Lessons learned from Process Safety Management A Practical Guide to Defense in Depth

NEAL LANGERMAN

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LAYER OF PROTECTION

Same da

fuse preload-

wooden cas of igniter

Alfred Nobel



Fabriken sedd från dalgången på 1910-talet; svavelsyrefabriken ("Syran") i förgrunden. Foto i SSM



Enrico Fermi

0 0 Three Levels of control (protection 1. Manual control rod 2. Motor-driven control rod - activated by neutron activit 3. Gravity driven control rod, activated by man with axe

Layers of Protection === Defense in Depth

- Every defense has weaknesses
- Chemical enterprise learned from failures
- Share some lessons learned with the Nuclear Power enterprise



Installation Safety

- PROCESS SAFETY MANAGEMENT
 - A guide to defense in depth
 - Applicability
 - Basic chemical engineering principals
 - Regulatory, but broad applicability
 - US OSHA 29 CFR 1910.119

• Technical sections of 1910.119 = Layers of Protection



- Principles of PSM
 - Process Safety Information Process Hazard Analysis Operating Procedures
 Employee Training Contractors
 Pre-Startup Safety Review

- Principles of PSM (continued)
 - Mechanical Integrity of Equipment Non-routine Work Authorizations Managing Change Incident Investigation Emergency Preparedness Compliance Audits
- Lessons learned from a failure



Installation Safety

- T2 Failures
 - Mechanical Integrity
 - Management of Change
 - Process Hazard Analysis
 - Emergency Preparedness
- Failure to maintain LOP leads to disaster

- Process Safety Management
 - Applicable to any industrial activity
 - Scalable
 - Flexible
 - Well-documented
- Defense in Depth, INSAG-10 can be extended to include the PSM principles

COMPARISON OF DID AND PSM

IAEA DEFENSE IN DEPTH

Deterministic design

US OSHA PROCESS SAFETY MANAGEMENT

Process Safety Information Process Hazard Analysis Operating Procedures Pre-Startup Safety Review Mechanical Integrity of Equipment

Probabilistic studies and defense in depth	Process Safety Information Process Hazard Analysis Operating Procedures Employee Training
Means of achieving operational	Operating Procedures
safety	Employee Training
	Contractors
	Pre-Startup Safety Review
	Mechanical Integrity of Equipment
	Non-routine Work Authorizations
	Managing Change

Enhancement of safety

Process Safety Information Process Hazard Analysis Operating Procedures Employee Training Contractors Pre-Startup Safety Review Mechanical Integrity of Equipment Non-routine Work Authorizations Managing Change Incident Investigation Emergency Preparedness Compliance Audits

Accident control	Emergency Preparedness
Management of severe accidents	Emergency Preparedness
Emergency response	Incident Investigation
	Emergency Preparedness
Safety assessment and verification of defense in depth	Compliance Audits
The regulatory body	Compliance Audits
Topical Issues in Nuclear Installation Safety	

Process Safety Information
Process Hazard Analysis
Operating Procedures
Employee Training
Contractors
Pre-Startup Safety Review
Mechanical Integrity of Equipment
Non-routine Work Authorizations
Managing Change
Incident Investigation
Emergency Preparedness
Compliance Audits

- Management of change (word modified for reactor operators) 1910.119(1)
- The reactor operator shall establish and implement written procedures to manage changes (except for "replacements in kind") to process chemicals, technology, equipment, and procedures; and, changes to facilities that affect a process.

The procedures shall assure that the following considerations are addressed prior to any change:

- The technical basis for the proposed change;
- Impact of change on safety and health;
- Modifications to operating procedures;
- Necessary time period for the change; and,
- Authorization requirements for the proposed change.
- Particularly applicable to research reactors, where change is frequent

- PSM is enhancing operational safety at US chemical plants
- U.S. Chemical Safety and Hazard Investigation Board (csb.gov) investigates incidents and relates underlying causes to PSM correctable failures
- PSM principles are applicable to reactors and reactor operators
- PSM principles will enhance operational safety

- Recommendations for reactor operators
 - Review operating procedures in terms of PSM
 - Use PSM "lessons learned" to make operating procedures more robust
 - Adopt PSM principles as guides for all aspects of reactor operations

- Resources
 - 29 CFR 1910.119
 - AIChE Center for Chemical Process Safety library
 - http://www.aiche.org/ccps/resources/publications









