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Risk Assessment: An Employer's Perspective

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Introduction

There is no question that a careful assessment of risk is essential for safe industrial operations. For that reason, a thoughtful analysis of the effectiveness of available risk assessment technologies is a prerequisite for responsible corporate decision making.

An "employer's" perspective on risk assessment cannot be constrained by any artificial restrictions which that term may imply. In reality, all those who are involved in the execution of an industrial enterprise: managers, regulators, the affected public, and especially those employees exposed to hazards, are necessarily partners in the assessment of risk.

The perspective of this paper is that of the oil and gas industry, in which the author's organisation, Exxon Company, International, participates. The paper addresses what Exxon requires to assess and manage risk in its worldwide operations. The author is aware, however, through contacts with industry colleagues, that some of Exxon's initiatives are representative of similar actions being taken by others.

1992 is the European Year of Safety, Health and Hygiene, coinciding with the United Kingdom's Presidency of the European Council. It is also the year in which new "goal-setting" regulations covering safety in the U.K. offshore oil industry were put forward by the Health and Safety Commission. These regulations, based largely on Lord Cullen's recommendations following the Piper Alpha tragedy, set the pace for safety in the British North Sea and will significantly impact the safety of offshore oil installations worldwide. The requirement for risk assessment, using a systematic process of analysing and evaluating risk, is a key component of this safety regime.

The nature and perception of risk

Risk, broadly defined as "the possibility of harm or loss", pervades all human activities, whether in the businesses we undertake to earn a living or in our recreational pursuits. Some risks we accept voluntarily, like weaving through heavy traffic or darting across a busy street. Many sports purposely incorporate risk taking, where the possibility of harm and the avoidance thereof, often through acquired skill, is seen by some as a pleasurable pursuit.

However, we also face risks created by others, risks **not** of our choosing, and some of these may arise from industrial activity. When risks are reduced to the lowest practical level that still preserves the essential benefits of such activity, they are usually viewed as reasonable.

The point to make, is that there are very few activities entirely free of risk and informal risk assessment is something we all do constantly, as individuals.

In Exxon, we define risk as the probability of a hazardous situation occurring and the associated consequences or impacts of that situation upon our own and contractors' employees, society, the

environment or physical assets. This means we consider the implications of risk in all that we do. Exxon's long-standing and uncompromising commitment to human welfare has resulted in safety policies and practices that go well beyond passive compliance with existing laws and regulations.

Need for enhanced risk assessment/understanding

Traditionally, industrial risk assessment has included safety engineering, operator training, inspections and other proactive initiatives, as well as industry-wide sharing of the lessons learned from major accidents. The investigation of such incidents has often resulted in better design codes, specifications, operating practices, and new regulations. Exxon's Alaskan oil spill, for example, prompted a re-examination of industry-wide practices and resulted in new regulations impacting the marine transport of oil.

The increasing complexity of industrial activities and rapidly evolving technologies cause the nature of risk to evolve as well. Risk assessment today demands approaches which systematically and proactively allow the management of hazards at an acceptable level. We can no longer rely solely on traditional practices.

Judgment as to what constitutes an "acceptable risk" depends, however, on the perceptions of the individual or societal group involved. These perceptions can change over time based on individual and company experiences. Other factors influencing the acceptability of risk include whether it is taken voluntarily or involuntarily and who benefits, directly or indirectly, from the activity. Because risk acceptance is an ever-changing "social" process, it must include everyone involved – employees, industry groups, government and relevant sectors of society.

While we cannot totally eliminate risk in our lives, industrial risks can be managed, both in terms of the likelihood of hazardous events occurring and the consequential impacts should they unavoidably occur. A prerequisite to the successful management of risk is an increased understanding of the risks involved; this is the role of risk assessment.

Oil and gas industry risks

The oil and gas production industry is subject to a variety of risks, some familiar and obvious to everyone, others more subtle. In particular, the increasing complexity of operations has introduced the possibility of latent risks, that is, risks which may not be within our experience base nor intuitively obvious. A systematic assessment process can help expose these hidden risks.

Weather and environmental conditions are among the more familiar, externally imposed, risk sources. Oil and gas seem to be found at their most abundant in areas where extreme temperatures, high winds, Arctic ice and rough seas prevail or where deep water and challenging terrain test our ability to operate safely. More sophisticated weather forecasting, better structures and improved safety practices have aided the assessment and management of these sources of risk.

Other externally imposed risks, over which we often have no direct control, include ship/platform collisions and earthquakes. Even here, however, improved platform structural designs are now better able to withstand such events and emergency response capabilities help to mitigate the consequences.

Hardware failures, involving breakdowns of materials or equipment, are common and familiar in our daily lives. However, in the oil industry and most other industries they are rarely, by themselves, the root cause of significant safety or environmental incidents. Prudent operating procedures and established engineering practices, based on codes and standards, and past experience, together with safety redundancy, help to assure this.

Studies and incident investigations conducted within the oil industry and elsewhere clearly indicate that the more significant sources of risk to safe and environmentally sound operations involve people. Human errors, which may occur at all worker and management levels, predominate as contributors of incidents. Weather and environmental or hardware conditions may act in conjunction with errors in decision-making, actions taken or other human behavior to produce an incident.

The "Challenger" space shuttle and Piper Alpha tragedies resulted from such event chains and clearly illustrate that we cannot depend on technology and engineering alone to control risk. More attention must be given to continuous safety training, including unannounced drills that thoroughly test the available emergency response capability. In addition, more research needs to be done on critical man-machine interfaces, such as the effect of human sleep-wake cycles and other ergonomic impediments to safe work behaviour. Finally, we must share our research findings with our employees and one another.

People in an operating company and its interfacing organizations work within a "safety management system", whether or not formally identified as such, which defines their standards of safe behaviour. Weaknesses or omissions within this managing system, such as poor documentation of process equipment changes, create potential for latent failures to occur. These may "bait the trap" for the initiation of human errors.

Exxon's formal risk assessment

In Exxon, we believe the development and use of a more structured, disciplined and comprehensive safety management system, or "Operations Integrity Management Framework", as we call it, assists us in further minimising operational and decision-making errors and expose risks. It allows us to continue managing our increasingly complex business in a safe and environmentally sound manner.

No approach can totally eliminate industrial hazards, however, they can be better managed and the impact of incidents reduced when the risks are fully assessed. There are many methods for achieving this assessment. In Exxon, we see risk assessment as first and foremost a "questioning" process, which may range from a simple conversation about the risks involved in a routine operational task to more sophisticated investigations of an entirely new production concept. We encourage this questioning of risk at all levels of our operations by designers, suppliers, constructors, operators and managers, to name a few.

The risk assessment process we use is the same irrespective of the analytical tools used to support it (Figure 1). The five questions we ask ourselves are these:

1) What can go wrong with this design, process or operating procedure? That is, let's identify the potential hazards.

2) What sequence of events would cause these hazards and how likely are they to occur? Risk assessment professionals call these "causal and frequency analyses".

3) What are the consequences or impacts of the hazards occurring?

4) How can the causes be prevented?

5) How can the impacts of a hazard, however unlikely, be reduced or mitigated, should it occur?

Prevention of the causes of hazards and reduction of their consequences, the last two questions in our process, represent areas where an operating company can identify and exert the most influence upon risk.

Hardware v. software

Looking first at cause prevention or elimination, this has traditionally been achieved by hardware means. Incorporating tolerance of a wide range of upset conditions into equipment design and specification of materials is typical of this approach.

Hardware remains important. However, experience has shown us that a broad range of "software" issues are also fundamental to reducing risk. These include, among others, selection and training of employees, including supervisors and managers, choosing contractors based on competency and experience, not just price and social-economic parameters, and implementing an effective drug and alcohol policy.

Of primary importance, however, is the implementation of a formal, structured and proactive system of safety management.

Exxon's "operations integrity management framework"

Reference was made earlier to Exxon's "Operations Integrity Management Framework" or OIMF. This concept clearly defines corporate objectives and expectations for all facets of safety management. It is aimed at incident prevention through effective and pre-emptive management of the causes of risk. Although not driven by the Cullen Report recommendations, Exxon's OIMF is consistent with the safety management principles Lord Cullen outlined following his investigation of the Piper Alpha tragedy.

OIMF consists of eleven principal elements forming a disciplined and structured safety management system (Figure 2). Management, leadership, commitment and accountability is the first element in Exxon's system. It extends right up to Exxon's Board of Directors, where a Public Issues Committee, with both inside and outside directors, has oversight responsibility regarding the company's policies, programs and practices in the areas of safety, health and environment.

The management leadership element provides the driving force for other elements covering systems, practices and procedures in the following areas:

- risk assessment and management
- facilities design and construction
- process and facilities information and documentation
- personnel and training
- operations and maintenance
- management of change
- third party (contract) services
- incident investigation and analysis
- community awareness and emergency preparedness

The last element, operations integrity assessment and improvement, encompasses the critical need for regular reviews of operational performance relative to the safety, industrial health and environmental expectations outlined within the OIMF. These assessments are conducted by multi-disciplinary teams which include expertise from outside the organizational unit under review.

Each of these integrity management elements must have clearly defined objectives, responsibilities, standards and procedures, as well as an ongoing process of self-assessment and self-improvement to ensure that objectives are being met. These goals and requirements are determined by the organizational group involved and the level of assessed risk. Simply stated, Exxon's OIMF is not an inflexible corporate directive. It is a framework within which different business and operating units can address their particular risks with different priorities and action plans.

The ultimate goal of Exxon's OIMF is to make the identification of every kind of risk, and proactive responses to them, an integral part of day-to-day business throughout the organization. This process of continuous improvement will help achieve "operational excellence" – leading to better managed, better controlled, more efficient and, ultimately, more profitable operations.

Emergency preparedness

The final question in the risk assessment process is one that must be addressed regardless of how many risk prevention measures have been implemented. When safety or environmental incidents occur, despite sound risk management, how can the impacts be reduced or mitigated?

Emergency preparedness is always necessary and Exxon spends significant time and resources to be ready to respond to unexpected operational situations involving safety of personnel or the public and protection of the environment. Our emergency response training has been developed to include scenario-based drills, which make use of escalating incident conditions and breakdowns in the command structure. It involves participation by external agencies such as public fire services, coast guard, industry oil response teams and others. Exxon also has access to emergency supplies and expert personnel, who are immediately available from around the world to assist in an emergency situation.

Risk assessment tools

It should be clear that within Exxon, the act of "questioning" is seen as fundamental to any risk assessment process. However, numerous and increasingly powerful tools are available to address the questions posed in the risk assessment process. Correctly applied, these tools can effectively supplement, but not replace, what we learn from direct "hands-on" human experience.

Exxon makes use of a suite of risk assessment tools, each with its own strengths and limitations. Hazard identification is carried out using design reviews, checklists, Hazard and Operability Studies (HAZOP) and Failure Mode and Effects Analysis (FMEA). Mathematical models are used to examine hazard consequences, such as fire impacts, explosion overpressures, the fate of oil spills and wave loadings on platforms. Event and Fault trees are employed to determine hazardous event sequences. Risk matrices are developed to examine specific risk scenarios. Operations that benefit from the use of numerical risk estimates utilise quantitative risk assessments. Each of these tools has a role to play in the risk assessment process.

Quantitative risk assessment

Today, there is much discussion of the use and value of Quantitative Risk Assessment (QRA), often to the exclusion of other methods, especially those of a more qualitative nature. Exxon's experience with a broad range of worldwide operations indicates significant value in utilising a diverse spectrum of risk assessment techniques. Indeed, it appears unsound to rely only on one methodology.

The discipline imposed by QRA is its greatest benefit and Exxon supports expanded use of the technique within the oil industry. QRA also provides a means to compare alternative risk management strategies. However, the exclusive use of QRA as an absolute measure of risk is suspect at this time. We share the common concerns about the quality of data available to input to QRA tools and the caution that is required to ensure that reality is reflected in the analysis.

However, these concerns should not prevent effective use of this tool for comparison studies. To improve future analyses, Exxon participates, with other members of the oil industry, in the development of improved reliability and failure rate data bases.

Qualitative risk assessment

As previously indicated, Exxon strongly encourages the questioning of risk at all levels of its operations. This includes a range of assessment tools, many of an intuitive nature, such as operational checklists and "hazard hunts" at operating sites. These are needed to reflect the capabilities and experience of the personnel involved. Furthermore, care must be taken not to limit involvement in risk assessment to only those persons with specialized risk analysis skills. Such a limitation would undervalue the intuitive input of experienced platform employees and installation managers, and subvert the original intent to broaden the understanding of risk.

There can be no "black boxes". People at all levels need to be fully involved in risk assessment. Risk understanding, which is crucial to the successful management of risk, comes from such direct involvement. In practice, this means providing opportunities for workers to participate in such activities as the development of design basis documents, the design of operating procedures, the determination of safety controls and the ongoing daily assessment of hazards in their work place, among many others.

Whatever risk assessment techniques are used, it is important to realize that they are just tools and no more. They cannot make decisions. They can only support the judgment of those individuals who do make decisions – operational employees, supervisors and management, as well as the societal judgments of regulators and the public. In Exxon, we enhance the capability of our staff to apply sound judgment to risk management decisions through extension formal training and assignment rotations which expose them to many different types of risk scenarios worldwide.

Societal risk assessment

Risk management decisions are also strongly influenced by other considerations, such as social and corporate values and the risk perceptions of employees and the affected public. In order for individuals or society, through regulatory agencies or direct public hearings, to agree on an acceptable level of risk, they must first understand the risks involved. As observed earlier, the assessment of risk is a social process and one that must, necessarily, involve everyone who is exposed – directly or indirectly – to the risk in question.

The allocation of adequate time to conduct a risk assessment and the availability of credible data are also essential. Rushing through a risk assessment or seeking to use the results as an absolute measure of risk, when this is clearly not justified by the quality of the input data, does little to build commitment to risk management solutions.

Summary

- Industrial risks cannot be eliminated, but they can be assessed and managed at levels acceptable to individuals and society.
- Risk assessment is an essential prerequisite to risk management and demands a clear understanding of the risks involved. This means supplementing our knowledge of past incidents with an assessment process which enables potential hazards to be uncovered or predicted.
- Exxon believes this process should involve intense questioning of risk at all organizational levels, and is best supported by a diverse blend of quantitative and qualitative techniques. Many of these techniques should be relatively unsophisticated, so they can be understood by a wide range of people with firsthand knowledge of risk exposures.
- Where the use of rigorous quantitative techniques is necessary, it is essential that people with a broad spectrum of differing skills be fully involved. This assures understanding, validity and shared ownership of both the results and the process by which they were achieved.
- Human errors, occurring at all worker and management levels, are often enabled or initiated by failures and omissions in the underlying safety management systems. Prevention of these system breakdowns may be enhanced by greater attention to non-hardware, "people" issues and implementation of more structured, disciplined and proactive approaches, such as Lord Cullen's Safety Management System and Exxon's Operations Integrity Management Framework.
- Lastly, improving our assessment and management of risk in no way reduces the need for well prepared emergency response plans, which must be regularly tested through realistic scenario-based drills. Mitigating the consequences of hazards, foreseen or unforeseen, is essential to achieve the lowest practical level of risk to individuals, society and the environment.

Formal Risk Assessment Process

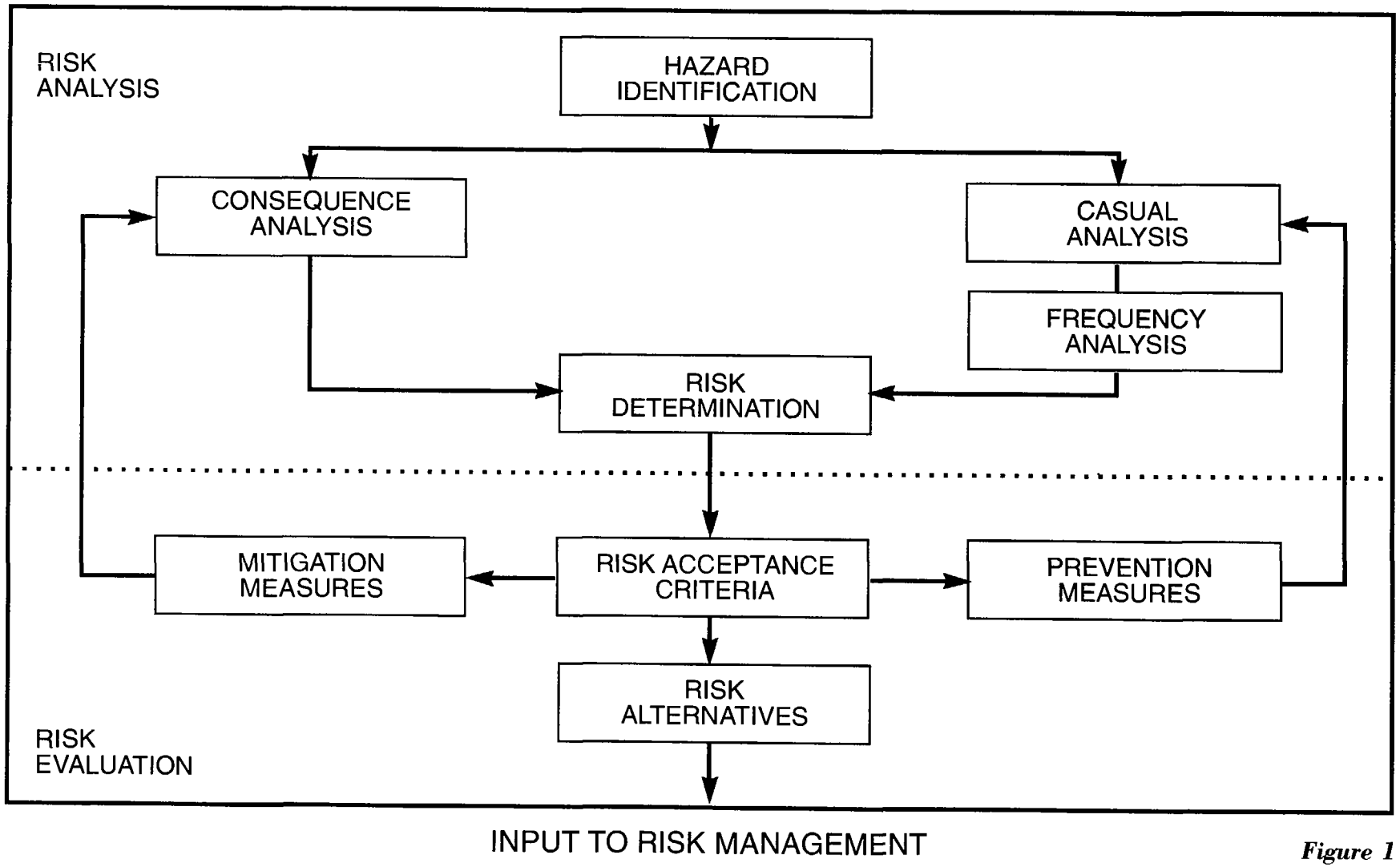

Figure 1

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EXXON CORPORATION

Operations Integrity Management Framework

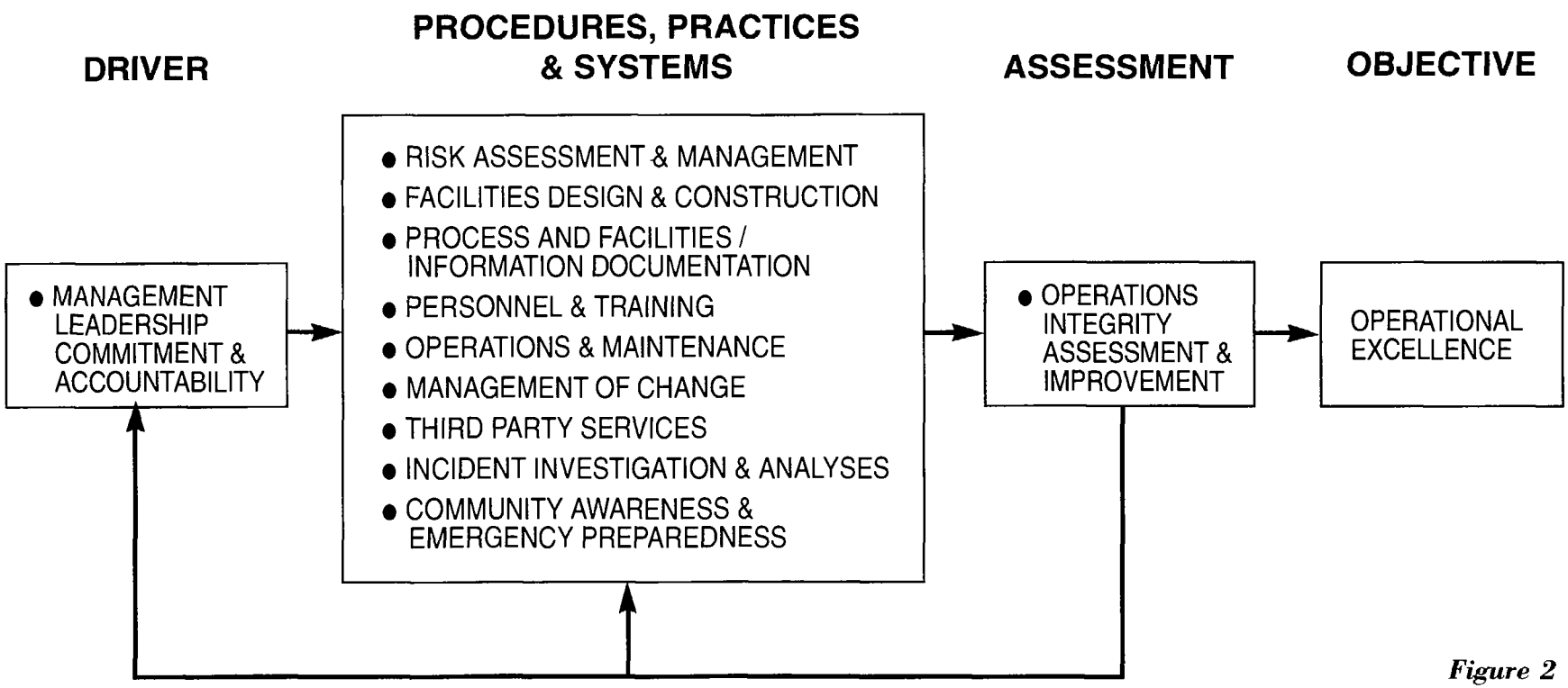

Figure 2