ENG 104.2 ENGINEERS AND SOCIETY (LECTURE NOTE)

TOPIC: SAFETY ENGINEERING; CONTROL OF OCCURRENCES OF ACCIDENTS IN PRODUCTION AND CONSTRUCTION INSDUSTRY; RULES AND REGULATIONS GUIDING THE POLLUTION OF THE ENVIRONMENT

TERMNOLOGIES SAFETY ENGINEERING

Safe: a condition in which all hazards inherent in an operation have either been eliminated or are controlled such that their associated risks are both below a tolerable threshold and reduced to a level which is as low as reasonably practicable.

Safety: freedom from unacceptable risk or personal harm.

Safety management system: the company structure, responsibilities, practices, procedures, processes and resources for implementing safety management.

Safety policy: a public statement of the intentions and principles of action of the company regarding its safety, giving rise to its strategic and detailed objectives.

Safety strategic objectives: the broad goals, arising from the safety policy, that a company sets itself to achieve and which should be quantified wherever practicable.

Accident: It is an unintended event involving fatality, injury, property loss or damage and/or environmental damage.

Incident: An event or chain of events which has caused or could have caused injury, illness and/or damage (loss) to assets, the environment or third parties. The word 'accident' is used to denote an incident, which has caused injury and/or damage.

Hazard: It is a physical situation or a condition with a potential for human injury, damage to property, damage to the environment or some combinations of these.

Risk: a combination of the probability of occurrence of an undesired event and the degree of its possible consequences, or a term which combines the chance that a specified undesired event will occur and the severity of the consequences of the event.

Risk assessment: a comprehensive estimation of the probability and the degree of the possible consequences in a hazardous situation in order to select appropriate safety measures.

Fault: An accidental condition that causes a functional unit to fail to perform its required function.

Failure: It is the termination of the ability of an item to perform a required function. Failures may be unannounced and not detected until the next full test (covert/hidden failures), or they may be announced and detected at the instant of occurrence (revealed failures).

Common cause failure: It is the failure of two or more apparently independent items or systems due to the occurrence of a single event.

Mean time between failures (MTBF): For a stated period in the life of an item the mean value of the length of time between cumulative failures computed as the ratio of the cumulative time to the number of failures under stated conditions.

Mean time to failure: for a stated period in the life of an item, the ratio of the cumulative time to failure for a sample to the total number of failures in the sample during the same period under stated conditions.

Repair time: the time during which an item is undergoing diagnosis, repair, checkout and alignment.

Availability: It is the ability of an item (under combined aspects of reliability, maintainability and maintenance support) to perform its required function at a stated instant of time or over a stated period of time.

Down time: It is the time during which an item is not able to perform to specification.

Cut set: It is a collection of basic events; if all these basic events occur, the top event is guaranteed to occur.

Initiating event: A postulated occurrence capable of leading to possible consequences. Loss of control point. Representation of a hazard to be analysed.

Maintainability: The ability of a machine to be maintained in a state which enables it to fulfil its function under conditions of intended use, or restored into such a state.

Maintenance: The combinations of all technical and corresponding administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function.

Mean time between maintenance (MTBM): for a stated period in the life of an item the mean value of the length of time between cumulative maintenances

computed as the ratio of the cumulative time to the number of maintenance activities under stated conditions.

Quantitative Risk Assessment (QRA): quantitative evaluation of the risk imposed by a system design, whether those risks are from human, hardware or software failures, or environmental events, or from combinations of such failures/events.

Redundancy: the performance of the same overall function by a number of independent means. The means need not be identical.

Reliability: the ability of a machine or components, or equipment, to perform a required function under specified conditions and for a given period of time without failing.

Scenario: the path of an incident from an initiating event to the final outcome.

SAFETY IN ENGINEERING PRACTICES (SAFETY ENGINEERING)

This is a field of engineering that deals with the control (prevention) of occurrence of accident, reducing the risks associated with human error, and deriving safety benefits from engineering systems, designs, practices operations and activities. It makes safety an integral part of engineering operations by reducing or completely eliminating risk.

Safety must be considered first in every engineering operation right from the design phase to reduce the rate of failures in engineering systems.

Common engineering activities are:

Welding and fabrication

Construction

Drilling

Cargo operations/cargo works

Wiring/electrical installations

Operating heavy machines

Mixing and handling harmful chemicals

Etc.

COMMON HAZARDS

Fire and Explosion Hazards

Respiratory Hazards

Skin Contact Hazards

Limited Access Hazards

Slip and Trip Hazards

Fall Hazards

Work Environment Temperature Related Hazards

Excessive Noise Hazards

High-Pressure Hazards (for example, abrasive and hydro blasting)

Electrical Hazards

Impact Hazards (for example, grinders, or needle guns

Impact Hazards

Workers may be exposed to impact hazards from:

Sparks

Metal particles

Grinding debris

Paint debris

Falling objects

Injuries may include:

Particles becoming imbedded in the skin

Eye damage

Skin burns

Skin trauma

Requirements/Solutions:

Proper use of PPE.

Electrical Hazards

All workers who work with electrical equipment in wet or damp locations have an increased risk of getting shocked or electrocuted due to:

Faulty electrical connection in power tools.

Open lighting parts.

Broken insulation on power cables and cords.

Requirements/Solutions:

Portable electrical tools must be grounded or double insulated.

Temporary lighting must be grounded.

All electrical tools or equipment should undergo a visual inspection prior to use.

All portable electric hand tools and temporary lighting systems should utilize Ground Fault Interrupters (GFI).

Electrical tools and equipment should correspond with the requirements of the job.

Electrical equipment and tools should be used with proper circuit protection for the voltage and amperage used.

Only qualified electricians should attempt to repair electrical tools and equipment.

A Ground Assurance Program should be in place for all electrical tools and equipment used including:

- Records of tools inspected and repaired.
- Records of electrical boxes inspected and repaired.
- Records of electrical extension cords inspected and repaired.
- Recall of records of the above.
- The requirements of the Ground Assurance Program should be performed on a regular basis.

High-Pressure Hazards

The use of high-pressure equipment may expose operators and bystanders to the following hazards:

- Contact with high-pressure steam, water, grit, or air streams from cleaning equipment.

- Contact with uncontrolled high-pressure hoses.

Injuries associated with these hazards include:

- Loss of body parts (for example, fingers, or hands)
- Lacerations
- Burns
- Loss of sight

Requirements/Solutions:

- Use appropriate PPE.
- Control access to the area.
- Inspect hoses and connections prior to use.
- Use pressure equipment according to the manufacturer's recommendations.
- Warning: Do not use oxygen for cleaning (blow-off), operation of air tools, or ventilation

Excessive Noise Hazards

Use of tools and equipment may produce high noise levels, which could lead to permanent hearing loss, and often necessitates a hearing conservation program. Some examples of excessively loud operations include:

- Use of high-pressure water and steam guns
- Abrasive Blasting
- Needle Gunning
- Scaling
- Grinding

Requirements/Solutions:

- Hearing protection (ear muffs)
- Hearing conservation program

Work Environment Temperature Related Hazards

Environmental hazards include temperature, humidity, and air movement within the work area. A combination of PPE use, heat-producing equipment, work activity, and environmental conditions can cause temperature-related illnesses.

Heat-related illnesses include:

- Heat Stress
- Heat Stroke
- Heat Cramps
- Dehydration

Cold-related illnesses include:

- Hypothermia
- Frost Bite

The following precautions for heat-related illnesses are recommended:

- Plenty of fluids
- Frequent breaks
- Ice vest
- Shaded or cooled break areas
- Ventilation
- Awareness training

The following precautions for cold-related illnesses are recommended:

- Appropriate insulated PPE
- Warming areas for breaks
- Awareness training

FACTORS INFLUENCING THE SAFETY

1. Design

During the design stage of marine and offshore system, decisions that can significantly ensure the safety of the sytems are made. Therefore, experienced designers are needed in the design stage of the system. Designers reveal danger zones in the system and carry out design with specifications that cannot compromise the safety of the system. Failure of the designers to recommend right specification with respect to safety can cause the system failure while in operations.

2. Manufacturing

Manufacturing can influence the safety of a marine and offshore system. Once there is manufacturing error in any of the systems and subsystems, the safety of the vessel has been compromised. Such error can result to an accident that can be catastrophic. Manufacturing error causes malfunctioning of various systems and subsystems. It causes frequent system failure.

3. Installation

Manufacturing can influence the safety of a marine and offshore system. Once the systems and sub systems of marine and offshore product is installed wrongly, failure is likely going to occur', and the consequence could be catastrophic. Proper installation of various systems and sub-system of any marine and offshore product can guarantee optimal operations of the system to reasonably extent.

4. Commissioning

Commissioning of various systems and subsystems as a standalone and in combination with each other can influence the safety of marine and offshore product. Commissioning is a process in which a system that is installed, or is complete or near completion is tested to verify if it functions according to its design objectives or specifications. Improper commissioning of a system can comprise the safety of the marine and offshore product. This is because any system that is likely going to fail will not be identified.

5. Operations

Operations of various systems and subsystems of the marine and offshore product can influence its safety. If the system operations are not in optimal level, it can lead to gradual failure of such system, thus the marine and offshore product safety will be compromised. Secondly, if the system is operated by inexperienced professionals, it can also affect the system integrity. The operations of the systems contribute significantly in ensuring the safety of the marine and offshore product.

6. Maintenance

Maintenance can influence the safety of marine and offshore product. Failure to carry out maintenance on a system can cause the breakdown of the marine and offshore product, thus the safety level has dropped significantly. Secondly, application of the correct maintenance techniques on any system or subsystem can improve the overall safety of the marine and offshore product. It can also increase the life span of the systems and subsystems and contributes significantly in ensuring optimal operations of the ship.