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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

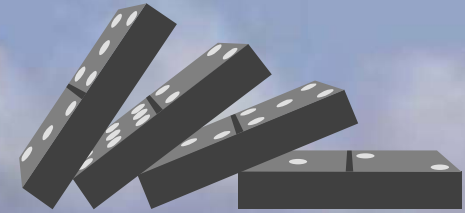
- People
- Equipment
- Material
- Procedures
- Work Environment

*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**