**Integrated Environmental, Health and Safety Management:
The Outcome of The "Necessary and Sufficient Process"**

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This paper presents a paradigm for integrating the many facets of ES&H management based on the necessary and sufficient control of hazards and the resulting risks through a systems approach. The paradigm answers the question "What is the best approach to managing ES&H to increase value, reduce risk, improve satisfaction?"

Success in managing ES&H ultimately depends on the value perceived by activity and operations "owners", who are also hazard owners, in identifying and managing the risks to people, property, performance, and the environment from their activities and operations. If the owner perceives that the process of identifying and managing ES&H risk directly contributes to doing the job better, faster, and cheaper, as well as safer, the process will be valued. Conversely, if the process imposes additional requirements or constraints which are perceived to reduce performance, adversely impact schedules, or cause higher cost, the process will not be valued.

The "Necessary and Sufficient" criteria provide a basis for an integrated approach to ES&H management focused on identifying and managing risks intrinsic to operations and activities. It provides a framework for using "off-the shelf" (standard) or "tailored" (specialized) approaches to managing risk in addition to the usual "one size fits all" approach. Characterizing hazards and risks against standards applicable to industrial/commercial activities results in two broad risk classes: those risks commonly found in industry and, those risks not commonly found in industry (Figure 1). These two classes of risks should be managed differently. Risks common to industry can be managed using generic methods. For example, an acceptable level of risk would be achieved by operating equipment according to the manufacturer's instructions, or by using chemicals according to the precautions stated in the Material Safety Data Sheet (one size fits all), or by following corporate/generic risk mitigation processes scaled to the hazard (off-the shelf). Operations using Standard Industrial Hazards such as compressed gases, lasers, confined spaces, or high voltage would be conducted according to "Safe Operating Procedures" (SOPs) which would be provided as a compendium to risk owners. The SOPs would be incorporated into line operating procedures by simple reference.

For non-common hazards, the detail of the required safety analysis is based on the severity of likely consequences. For example, "low-consequence" hazards would require a simple analysis of the consequences, the events which could produce the consequences, and identification of the methods used to obtain an acceptable level of risk. Moderate-consequence hazards would require a more detailed qualitative risk assessment and risk management plan; high-consequence hazards would require a detailed quantitative risk assessment and detailed risk management plan.

Figure 2 shows the "Necessary and Sufficient Hazard Management Process". This process is "Necessary and Sufficient" because risk management beyond standard industrial practice is only imposed if warranted by the risk resulting from the hazard. The process begins with identifying the Type, Form, and Quantity of each hazard inherent in a proposed activity, operation, or facility. A preliminary hazard screen (PHS) is performed on the identified hazards to separate them into the two broad categories of "Standard Industrial Hazard" and "Non-Standard Industrial Hazard".

Hazard identification is the foundation of Integrated ES&H Management because unidentified hazards may result in unacceptable risks. Hazards also define the input parameters for the system by scoping requirements to protect people, property, performance, and the environment.

Knowledge of risk is essential to the necessary and sufficient management of risk. "Risk" is the qualitative or quantitative expression of possible harm that considers both the likelihood that a hazard will result in harm, and

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the resulting consequences. "Managing risk" is the process by which the acceptability of risk is determined and resources are allocated to reduce the risk to an acceptable level. If risks are unacceptable, risk management tailors allocation of resources through a technically defensible, defined process which takes into consideration the severity of consequences, the likelihood that the consequences will occur, and the cost to obtain an acceptable level of risk for a proposed activity or operation.

Six principles must be followed to reduce risk:

1. Those who own the risk must manage it (and be held accountable) because they determine system input and manage the "transform" process;
2. ES&H professionals cannot make the workplace safe, healthful and non-polluting. They are a resource for the risk owner to effectively manage risk. They are not the all-powerful keeper of the keys to information, processes, or ES&H performance.
3. Risk management processes apply to all sites, facilities, operations, and activities from concept through clean-up;
4. Resources must be allocated based on hazard, risk, cost, and benefit.
5. Evaluation includes self and independent assessments; and,
6. Hazard-related information must be usable and accessible by the risk owner, management, and the ES&H staff.

A systems approach to identifying and managing risks is essential in achieving integrated ES&H management through the necessary and sufficient process. Any system can be viewed as four components: inputs, a transformer, outputs, and feedback (Figure 3). For ES&H to be integrated and deemed "necessary and sufficient", ES&H actions and considerations must be incorporated into the overall system and each of the components. The compartmentalizing of ES&H as independent or apart from the overall process is artificial and has, in large part, led to perspective by the owners of operations that ES&H impedes their ability to perform. Initiatives that are currently viewed as distinct such as "Design for ES&H", "Necessary and Sufficient", and "Self Assessment" must become part of the process of defining the inputs, the transformer, the outputs and the feedback, not an afterthought to achieve compliance. Measures of ES&H performance follow naturally from defining the acceptable level of risk and understanding customer requirements and expectations. Feedback, i.e.; "Self Assessment", becomes the process of comparing the results obtained from the transform to the required results, whether in terms of customer requirements and expectations, or in terms of measures of ES&H performance.

Sandia National Laboratories has identified three "over-arching objectives", generally applicable to any aspect of a process or project: Increase Value, Reduce Risk, and Improve Satisfaction. These objectives can be applied to the function of risk management using the "Know, Understand, Manage and Document" (KUMD) paradigm. Figure 4 depicts a one-to-many relationship between the over-arching objectives and the KUMD actions. For example, managing performance, cost, and schedule requires understanding customer requirements and expectations; the operational constraints which ensure an acceptable level of risk; and the motivations, values, ethics, and performance capability of the human resource being applied to the task. Actions pertinent to reducing risk are only one subset of the overall "actions" required to meet the objectives - e.g.: "knowing the hazards is only part of the overall requirement to "know". This matrix, coupled with a systems perspective, can achieve a merger of top-down strategy and policy with bottom-up operations and activities.

The organizational structure is crucial to the success of integrated ES&H management. Working together, the ES&H staff and the risk owner can use their individually unique expertise to identify hazards, determine the likely consequences, and establish safe operating conditions - or avoid selecting an unsafe alternative - much more expeditiously and at less cost than if either attempted the task alone. Synergism cannot occur without a constancy of personnel who work from a common knowledge base and develop a trustful working relationship based on common and shared objectives, and accountability for results. The level of ES&H support to the risk owner is based on hazard type, consequence, and likelihood of the occurrence of the consequence(s). Full-time, on-site ES&H staff may be needed for some "risky" operations and activities, whereas only occasional ES&H support may be needed for standard industrial operations and activities. The decision to place ES&H professionals in the line organization should be based on the phase of the life cycle of the operation or facility (more support for start-up; less support for mature operations near the end of their life cycle), the type and level of hazard and complexity of the systems, structures, and components required for an acceptable level of risk. Finally, the organizational structure must provide for programmatic functions such as Oversight and Trend Analysis, Regulatory Assessment, Program Development, and corporate ES&H Operations such as waste management and environmental restoration.

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Framework for Managing Risk

Figure 1

The Necessary & Sufficient Hazard Management Process

Figure 2

Figure 3

Top-Level Action Matrix For Achieving SNL Over-arching Objectives

Figure 4