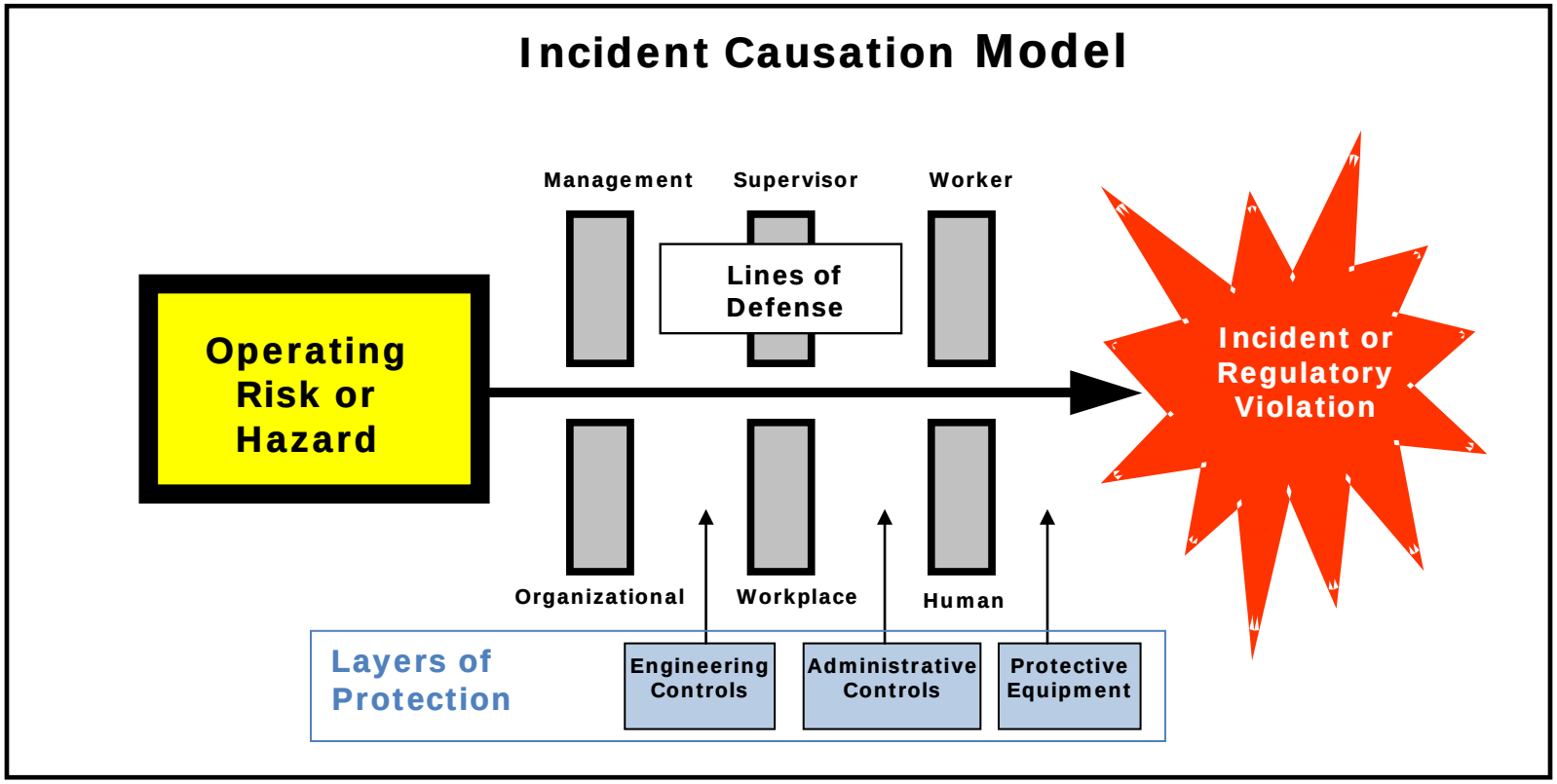
Incident Causation Model & Investigation Methodology



- Determining the Nature of Incident Dynamics
- Understanding the Physical Operations Being Completed
- Identifying Site Layout, Equipment and Protection
- Assessing the Ability of People to Avoid Errors

Summary Incident Investigation and Analysis Methodology

There are two important background items that must be considered when investigating and following up on an incident:

1. Understanding and Applying Accident Theory Models

The accident theory applied to reviewing the incidents shapes the conclusions drawn. With this in mind, an effort was made to assess the various accident theory models used by the safety industry. While each of the models has some merits, the combination of James Reason's "Swiss Cheese" model and Edward Adam's "Organizational Responsibility Model" seem to be the most appropriate to apply to assessing incidents.

- Reason's "Swiss Cheese" model sets out the basic relationships between hazards, defenses and losses. The model identifies three basic levels of defenses based on organizational, local workplace and human factors. Reason's theory reminds us that in most situations these defenses are likely in place. Reason's theory also reminds us that there will be holes in those defenses. The number and size of those holes will determine the likelihood of an incident.
- Adam's "Organizational Responsibility Model" is a more people oriented accident model that looks more closely at the activities of managers, supervisors and workers, the key people in every management system. More importantly, Adams theory reminds us that to address a problem we must shift our thinking from "blame the worker or blame management" to "how can we attack simultaneously on all fronts".

  The principles of this model are further elaborated on the Internal Responsibility System (IRS), which is the basis for much of the OH&S legislation in Canada today. This system acknowledges that the people at each level of responsibility within an organization have specific due diligence obligations. A schematic diagram of the IRS as it relates to accident causation is highlighted in Appendix 3.

Based on the complexity of the incidents evaluated, it is important to understand each of the dimensions highlighted by these theories if we are to improve industry defenses in a manner that creates a sustainable improvement in industry safety. The diagram introducing this section of the submission attempts to illustrate the synergies of these two models.

2. Understanding the problem

Based on the work being completed at the time of the incident, it is important that for any incident, the following dimensions must be understood:

A. The nature of the incident "mechanics" and the substances involved.
B. The physical operations being undertaken.
C. The physical site layout, equipment and protection features.
D. The ability of operations personnel to avoid errors.

To ensure that appropriate solutions are identified, it is important to take steps to understand the specifics of each physical operation. It is important to consider the nature of the hazards created by the activities at the time of the incident and the range of organizational issues that may have contributed to the cause of the incident. Attachment 1, 2 and 3 provide summaries of key organizational, workplace and human factors related to accident causation.

Based on an evaluation of numerous incidents, the following aspects are worth consideration:

- The majority of the incidents evaluated involved types of operations are often routine operations or operations where it is reasonable to assume that the personnel would have received some level of training and have a basic understanding of that task. Only a small percentage involved novel operations or those operations perceived to be high-risk. To improve the overall level of safety, there must be a focus on routine operations and an assessment of the appropriateness of the training being provided.
- The majority of the incidents evaluated where the operation control modes were either normal operations or maintenance operations. Only a small percentage occurred during emergency situations. These results suggest that to improve the overall level of safety, an increased emphasis on normal and maintenance operations will be required.
- If human performance factors are considered at the highest level, an interesting picture emerges. To address the accident causes, it is clear that problem must be attacked simultaneously on a number of fronts. Job planning activities as well as field execution activities must be equally considered. Considering the importance of planning, it is then necessary to look at the organizational factors more closely.
- The area of human factors engineering is a growing field. As a result the level of understanding is incomplete. The processes for identifying and applying effective strategies are not well understood. Not withstanding these concerns, it is clear that if the industry is to improve its level of safety, steps must be taken to address the issues related to human performance factors.
- Human performance factors come into play at each level of the operations and include: project management and planning, engineering and design, field supervision and job - task execution. A preliminary analysis highlights the need to also address human performance factors.
    - The number of violations tells us that enforcement is an issue that must be addressed.
    - The number of knowledge-based mistakes and skills-based errors tells us that worker awareness and training must be improved.
    - The number of rule-based errors suggests that adding more rules and procedures may not result in the desired safety improvement.

The issues surrounding work procedure requirements are often not clear. What is clear is that it will not always be possible to identify a prescriptive solution that can be universally applied. The results of incident reviews suggest that any solution will be role specific and will be differ for each level of personnel involved in the operation including management, engineering, field supervision and operations.

REFERENCES

The following references were used to prepare this discussion.

[1] Daniel E. Della-Giustina, *"The Fire Safety Management Handbook (Second Edition)"*, American Society of Safety Engineers, Illinois, 1987, 1999.

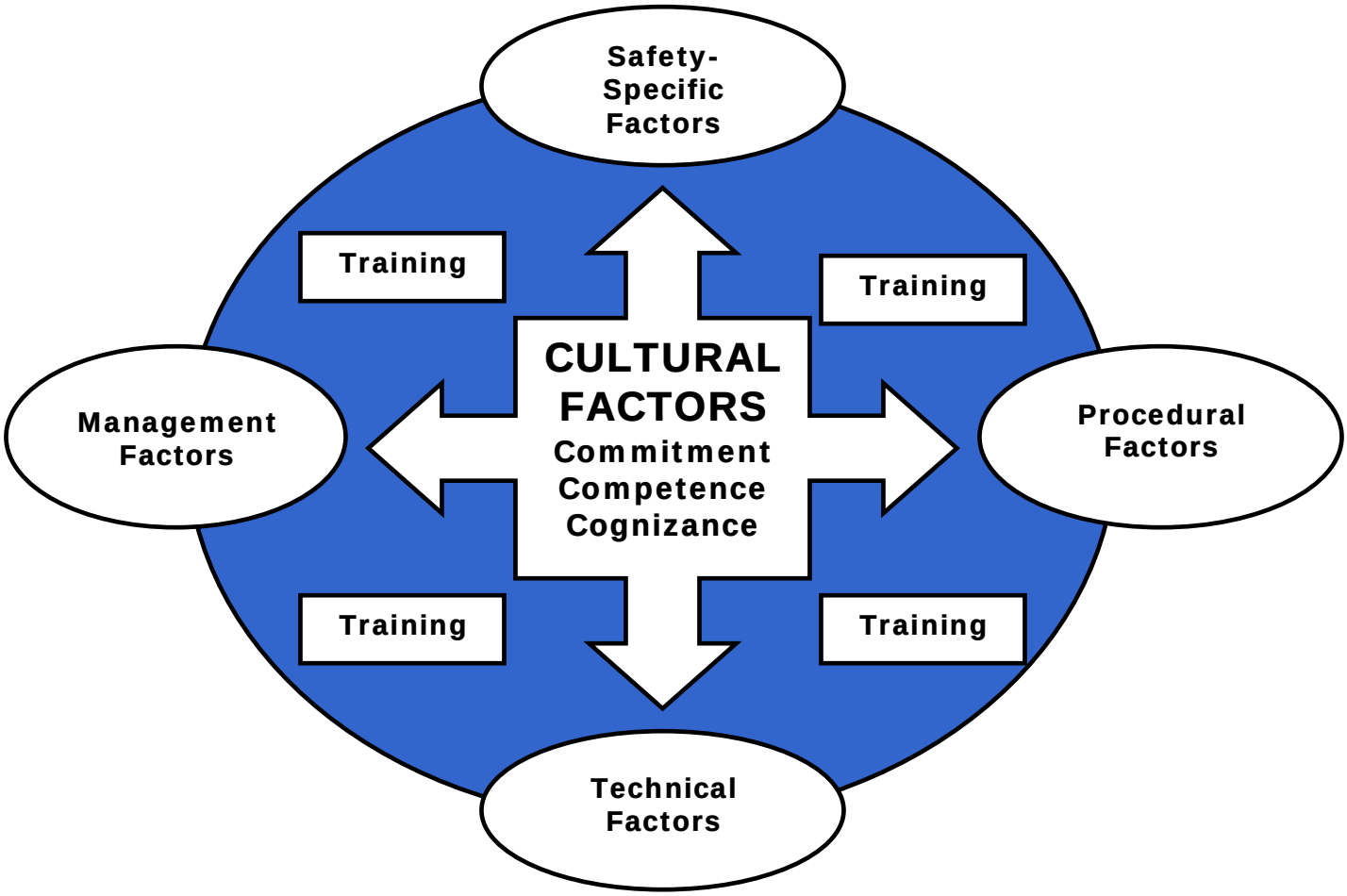
[2] James Reason, *"Managing the Risks of Organizational Accidents"*, Ashgate Publishing Company, Burlington USA, 1997.

[3] Dr. Peter Strahlendorf, "*Accident Theory Part I: Explaining How Accidents Happen"*, Occupational Health and Safety Canada, September / October 1995 and Dr. Peter Strahlendorf, *"Accident Theory Part II: What You're Missing If You Don't Use One"*, Occupational Health and Safety Canada, November / December 1995.

[4] Willie Hammer and Dennis Price, *"Occupational Safety Management and Engineering (Fifth Edition)"*, Prentiss Hall, New Jersey, 2001.

[5] James Reason, *"Human Error"*, Cambridge University Press, Cambridge 1990.

Attachment 1 – Organizational Factors [7]



Primary process subsystems underlying organizational safety.

A recent review of a number of safety process measures identified five broad clusters, as listed below:

- *safety-specific factors* (for example, incident and accident reporting, safety policy, emergency resources and procedures, off-the-job safety and so on)
- *management factors* (for example, management of change, leadership and administration, communication, hiring and placement, purchasing controls, incompatibilities between production and protection and so on)
- *technical factors* (for example, maintenance management, levels of automation, human-system interfaces, engineering controls, design, hardware and so on)
- *procedural factors* (for example, standards, rules, administrative controls, operating procedures and so on)
- *training* (for example, formal versus informal methods, presence of a training department, skills and competences required to perform tasks and so on).

Note: Training is represented as a universal feature rather than as a localized cluster of related items.

Attachment 2 – Workplace Factors [11]

After observing operations in a number of operating companies and studying their accident records, the following 11 workplace factors were chosen as best reflecting those most likely to contribute to unsafe acts and hence create lost time injuries. They are listed below:

- *Hardware.* This relates to the quality and availability of tools and equipment. Its principal components would include policies and responsibilities for purchase, quality of stock system, quality of supply, theft and loss of equipment, short-term renting, compliance to specifications, age of equipment, non-standard use of equipment and so on.
- *Design*. Design becomes a workplace factor when it leads directly to the commission of errors and violations. There are three main classes of problem: a failure on the part of the designer to provide external guidance (the knowledge gulf); designed objects are often opaque with regard to their inner workings, or to the range of safe actions (the execution gulf); and the failure of designed items to provide feedback to the user (the evaluation gulf).
- *Maintenance management*. This workplace factor is concerned with the management rather than the execution of maintenance activities (that are covered by other workplace factors). Was the work planned safely? Did maintenance work or an associated stoppage cause a hazard? Was maintenance carried out in a timely fashion?
- *Procedures*. This relates to the quality, accuracy, relevance, availability and workability of procedures.
- *Error-enforcing conditions*. These are conditions relating either to the workplace or to the individual that can lead to unsafe acts. They break down into two broad (and, to a degree, overlapping) categories: error-producing conditions and violation-promoting conditions. Error-enforcing conditions, receive influences from many of the “upstream” workplace factors.
- *Housekeeping.* This constitutes a workplace factor when problems have been present for a long time and when various levels of organization have been aware of them but nothing has been done to correct them. Its “upstream” influences include: inadequate investment, insufficient personnel, poor incentives, poor definition of responsibility, and poor hardware.
- *Incompatible goals*. Goal conflicts can occur at any of three levels:
  - Individual goal conflicts caused by preoccupation or domestic concerns
  - Group goal conflicts, when the informal norms of a work group are incompatible with the safety goals of the organization
  - Conflicts at the organizational level in which there is incompatibility between safety and productivity goals.
- *Communications*. Communication problems fall into three categories:
  - System failures in which the necessary channels of communication do not exist, or are not functioning, or are not regularly use
  - Message failures in which the channels exist but the necessary information is not transmitted
  - Reception failures in which the channels exist, the right message is sent, but it is either misinterpreted by the recipient or arrives too late.
- *Organization*. This concerns organizational deficiencies that blur safety responsibilities and allow warning signs to be overlooked. The three main components are: organizational structure, organizational responsibilities and the management of contractor safety.
- *Training*. Problems include the failure to understand training requirements, the downgrading of training relative to operations, the obstruction of training, insufficient assessment of results, poor mixes of experienced the inexperienced personnel, poor task analyses, inadequate definition of competence requirements and so on.
- *Defences*. These comprise failures in detection, warning, personnel protection, recovery, containment, escape and rescue.

Attachment 3 - Human Performance Factors [14], [15], [16]

Nature	Type of Error	Human Performance Issue	Job Activity
Errors	o Knowledge based mistakes	1. Task or situation not covered by procedures or training.	Planning
		2. A necessary step in unknowingly overlooked.	Retention
		3. A wrong decision or an inadequate response to a critical situation.	Execution
	o Rule based errors	1. Training or experience was not appropriate for the planned task.	Planning
		2. Work procedure for the planned task was unavailable or unworkable.	Planning
	o Skill based ‘slips’ or ‘trips’	1. Actions did not proceed as intended.	Execution
		2. Site personnel were unable to detect or correct a procedural omission.	Monitoring
	o Skill based fumble	1. Worker unable to complete required work due to job design or workload related issues.	Planning
		2. Worker unable to complete required work due to physical or mental limitations.	Execution
	o Lapse	1. Intention to carry out a planned action not recalled or completed at the appropriate time.	Retention
Violations	o Key step deliberately left out of action plan.		Planning
	o Worker deliberately took risk.		Execution