested parties, technological issues, finances, and other operations are considered when setting objectives and targets. This ensures that objectives and targets respond to legitimate concerns, that they are realistic for AST, and that it is possible to develop and implement effective Environmental Management Plan (EMP) to achieve them.

EMPs are action plans designed to achieve AST's objectives and targets. AST's EMPs contain details on the resources (e.g., financial, human, and technological) and timeframes to accomplish the objectives and targets. They also describe the approaches and strategies for achieving objectives and targets, as well as the performance indicators,

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operational controls, roles and responsibilities, and the required competency of individuals to accomplish those tasks. Operational controls are designed and implemented to support the achievement of EMS objectives and targets. An operational control is a specified engineering or administrative measure implemented to reduce the risk that an impact will occur for a given activity. Operational controls are documented and detailed as integral components of the EMPs.

Maintenance. Due to the wide variety of documents used in the AST EMS, a formal document management procedure has been developed. The document control procedure ensures that the documents being used are the most up-to-date versions. This includes removing obsolete documents from circulation. Records of implementation activities and other EMS results from training, audits, and management reviews are made available on a server for AST access.

Checking and Corrective Actions. Checking and corrective action refers to the monitoring, assessment, and self-corrective components of the EMS. The EMS calls for periodic assessments to determine if the system continues to be implemented in accordance with organizational arrangements. EMS audits test whether the system has been implemented and maintained as designed is designed to find the root causes of any system failures and other non-conformances in the EMS.

Management Review. The management review is senior management's periodic evaluation of the EMS. This review completes the EMS cycle and allows senior management to ascertain whether the EMS continues to be suitable, adequate and effective for the organization. Following this assessment, senior management must take the necessary actions and decisions to ensure that the EMS continues to suitable adequate and effective. The review also ensures that senior management stays involved in the EMS sets the environmental tone for the office, and gives guidance and direction for the continual improvement of the system.

Key Elements of SMS

An SMS provides a formal framework for integrating safety into day-to-day operations. While most systems are tailored to the individual needs of the organization in which they are being implemented, nearly every SMS includes safety goals and performance targets, risk assessments, responsibilities and authorities, rules and procedures, and monitoring and evaluation processes. The FAA is in the process of implementing an SMS. Under the FAA model, the SMS will contain the following four major elements: policy, architecture, assurance, and safety promotion.

Policy. The policy element of the SMS defines the requirements, responsibilities, and accountabilities for system functions. These declarations of the organization's commitment to safety collectively define the organization's safety mission and form the basis of all subsequent objectives and targets.

Architecture. Architecture refers to a Safety Risk Management (SRM) approach used to evaluate the safety risk of proposed changes to an organization or one of its systems. It defines the processes, procedures, and practices used to assess and document those changes. For example, when the airlines petition the FAA to make a change its air traffic control operating procedures, such as a decrease in the separation of controlled aircraft, or when a commercial entity seeks authorization from the FAA to perform a potentially hazardous activity, such as a launch of a commercial rocket, the FAA performs a systematic evaluation of the safety risk of these proposed changes on the rest of the airspace system and on the uninvolved public. An accurate assessment of the change in safety risk brought about by these proposed changes to the system, measured against their potential benefits, provides the authorizers of such changes with a basis from which to make informed risk decisions. All safety significant new and modified systems, procedures, and operations in an organization should be evaluated for safety risk whenever changes are proposed.

Assurance. An essential function of the SMS is to assure that safety objectives have been met. The safety assurance element provides a planned and systematic approach to the evaluation of the safety of and adherence to standards, processes, and procedures through monitoring, data tracking, and data analysis. This includes the monitoring of the effectiveness of efforts to identify and address deteriorating safety trends through safety reviews, evaluations, audits, and inspections. Safety data collection, tracking, and analysis provide additional means to identify safety trends, and as such they are important parts of the assurance function. Many organizations, including the FAA, employ both mandatory and volunteer programs to collect data on accidents, incidents, and unsatisfactory conditions.

Promotion. Safety promotion embodies the communication and dissemination of safety information to strengthen the safety culture and support integration of the SMS into operations. Fostering a strong safety culture requires the allocation of adequate resources, the establishment of unambiguous policy direction, the promotion of open communication, and the implementation of safety training. Organizations with strong safety cultures are founded on organizational commitment to safety and employee empowerment. These organizations often use reward and reporting systems to ensure involvement at all levels and to assure employees of the priority of safety in their duties

Although the EMS has already been implemented within AST, the SMS is still in development. As with the EMS, the policy statement will be the cornerstone of the SMS. Ideas for the safety policy are as follows:
- Continually strive to improve the level of safety of the commercial launch vehicle industry through the collection of safety data,
- Develop and implement effective regulations that reduce the risk to the public while promoting the industry,
- Adopt and promote best safety practices,
- Report, track to resolution, and evaluate the effectiveness of all preventive and corrective of all preventive and corrective actions resulting from investigations of accidents, incidents, mishaps, and anomalies,

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- Promote the growth of a strong safety culture in AST and throughout the commercial space launch industry.

Once fully implemented, the AST's SMS will integrate existing operational policies, processes, and procedures, and introduce new elements necessary for a systems approach to managing the safety risk. It will ensure a formalized and proactive approach to system safety and provide a common framework to assess safety risks of future proposed changes.

Collaboration of EMS and SMS

Environmental and safety aspects of a proposed launch or reentry operation are often invariably intertwined. In applying for a license or permit, a potential vehicle or site operator must provide AST with sufficient information to comply with the National Environmental Policy Act, to minimize potential environmental impacts, and sufficient information to comply with FAA regulations, to ensure that public health and safety and the safety of property would not be jeopardized by the conduct of the commercial launch activity. In that regard, safety measures, such as the placement of stored propellants to meet quantity-distance requirements, often require the construction of new facilities or improvement of existing infrastructure, which must be analyzed for potential environmental impacts. Conversely, alternations to a proposed activity made to address environmental considerations, such as placing a launch pad sufficiently far away from a protected area, could have safety considerations if they expose additional people to the potential hazards. Therefore, it is important that AST not only facilitate the transfer of necessary information across these two management systems but also identify ways in which they can work together to cooperatively reduce these impacts.

Further, AST safety inspectors need to be aware of both safety and environmental requirements to effectively verify a licensee's or permittee's compliance with the terms and conditions of a license or permit. Safety inspection teams may not include environmental staff; however, they may still be responsible for ensuring the completion of environmental monitoring and may be called on to answer environmental policy questions pertaining to the monitoring requirements.

Therefore, the goal within the FAA is to eventually combine the systems into an overall Management System. Such a combination could improve efficiency by consolidating common elements like configuration management and audits. Further into the future, AST hopes to develop guidance for commercial space launch site operators and launch operators to develop their own management systems.

AST anticipates that it will encounter a number of challenges while it goes through the process of combining these systems. Namely, the upkeep and maintenance of the combined system will require continued attention and the allocation of resources. Buy-in from senior management may be an issue as well, especially if the resource commitments

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over time become to too great relative to other priorities. IN addition, complications may arise if the SMS is not eventually mandated.

Conclusions

AST's mission is to ensure the protection of the public, property, and the national security and foreign policy interests of the United States during commercial space transportation activities and to encourage, facilitate, and promote U.S. commercial space transportation. AST faces unique challenges of ensuring the protection of public health and safety while facilitating and promoting U.S. commercial space transportation. AST has developed an Environmental Management System (EMS) and a Safety Management System (SMS) to meet its mission. Although the EMS and SMS were developed independently, the systems share similar elements. Because maintaining multiple systems to accomplish similar goals is neither cost effective nor practical in today's business environment, AST is building a collaborative approach in environmental and safety management. The long-term goal would be to integrate the systems, where appropriate, to potentially reduce the cost of implementation and maintenance and to improve the overall effectiveness of the integrated system.

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