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**Fundamentals of SH&E:
Hazard Identification and Control 101B**

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Overview



- **Definitions**
- **Hazard Identification and Control**
- **Accidents**
- **Work Planning**
- **Workplace Hazards**
- **System Safety**

Hazard Identification and Control



Hazards and Risk

Hazard:

- a dangerous condition, either potential or inherent, which can interfere with the expected, orderly progress of a given activity

Risk:

- a measured or calculated chance of exposure to hazard(s) which may or may not result in loss



Both should be managed!

Hazard Identification and Control



Accidents and Incidents

Accident:

- an *unplanned* and therefore unwanted or undesired event resulting in physical harm and/or property damage

Incident:

- an unplanned event that did not *but could have* resulted in physical harm and/or property damage



Both *should be investigated!*

Hazard Identification and Control



Hazard Identification

Hazard Identification



- Acceleration
- Corrosion
- Chemical Replacement
- Fire
- Electrical
 - Shock
 - Thermal
 - Inadvertent Activation
 - Power Source Failure
 - Electromagnetic Radiation
- Contamination
- Chemical Dissociation
- Oxidation (other than air)
- Explosion
- Heat & Temperature
 - High Temperature
 - Low Temperature
 - Temperature Variation
- Leakage

Hazard Identification



- **Pressure**
 - High
 - Low
 - Rapid Changes
- **Moisture**
 - High Humidity
 - Low Humidity
- **Stress Reversal**
- **Vibration and Noise**
- **Toxicity**
- **Radiation**
 - Thermal (IR)
 - Electromagnetic (RF)
 - Ionizing
 - Ultraviolet (UV)
- **Weather / Environment**
- **Shock**
- **Stress Concentration**
- **Structural Damage or Failure**

Hazard Identification



Where to Look for Hazards

- Machines
- Lifting Equipment
- Facility Design
- Confined Spaces
- Fire Considerations
- Biological
- Ergonomic
- Energy
- Chemicals
- Pressure Vessels
- Electrical



HAZARDS ARE EVERYWHERE!

Who should be looking for them?

Hazard Identification and Control



Hazard Reduction Measures

- Design Feature
- Safety Device or Feature
- Warning Device
- Procedure and Training

*It may require some serious thinking
before the best approach is determined*

Hazard Identification and Control



Hazard Identification and Closed-Loop Tracking System

- Hazard Identification
 - Know your requirements!
 - Inspection, Audit & Identification Program
 - Checklists
 - Procedures and Training

Hazard Identification and Control



Hazard Identification and Closed-Loop Tracking System

- **Corrective Action Plan**
 - Individual and completion date must be assigned
- **Must be Closed-Loop**
 - Make Closure Rate one of your leading indicators

Hazard Identification and Control



Accidents

Accidents



Look at past accidents for your first step in Accident Reduction

- **Were prior hazards adequately resolved?**
- **What work controls were implemented to prevent recurrence, and are they working?**

Accidents



Five Sources of Accidents

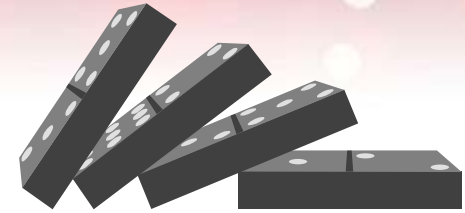
- People
- Equipment
- Material
- Procedures
- Work Environment

Note: There are typically multiple sources; rarely does a single source result in an accident

Accidents



The Domino Effect



Failure “here” may cause failure there”

- *Cause and effect* relationship

Five Phases of accident process

- Like dominos falling against one another
 - Management
 - Origins
 - Symptoms
 - Contact

} **LOSS**

Accidents



Accident Investigation

What is it?

- A systematic look at the event
- Examination of the risks
- Evaluation of the losses incurred
- An inquiry (who, what, when, where, why, how)

If done right

It will result in the control of future loss

Hazard Identification and Control



Work Planning

Work Planning



Accidents don't usually happen when people are doing what they usually do

- **It is usually something they don't do everyday**
 - **Different job**
 - **Different place**
 - **Different equipment**

Work Planning



Look at how new work is planned

**It takes two people not doing their
jobs to lead to an accident**

- **Supervisor – Inadequate planning and oversight**
- **Worker – Doesn't stop when the work doesn't look like the plan**





Work Planning



Incorporate checks for work planning

- PPE
- Required equipment
- Required training
- Other work controls
 - LOTO
 - Confined space
 - Etc.

Work Planning



Job Risk Assessment

- Identify the task
- Break-down the steps
- Assess the risk
 - Too risky – implement controls
- Reassess after controls to be sure adequate risk reduction is achieved
 - Include the people who have done the work or similar work before

Hazard Identification and Control



Workplace Hazards

Workplace Hazards



Facility Risk Assessment

- List the activities, processes and elements
- Identify the hazards and controls
- Assess the risk
 - Too risky – implement more controls
- Reassess after controls to be sure adequate risk reduction is achieved

Workplace Hazards



Facility Layout and Maintenance

- **Work area design and layout**
 - Corners, aisle-ways, work stations, laboratory setup, shop areas, location of hazardous operations
- **Maintenance and housekeeping**
 - Trip/slip hazards, clutter, damaged walking or working surfaces
- **Changes in original design or intent**
 - Layout changes may create new hazards to workers in the area

Workplace Hazards



Facility Layout and Maintenance

- **Illumination**
 - Improper lighting for the type of work
- **Ventilation**
 - Insufficient air exchange or air flow
- **Noise**
 - Interfere with other work, stress
- **Life safety considerations**
 - Means of egress
- **Access and Egress**

Workplace Hazards



Office Safety Considerations

- Furniture, equipment, electrical, bookcases, etc.
- Walking / working surfaces
- Illumination levels
- Sanitation and refrigeration
- Emergency egress considerations

Housekeeping

- Trash, Stock, Up-keep, Fire Concerns, etc.

Workplace Hazards



Machines – Anything Power-Assisted

- Controls
 - Lockout Provisions
- Guards & Interlocks
- Point-of-Operation
- Operator's Manual & Training
 - Beware of “Customary” Operations

Workplace Hazards



Lifting and Elevating Equipment - General

- Cables; chains; ropes; hooks; hasps; slings; shackles; rails; limit switches; lifting beams; related equipment
- Oil systems and hydraulics; fuel systems; electrical systems; warning devices; fail-safe mechanisms
- Maintenance records; proof testing; operator training and certification; procedures; rated loads

Workplace Hazards



Elevated Work Platforms

- Exceeding manufacturer's load limit
- Improper (or no) railings or toe boards
- Slippery floor surfaces
- Out-riggers not functioning / not used
- Defective / poorly maintained equipment
- Fall protection devices not available or not being used

Workplace Hazards



Forklifts

- Exceeding manufacturer's load limit
- Poor or improper maintenance practices
- Personnel riding on forks or load
- Operator not properly trained/authorized
- Exceeding posted speed limits or speeds appropriate for the conditions
- Backing with people in the area
- Carrying loads improperly
- Narrow aisle-ways/not marked
- Platform / ramp edges

Workplace Hazards



Cranes and Hoists

- Exceeding rated capacity
- Contacting high voltage lines and cables
- Excessive winds
- Insufficient guide ropes/tag lines
- Working under suspended loads
- Leaving elevated load unattended
- Personnel riding on loads, slings, hooks, etc.
- Dangerous motion, direction, or use of crane

Workplace Hazards



Working in Confined Spaces - General

- Any area, space, or enclosure not designed for continuous occupancy;
- Large enough to enter and perform work;
- Has limited or restricted openings for entry and exit;
- May lack adequate ventilation;
- May contain a hazardous atmosphere;
- May not be safe to enter.

Workplace Hazards



Working in Confined Spaces

- Boilers
- Furnaces
- Degreasers
- Storage tanks
- Test chambers
- Vessels
- Tunnels
- Pits
- Vats
- Sewers
- Underground utility vaults
- Utility access holes
- Aircraft work areas
- Around some spacecraft

Working in Confined Spaces



Classifications

- **Class A Permit-Required Confined Space**
 - Immediately dangerous to life and health (IDLH)
- **Class B Permit-Required Confined Space**
 - Potential for injury or illness, but not IDLH
- **Class C Confined Space**
 - Remote potential for injury or illness; no permit required

Workplace Hazards



Fire Protection and Prevention

- **General**
 - Reporting and response procedures
 - Construction contracts
 - Emergency vehicles, fire lanes
 - Fire fighting equipment, sprinklers, alarms, hydrants, extinguishers
 - Personnel training and awareness

Fire Protection and Prevention



Fire Hazards - General

- Appliances
- Holiday decorations
- Carpets, curtains, upholstery
- Housekeeping
- Storage cabinets
- Supply and bulk storage
- Smoking policies
- Extension cords

Fire Hazards - Specific

- Welding equipment, other open flame devices
- Flammable and combustible materials
- Outdoor inspections
- Vehicle fueling areas
- Pyrotechnics, explosives
- Life safety issues

Fire Protection and Prevention



Pyrotechnics and Explosives

- Procurement procedures or property transfers
- Shipping and receiving
- Transportation on- and off-site
- Inventory and control - use of logbooks
- Occupational exposure monitoring
- Training and certification of personnel

Fire Protection and Prevention



Welding and Other Open Flame Devices

- Operator training and certification
- Welding (or “Hot Work”) permits
- Personnel protection
- Fire prevention measures
- Ventilation concerns
- Working in confined spaces
- Electrical hazards (arc welding)
- Open flame (gas welding)

Fire Protection and Prevention



Outdoor Inspections for Fire Hazards

- Excess vegetation
- Debris and refuse collection
- Storage areas and yards

Vehicle Fueling Areas

- Proper spacing
- Fire protection measures
- Procedures enforced

Fire Protection and Prevention



Life Safety Issues

- Means of egress
 - Fire doors
 - Stairwells
 - Corridors
 - Emergency exits
 - Storage areas
- Inspections
 - Building codes
 - NFPA 101

Workplace Hazards



Electrical Safety - General

- National Electrical Code, NFPA 70, 70B, 70E
- Other standards and regulations (local, state, etc.)
- Use of “Listed” or “Labeled” equipment
- Use of Lock-out/Tag-out procedures
- Personnel training and awareness
- Ground Fault Interrupter (GFI) usage
- Arc-flash and Shock Hazards

Electrical Hazards



What to Look For:

- Shock hazards
- Fixed equipment
- Safety disconnect
- Dangerous conditions
- Clear working space
- Equipment mounting
- Automatic start equipment
- Extension and power cords
- Arc-flash hazards
- Portable power strips
- Portable tools
- Computers
- Portable power systems
- Temporary wiring
- Openings in enclosures
- Unusual or special conditions

Electrical Hazards



Common Appliances

- Radios
- Desk lamps
- Hot plates
- Refrigerators
- Coffee makers
- Television Sets
- Toasters and toaster ovens
- Microwave ovens
- Fans
- Typewriters
- Space heaters
- Adding machines
- Paper shredders, copy machines, fax machines
- Personal computers and peripheral devices

Lockout / Tagout



General

- OSHA 29 CFR 1910.147
- Applies to the control of ALL types of hazardous energy sources
- Lockout:
 - *To positively hold an energy isolating device in a safe position*
- Tagout:
 - *The use of a tag on an energy isolating device to warn others*

Lockout / Tagout



Requirements

- Applies to all employees performing work around machinery where they could be injured by:
 - *Unexpected start-up of the equipment*
 - *Release of stored energy*
- Examples when “LOTO” should be used include:
 - *A guard must be removed or a safety interlock by-passed*
 - *Repairing electrical circuits*
 - *Cleaning or oiling machinery that normally has moving parts*
 - *Clearing a jammed mechanism*

Lockout / Tagout



Requirements

- Only the person who applied the lock/tag can remove it
 - *Supervisor, with concurrence from Safety & Health representative*
- Training
 - *Proper methods of applying LOTO*
 - *Periodic re-training (semi-annual, annual, etc.)*
 - *Only those trained can use locks and tags*
- Employee Responsibilities
 - *Must understand the LOTO program*
 - *NEVER interfere with a lock or tag*

Workplace Hazards



Pressure Vessel Hazards - General

- **ASME design specifications**
 - Includes piping
- **ANSI requirements**
- **Compressed Gas Association**
- **Local or State codes and standards**
- **Labels and placards**
- **Piping Identification**

Workplace Hazards



Pressure Vessel Hazards

- **Design**
 - Safety factors; MAWP; Supports (for horizontal and vertical vessels); Hydraulic systems (hydraulic shock)
- **Components**
 - Relief valves; Redundancies; Identification plates; Testing; Gauges; Piping and tubing; Flexible hoses

Workplace Hazards



Pressure Vessel Hazards

- **Compressed Gas Cylinders**
 - Proper handling, use, and storage practices
 - Maintenance and certifications
 - Leaking and defective containers
- **Cryogenic Systems**
 - Hazards of cold temperatures
 - Pressure relief devices
 - System and materials compatibility requirements

Hazard Identification and Control



System Safety Techniques

System Safety Techniques



Definition of System Safety:

“A sub-discipline of systems engineering that applies scientific, engineering, and management principles to ensure adequate safety, the timely identification of hazard risk, and initiation of actions to prevent or control those hazards throughout the life cycle and within constraints of operational effectiveness, time, and cost.”

System Safety Techniques



**THE SAFETY PROFESSIONAL MUST ASSESS THE
RISK OF HAZARD EXPOSURE AND DETERMINE
THE PRACTICAL METHODS TO BEST ELIMINATE
OR REDUCE THAT RISK TO THE LOWEST
POSSIBLE LEVELS**

THIS IS THE ESSENCE OF SYSTEM SAFETY

System Safety Techniques



System Safety Concepts

- *A forward-looking process that considers how:*
 - Human resources (*people*)
 - Operating equipment (*parts or hardware/tools*)
 - Facilities (*positions or location in plant or factory*)
 - Operating procedures (*paper or written instructions*)

Affect the performance of the job/task in the

WORK ENVIRONMENT

System Safety Concepts



System Safety Criteria

- **Hazard severity:**
 - A categorical description of hazard level
 - Based on real/perceived potential for causing harm/damage
- **Hazard probability:**
 - The calculated likelihood that a condition(s) will exist
- **Can be Qualitative or Quantitative**

System Safety Concepts



DESCRIPTION	SEVERITY CATEGORY	MISHAP DEFINITION
CATASTROPHIC	I	DEATH OR SYSTEM LOSS
CRITICAL	II	SEVERE INJURY, ILLNESS, OR SYSTEM DAMAGE
MARGINAL	III	MINOR INJURY, ILLNESS, OR SYSTEM DAMAGE
NEGLIGIBLE	IV	LESS THAN MINOR INJURY, ILLNESS, OR SYSTEM DAMAGE

System Safety Concepts



DESCRIPTION	PROBABILITY LEVEL	MISHAP DEFINITION
FREQUENT	A	LIKELY TO OCCUR FREQUENTLY
PROBABLE	B	WILL OCCUR SEVERAL TIMES DURING ITEM LIFE
OCCASIONAL	C	LIKELY TO OCCUR SOME-TIME DURING ITEM LIFE
REMOTE	D	UNLIKELY, MAY POSSIBLY OCCUR DURING ITEM LIFE
IMPROBABLE	E	SO UNLIKELY, IT CAN BE ASSUMED THAT HAZARD WILL NOT OCCUR

System Safety Concepts



System Safety Techniques

The Hazard Matrix



- A recommended tool to assess & understand hazard risk
- Combines severity and probability into single rating
- Establishes Risk Assessment Code (“RAC”)

HAZARD CATEGORIES

PROBABILITY LEVEL	I Catastrophic	II Critical	III Marginal	IV Negligible
A - Frequent	1A	2A	3A	4A
B - Probable	1B	2B	3B	4B
C - Occasional	1C	2C	3C	4C
D - Remote	1D	2D	3D	4D
E - Improbable	1E	2E	3E	4E

HAZARD RISK INDEX

Risk Classification

1A, 1B, 1C, 2A, 2B, 3A

1D, 2C, 2D, 3B, 3C

1E, 2E, 3D, 3E, 4A, 4B

4C, 4D, 4E

Risk Criteria

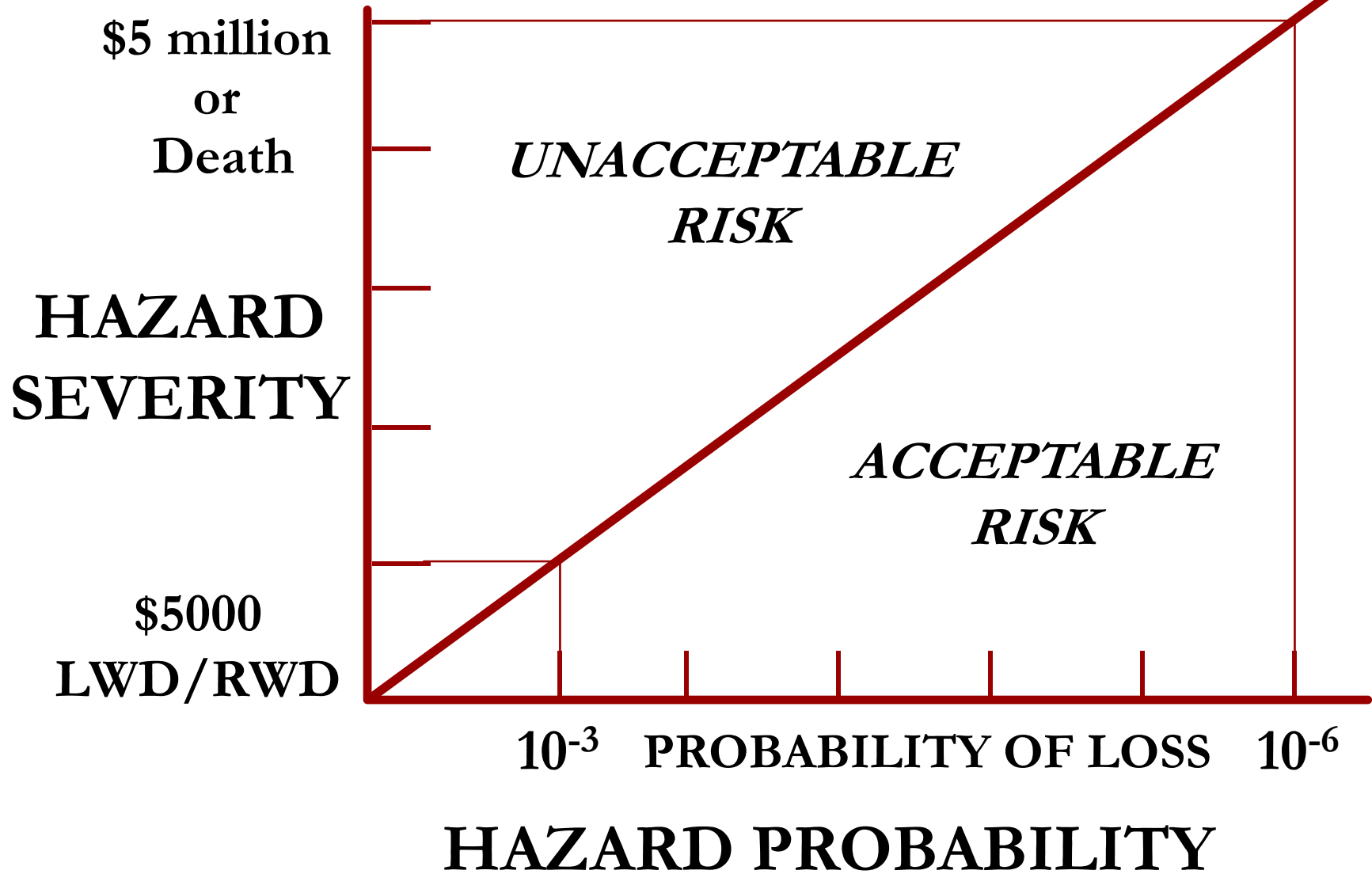
Unacceptable

Undesirable

Acceptable, with review

Acceptable, without review

RISK



System Safety Concepts



Precedence for Reduction of a Hazard

What do you do if a risk is unacceptable?

1. Design feature
2. Safety device
3. Warning devices
4. Procedures and training

System Safety Concepts



1. **Line Safety Program**
2. **Management Commitment and Buy-in**
3. **Hazard Identification, Reporting, and Tracking**
4. **Life-Cycle Phases and Hazard Analyses**
5. **Hazard Risk Management and Acceptance**

Hazard Identification and Control



Analytical Techniques

Analytical Techniques



- Checklist
- Job Safety Analysis/Job Risk Assessment
- Facility Risk Assessment
- Management Oversight & Risk Tree (MORT)
- HAZOP

Analytical Techniques



- **Fault Tree**
- **Failure Modes & Effects or Fault Hazard**
- **Operating & Support**
- **Preliminary Hazard Analysis**
- **Sneak Circuit**
- **Energy Analysis**
- **What-if**