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Job Safety Analysis (Human & Equipment)

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Abstract Risk assessment, the proactive and systematic assessment of risks, is a standard element of most offshore and maritime companies' safety management systems. Risk assessment is a powerful and flexible tool to identify and control potential undesirable events that can have safety, environmental, quality, or financial repercussions. The focus of these Guidance Notes (prolusion) is risk assessment applied to work tasks, commonly referred to as job safety analysis for human and equipment. This paper will discuss safety of seaman and equipment (JSAHA) before the start of any job. In this regard all safety and errors of any task will be checked and investigated. Moreover, the manner in which the equipment Functions is studied the instruction for the preparation of the full manuscript is detailed in this template file. The template is intended as a tool to assist you in the layout of your manuscript. It is encouraged that this template can be used for submission of manuscripts. Use of the template will save time during production and expedite publication.

Keywords Safety ,Human , Equipment, Analysis

1. Introduction

The marine and offshore industries have implemented job safety analysis at varying levels of maturity. The best practices and concepts contained within this document can be applied by any marine or offshore company wishing to initiate or improve their JSA (H&E) program.

There are therefore a number of factors which influence the behavior of maintenance crews and the likelihood of human error and human error needs to be considered both in terms of its effect on safety of people and also in terms of its effect on damage to plant or equipment or reduced reliability and subsequent breakdown.[1]

Accident analysis always implies an accident model is a set of assumption s of what the underlying "mechanisms" are [2]. An accident model is an abstract conceptual representation of the occurrence and development of an accident; it describes the way of viewing and thinking about how and why an accident occurs[3].

Accident model is also a very important process for providing input to the development of proactive and cost-effectiveness safety measures[4]. There are extensive literatures about accident model, most of which analyzes accidents using conceptual representation or summary statistics. For example, [5] carried out marine accident analysis to deter-mine the most common causes of accidents on fishing vessels using accident data collected from the Marine Accident investigation Branch. They carried out a statistical study of accident type, deaths and vessels lost in period from 1994 to 1999, which showed that there was a real safety problem in the fishing vessel industry.

Safety measures by identifying the benefit from accident prevention and the cost associated with safety measures. The evaluation of costs and benefits may be conducted using various techniques[6].

Ignoring work health and safety leads, therefore, to significant economic losses, which has a serious impact on labor productivity. There are three to four times more fatal occupational accidents in developing countries than in developed countries and these events are usually avoidable; in Iran, about 14,000 occupational accidents occur annually [7]. Due to the massive volume of data available and the limitations of statistical methods for data analysis, data mining has received a great deal of attention in recent years. Data mining is the process of managing knowledge and extracting it from large data bases. [8] classified the data from the US National Response Center (NRC) data base in to different groups and, using data mining techniques such as association rules, found interesting patterns in occupational accidents in the American petro chemical industry in terms of the type of equipment involved, the type of chemical released, and the cause of the accident.

Keren et al. [9] also used the NRC data base to try to identify the operational risks in the chemical industries of Harris County, Texas, USA. Again, the association rule data mining tool was used, as well as lift methodology, to calibrate the failure risk of equipment involved in a chemical process.

For the period 2000-04, [10] examined the rate of occupational injuries in different Italian industries and

compared the working conditions of temporary and permanent employees using injury frequency indices and characteristics of the labor force. The data was derived from the National Organization for Work's injury insurance, which relates to three large manufacturing firms. Then, the results were analyzed using the injury frequency(FI), the characteristics of the labor force, and the accident intensity index(SI). In the most hazardous industrial sectors, the FI and SI for temporary workers were found to be higher than for permanent employees. Evidence was also collected from the responses of injured temporary workers.

Hintikka and Saarela[11] used the European Statistics on Accidents at Work (ESAW) methodology to analyze accidents related to violence, especially those involving women. The data base included statistics for Finland's occupational accidents between 2003 and 2006, and indicated that the number of such accidents had increased in recent years (2003-06) due to changes in the labor market and women's working lives .Applying association rules, Mirabadi and Sharifian [12] analyzed accident data for the Iran Rail way (RAI) and discovered correlations and new patterns. CRISP-DM was the data mining methodology and Clementine 12.0 the software tool used for this study. They selected 6500 records of accidents between 1996 and 2005 from the Iran Railway accidents data base (RAI) and examined the conditions and other factors related to each In order to develop and improve preventive regulations and rules: among the most common causes of accidents were human error, wagon, and track. [13]analyzed the factors contributing to the increase in occupational accidents, examining the effect of changes in working hours, years of employment, types of employment contracts, and working conditions on occupational and public health. The results showed that these factors increase worker's fatigue, alter working hour patterns, and affect years of employment. Moreover, job in security and occupational stress had a serious impact on workers' health hand, as a result, increased occupational accidents. The overall results indicated that the physical, mental, and social health and safety of the labor force must be given more consideration than the retention of their work ability.

1.1. What is JSA(H & E)?

A job safety analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, after we identify uncontrolled hazards, we will take steps to eliminate or reduce them to an acceptable risk level.

1.2. Objective

Why is job hazard analysis important?

Many workers are injured and killed at the workplace every day in the world. Safety and health can add value to our business, our job, and our life. We can help prevent workplace injuries and illnesses by looking at our workplace operations, establishing proper job procedures, and ensuring that all employees are trained properly.

One of the best ways to determine and establish proper work procedures is to conduct a job hazard analysis. A job hazard analysis is one component of the larger commitment of a safety and health management system. [14]

A Job Safety Analysis is a task-oriented risk assessment used to review the hazards and errors associated with a particular work task, and to verify that adequate safeguards are in place to control those hazards and errors. The main goal of the analysis is to prevent harm to the individual(s) carrying out the task. JSA (H&E) are known by a variety of terms, including Job Hazard Analysis (JHA), Job Risk Assessment (JRA), Safe Job Analysis (SJA).

2. Methods

JSA (H&E) is the analytical process of:

- Identifying the basic job steps of the task,
- For every job step, reviewing associated potential safety and health hazards, and also safety of equipment
- Planning for effective controls or safeguarding mechanism to control (i.e., eliminate or mitigate) the effects the hazards and errors may pose.

JSA(H&E)s are primarily used for controlling risks to the safety and health of the workers and equipment. However, a JSA(H&E) can be used as a tool to identify how the task can pose hazards to the environment or to the asset.

In addition to identifying the inherent hazards of a task, a well-conducted JSA(H&E) can uncover other subtle issues that pose risks to the individual, such as discrepancies between the way the procedures recommend a task to be carried out and the actual situation; problems with risk controls that supposedly act to reduce the risk but when brought to light during the JSA(H&E) are found to be deficient, missing, inoperable, or bypassed; or the hazards associated with personnel change during the tasks. The identification of these problems and the implementation of corrective actions before the task if performed can prevent undesirable incidents during the execution of the work task.

Hazards and errors associated with all tasks should be identified and controlled. However, some tasks require a more detailed JSA (H&E) than others. Instead of suggesting a JSA (H&E) program where certain tasks are left without the benefit of the JSA(H & E), or a program where all tasks are required to undergo a formal and comprehensive JSA(H & E), a tiered approach is recommended with two or more levels of JSA(H&E). Typically, two JSA (H&E) levels could be defined:

i) An informal JSA (H&E) (mental or verbal)
ii) A formal JSA (H&E) (comprehensive and documented)

The JSA (H & E)s can be carried out to varying degrees of detail, depending on the situation at hand.

A tiered JSA(H&E) program necessitates criteria to decide what type of JSA(H&E) is needed for each particular task depending on factors such as the type of task, its complexity, its regularity, etc. These Guidance Notes describe these two types of JSA (H&E) along with guidance on when to use one versus the other, but ultimately, each company will develop their program and criteria according to their needs and goals.

Consequence is the measure of the impact of an event occurrence in terms of people affected, property damaged, outage time, dollars lost, or any other chosen parameter. For purposes of a JSA (H&E), the focus is on impacts on safety and health of worker and equipment, but impacts on environment can also be considered and mitigated.

Controls are the measures taken to prevent hazards from causing undesirable events. Controls can be physical (e.g., safety shutdowns, redundant controls, added conservatism in design), procedural (e.g., operating procedures, routine inspection requirements), and can also address human factors (employee selection, training, supervision).

Event is an occurrence that has an associated outcome. There are typically a number of potential outcomes from any one initial event that may range in severity from trivial to catastrophic, depending on other conditions and subsequent events. The terms Event and Incident are used interchangeably.

Hazards are conditions that exist that may potentially lead to an undesirable event.

Incident, same as Even, Both concepts may include near misses (unsafe conditions) and injuries.

Job Safety Analysis (H&E) is an analytical process that focuses on a means to identify and control hazards/errors inherent in job tasks before they can result in an accident. JSA (H&E) also refers to the formal document that is developed as a result of the analysis process.

Likelihood indicates the potential that a hazard/error could be realized.

Risk is defined as the product of the frequency with which an event is anticipated to occur and the consequence of the event's outcome.

Risk Assessment is the process of understanding (1) what undesirable things can happen, (2) how likely they are to happen, (3) how severe the effects can be and (4) evaluating what the risk of each undesirable event is.

2.1. JSA (H&E) Process

FIVE STEPS TO RISK ASSESSMENT

Step 1: identify the hazards
Step 2: decide who might be harmed and how
Step 3: evaluate the risks and decide on precautions
Step 4: record our findings and implement them
Step 5: review our risk assessment and update if necessary [15]

A JSA (H&E) focuses on identifying the tasks necessary to perform a specific job; the potential safety and health, and in some cases, environmental, hazards associated with each task; and the possible risk control measures needed to eliminate or reduce these hazards and errors. The JSA (H&E) process can be divided into a number of steps, the complexity of which can vary depending on the job being analyzed. As mentioned before, it can be used informally through a verbal discussion before performing a simple, routine job, or formally following a prescribed set of steps and a well-defined JSA (H&E) form for more complex, non-routine, or new jobs. The JSA (H&E) process presented in these Guidance Notes is a flexible approach that can accommodate any level of detail. A so-called informal JSA (H&E) process is described, as well as a formal JSA (H&E) process for more complex jobs. Even within the formal JSA (H&E), the process can be applied at different levels of detail, depending on the complexity of the job. It can take minutes to several hours to complete. These Guidance Notes describe a range of options in terms of level of detail and complexity of each JSA (H&E) process step. Each company can modify and adapt this JSA (H&E) process to the appropriate level of detail for the different type of jobs applicable to them.

Regardless of the type of JSA (H&E) to be performed, there are three basic parts that need to be completed:

- Understand the task to be performed
- Identify potential hazards/errors for the task
- Identify risk control measures for each hazard/errors

The following sections provide guidance on how to complete these basic parts, with varying levels of detail appropriate for each type of JSA (H&E) approach.

Informal Job Safety Analysis

Informal JSA (H & E)s are mental or verbal individual risk assessments carried out by the worker(s) before starting any job. They are the most basic, quickest and simplest of task risk assessment, which help promote a risk management culture through continual self-evaluation. They aid in the identification and control of immediate hazards as personnel conduct their day-to-day work, and assist personnel in maintaining situational awareness of their environment at all times.

The informal JSA (H&E) described here is similar in nature to other planning tools that share the same intent: help workers perform even the most mundane tasks without getting hurt. These personal planning tools include techniques such as Stop and Think.

When to perform an Informal JSA (H & E)

The informal JSA (H & E)s are generally used for routine and simple tasks involving only one or two individuals and a small piece of equipment. The following tasks are examples for which an informal JSA (H&E) is appropriate:

- Routine materials and stores handling (e.g., moving dry stores from the storeroom to the galley, stocking storeroom shelves with received stores, etc.)

- Routine maintenance tasks (e.g. Painting and chipping in the open air, changing air conditioning filters, etc.)
- Routine housekeeping activities (e.g., mopping decks, cleaning up tank cleaning equipment, etc.).
- Routine and repetitive operations (e.g., tripping pipe in or out of the hole, connecting cargo hoses, applying securing devices to cargo or stores at deck level, etc.).

Personnel should be made aware that any time there is uncertainty regarding the risks, or a suspicion of high risks associated with the performance of a task, a formal H E S A should be conducted.

How to do an Informal JSA(H&E)?

A typical informal JSA(H&E)involves taking a moment before starting the job to consider the following factors, trying to identify their inherent hazards/errors, or what can go wrong with each one of them:

i) Task
ii) Work area/environment
iii) Equipment
iv) People
v) Controls

A) Task

The identification of hazards leads to devising methods to manage the risks associated with the hazard. The JSA(H&E)should be repeated throughout the duration of the task to account for changing conditions or circumstances and prompt the worker to step back and think through emerging issues.

Personnel doing the work are responsible for carrying out the informal JSA (H&E) and supervisors are responsible for encouraging and communicating the process.

Mentally or verbally understand the steps that need to be accomplished:

- Are the job description and instructions clear?
- Do task participants have sufficient knowledge or experience to handle the job safety?

Do task participants feel comfortable about job?

Will completion of the task lead to the creation of other hazards that need to be controlled

B) Work area

Identify hazards associated with work area and surroundings

For example. Cleaning of work area, lighting, weather conditions

C) Equipment

What equipment is needed to safely complete the task

- Is equipment available and in working order?

Are the task participants familiar with its use?

- Is the personal protective equipment (PPE)to be used in good condition?
- Is the test /monitoring equipment available properly calibrated and in working order?
- Are electrical cable/leads in working order?

D) People

Is there a need to communicate with other personnel prior to conducting the task?

How will the task participants communicate with others who may inadvertently interact with the job?

Does this task require more people/equipment to carry it out safely?

E) Risk control

Examine the need for control to reduce or eliminate hazards, and evaluate existing control for adequacy

Can I eliminate the hazards from work task?

Can I do the job perfectly?

If not how can I control/do the job perfectly?

Am I satisfied that hazards in the job are controlled?

If so start the task

Before actually beginning the job safety analysis, take a look at the general conditions under which the job is performed and develop a checklist. Below are some sample questions you might ask.

- Are there materials on the floor that could trip a worker?
- Is lighting adequate?
- Are there any live electrical hazards at the jobsite?
- Are there any chemical, physical, biological, or radiation hazards associated with the job or likely to develop?
- Are tools including hand tools, machines, and equipment in need of repair?
- Is there excessive noise in the work area, hindering worker communication or causing hearing loss?
- Are job procedures known and are they followed or modified?
- Are emergency exits clearly marked?
- Are trucks or motorized vehicles properly equipped with brakes, overhead guards, backup signals, horns, steering gear, and identification, as necessary?
- Are all employees operating vehicles and equipment properly trained and authorized?
- Are employees wearing proper personal protective equipment for the jobs they are performing?
- Have any employees complained of headaches, breathing problems, dizziness, or strong odors?
- Is ventilation adequate, especially in confined or enclosed spaces?
- Have tests been made for oxygen deficiency and toxic fumes in confined spaces before entry?
- Are work stations and tools designed to prevent back and wrist injuries?
- Are employees trained in the event of a fire, explosion, or toxic gas release?[16]

2.2. Formal JSA (H&E)

Like the informal JSA (H&E), a formal JSA (H&E) focuses on identifying hazards/errors associated with performing a specific job, the potential safety, health, and in some cases environmental hazards associated with each step; and the recommended risk control measures needed to eliminate or reduce these hazards and errors.

The main difference between an informal and a formal JSA (H&E) is that the latter process has an expanded level of detail and is documented. A formal JSA (H&E) documents the job steps, the identified hazards, and the means by which the risk of these hazards is eliminated or mitigated. The documentation becomes a means of communicating information about the job. All personnel involved in the job and the assessment have access to the results and can provide additional input as appropriate. Formal JSA(H&E)s should be filed for future reference whenever the same, or similar, task arises. These JSA (H&E)s should be reviewed and adjustments made as necessary to fit the existing conditions at the later time (i.e., time of day, type of weather, experience level of task participants, time restraints, etc.).

Timing and Location of JSA (H&E)

In close proximity to the task location, as well as shortly before commencing the task.

If a JSA(H&E) was performed well in advance of the task in order to allow time to install any recommended engineering controls, such JSA(H&E) must be reviewed again prior to commencing the task with all the personnel involved in the task.

Approval of the JSA(H&E) analysis is needed before starting the task. Approval process according to company procedures, usually by the relevant member of offshore facility management, Master, Offshore Installation Manager, HSE or shore-office.

Documentation and Record Keeping

Yes, according to company procedures. Records stay on vessel and usually shore side too.

When to do a Formal JSA(H&E)?

A formal JSA(H&E) shall be carried out for new major tasks or groups of tasks, or when the informal JSA(H&E) has been found not to suffice/or when required by company procedure. A task involving one or more of the factors below should normally trigger a formal JSA(H&E):

i) Non-routine tasks
ii) Tasks with known potential for harming crew, equipment or environment, including near-misses, or tasks that have been associated with recurring HSE events
iii) Complex/difficult tasks
iv) Tasks requiring the interaction of many people or systems
v) Routine tasks performed under unusual or unfavorable situations
vi) Tasks involving a change from the norm, or something/someone new or different
vii) Work on critical equipment

How to do a Formal JSA(H&E)?

The formal JSA(H&E) process is conducted in a series of sequential parts, all of which are to be documented, the formal JSA(H&E) will include all of the following parts:

1) Define the job specifically.
2) List steps of the job.
3) Identify hazards and errors for each job step.
4) Identify existing risk control measures for each hazard and error.
5) Verify implementation of the controls.

Some of parts of the JSA(H&E) process may be simplified or skipped for a simplified version of the formal JSA(H & E).

Formal JSA(H&E): Define the job

The first part of all JSA(H & E)s is to define and describe the job to be performed. It should answer the what, why, who, where, and the when of the job. It provides a clear understanding of the following aspects:

- Specific job to be performed and the scope
- Reason for the job
- Personnel that will be involved and their competence and experience
- Clear instruction, communication and understanding of the task with all those concerned, is in itself an important action to reduce the likelihood of incident occurrence.
- Types of tools and equipment and spare parts that will be used in the job
- Physical location of the job, work area, environment
- Time period for the job

JSA (H&E) Example: Defining the job

The fall cable on one of the lifeboats is chafed and needs to be replaced. Launching, retrieving and maintaining a lifeboat can be a high-risk activity leading to injury and death, and also causes damage to lifeboat when it will be operated, in particular while at sea. As a high risk activity, a formal JSA (H&E) should be conducted. The first step of the JSA(H&E) process is to clearly define the job by answering the what, where, why, who, and when.

What: Replace fall cable on davit-fall lifeboat No.1
Where: Muster area No. 1
Why: Fall cable shows visible signs of wire fraying
When: Morning shift
Who: 2nd Mate, and Deck Department

Reason of job

- Why: Fall cable shows visible signs of wire fraying
- Read manual/instruction of maker
- Tools and equipment/spare parts:
- New wire must be original and has certificate and approved by class otherwise job must be postponed up to receipt of new wire with certificate

- Two preventer wire strap pendants of the correct length and four safety shackles within the safety working capacity of each to hold each end of the lifeboat in place during the fall replacement;
- Supervised by Chief Mate, under the authority of the Master with a permit to work
- A box of rags for clean-up, including degreasing liquid (Material Safety Data Sheet for the degreaser);
- PPE (leather gloves, safety goggles, steel-toed shoes/boots, Company coveralls or pants/shirt; hard hats with chin straps; fall-arrest gear when working at height);
- Wrenches necessary to disconnect the cable from the drum;
- Channel locks or other type of pliers for working with safety shackle cotter pins,
- Empty spool to coil the old fall to be removed,
- Power to the davit winch to turn the fall off the davit and take-up drum;
- Crane and rigging straps to hoist the new fall drum to the working area and to remove the old fall to the ship's disposal area;
- Walkie-talkies for communicating with each other and the bridge as necessary

Formal JSA(H&E): Identify the hazards associated with each job step

Hazards for each job step need to be identified to determine if there are any potential risks which require control. Personnel should give consideration to the following information and resources in their quest for potential hazards:

Crew skill /Location /work area/ environment/ Equipment /tools/materials/spare parts/ Process/materials used

Past incidents/near misses/Checklists of human error /hazard

Example: engine staff decided to overhaul one generator at sea, this job will be checked according of JSA (H&E) fig 1

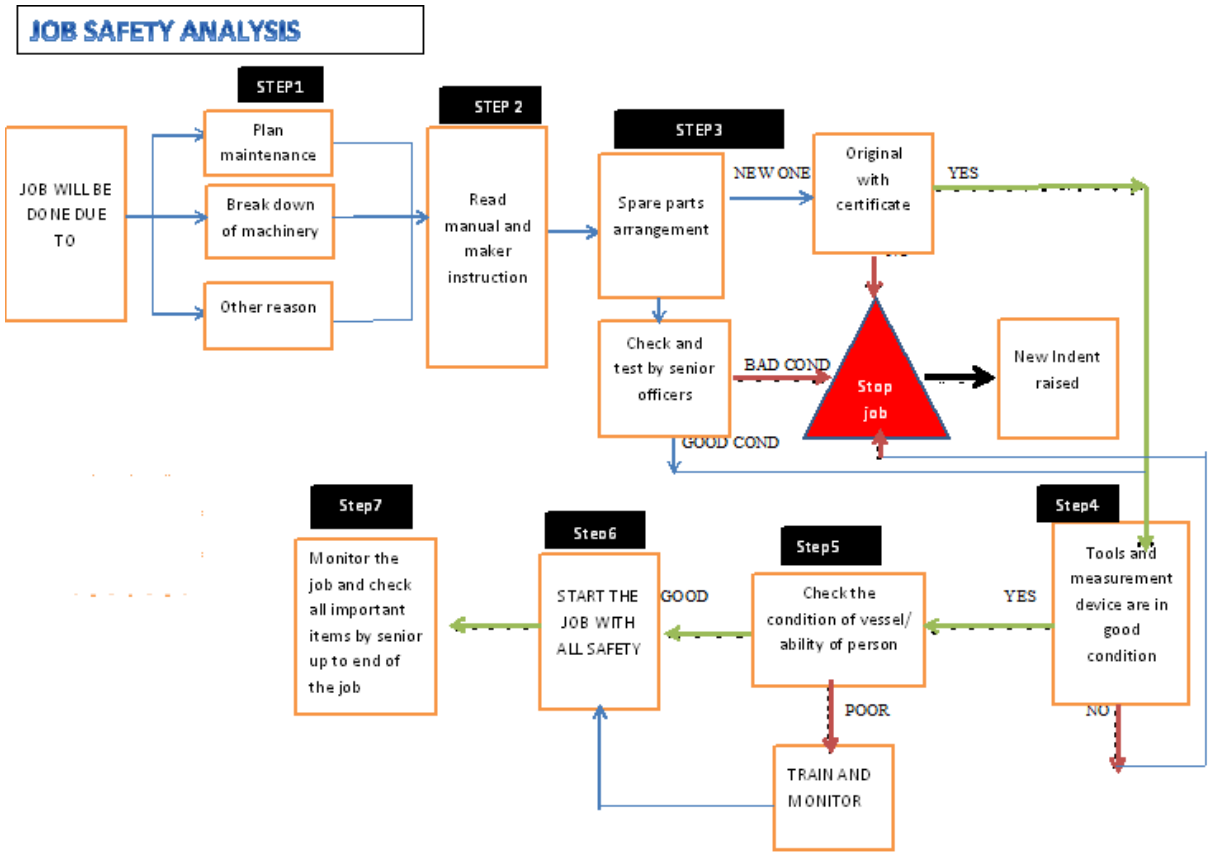

Figure 1. Generator overhauling according JSA (H&E)

Step 1) Job will be done due to

1-plane maintenance/2-breakdown/3-noise and vibration and leakage/4-office order/5-csm items/6-other reason.

In this regard if needed must inform & call office/class survey /insurance survey/port authority in advance and make arrangement. For example immobilization letter.

Step 2) Manual and instruction of maker must be read carefully and also any instruction and service report must be read and understood. For example opening/closing hyd pressure and also torque meter and also clearance and also time of service and change of parts.

Sometimes the makers due to some defects which are created in equipment because of duration of time change spare parts and quality of them which are mentioned in service report.

Items which are very important to underwrite after any incident and will be investigated must be done according to instruction of maker.

b) All jobs done through maker plane maintenance for example if any accident happens for generator in running hrs. 11000, they will check all maintenance which must be carried out before this time and any contradiction b/w maker instruction and ship staff time maintenance causes the no pay any cost for this incident In this regard it is very important that ship staff become familiar with all instruction manual in detail.

Example: In one incident on irisl fleet, at the time of overhauling generator ship staff thought more tightening of the hyd.bolt is better, then they decided to tighten the bolt more than the limit. This action caused bottom bearing to turn when the generator was running and as a consequence damage was done to crankshaft of generator.

In another experience at the time of overhauling one generator 4/e one bottom bearing was not tightened and this caused the bolt to be cut and damage to the crankshaft was done.

Step 3) Spare parts

All spare parts must be checked for availability on board and condition.

Any fake spare parts cause injuries to ship staff and damage to machinery and brings about

Wild goose chase and it can also cause to create damage to other equipment. Remember underwriter will not pay for any damages if spare parts are not original.

And some parts which were overhauled on board vessel or workshop must be checked by a senior officer for working normally. By considering these important items, if any out of arises about the condition of spare parts the office must be informed and a new indent must be made.

Step 4) Tools and measurement devices

All tools & measurement devices exm.(hyd.jack, torque meter, pressure and temp. calibrator and other devices …) must be checked before the beginning of any job. It is important to start the job. Any malfunction of these devices can cause serious damages to machinery while these damages are not covered by insurance if their certificate of tools s is not valid

Shore calibration certificate/Overhead crane / Chine block derrick safety devices are apparently operational and regularly tested

Step 5) Vessel condition and ability of ship staff

The vessel condition means the situation of sea and position of it.

It is better not start the job in rough sea and also in war zone area because they cause ship staff not be able to work in appropriate condition. Senior officers must know about the ability and behavior of their staff as this can help them for better management. If there are doubts about the ability of staff then it is duty of senior officer to train and monitor the staff before starting the job and performing it.

Step 6) Job Safety

It means to take care of safety of our self and equipment

Before starting the job it must be made sure that standby equipment is ready and in good condition (operational); then it must be isolated from other related machinery (power/valve/line,..) then a notice must be put on local and control room and bridge if needed.

All proper wear and proper tools must be used/Job must be monitored by senior officers/Do not work alone after working time/Cleanness and clarity are always important/Remember nonuse of proper wear and tools, not only causes damage to yourself but it is also not covered by the underwriter.

Step 7) Monitor and complete job

All parts must be checked carefully and defective parts must be examine to find out the reason for (wear/tear or other reasons) and this is true for all measurements and pic if the need arises and when finishing the job all systems must be returned to normal condition and all safety items including alarm system must be tested before and when machinery is running. All this has to be recorded and when equipment is turned on all important items including press, temp. Vibration, noise must be monitored.

Another practical case which shows how JSA performed.

Entry to tank for cleaning

Step 1) Job will be done due to

Cleaning of tank, Determine what is in the tank, what process is going on in the tank, and what hazards this can pose.

Step 2) Manual and instruction of maker (kind of HAZARDS)

Hazards: Explosive gas, Improper oxygen level, Chemical exposure — Gas, dust, vapor: irritant, toxic, liquid, corrosive, heated, Solid, irritant, corrosive, moving blades/equipment

Step 3) Spare parts (Set up equipment)

For cleaning of tank which equipment's are essential and they must be ready before attend the job

Oxygen analyzer, Hoses, cord, equipment — tripping hazards, Electrical device

Arrange hoses, cords, lines, and equipment in orderly

fashion, with room to maneuver safely.

Use ground-fault circuit interrupter.

Step 4) Tools and measurement devices

Oxygen analyzer/gas detector must be used for checking the inside the tank also date of calibration certificate is important

Step 5) Vessel condition and ability of ship staff (weather)

Select and train operators, avoid from operator with respiratory or heart problem or other physical limitation. Untrained operators will failure to perform task.

Step 6) Job Safety

Test air by quailed person.

Ventilate to 19.5% -23.5% oxygen and less than 10% LEL of any flammable gas. Steaming inside of tank, flushing and draining, then ventilating, provide appropriate respiratory equipment — SCBA or airline respirator. Provide protective clothing for head, eyes, body, and feet, Provide harness and lifeline. Tanks should be cleaned from outside, if possible. In work permit signed by safety, maintenance, and supervisors and at end check of jobsite by industrial hygienist or safety professional

Step 7) Monitor and complete job

Gas or liquid in tank, Empty tank through existing piping, Review emergency procedures.

Open tank, Install blanks in flanges in piping of tank (isolate tank)

Test atmosphere in tank by quailed person (long probe).

Place equipment at tank-entry position

Use mechanical-handling equipment.

Provide guardrails around work positions at tank top.

Enter tank, Ladder — tripping hazard, Exposure to hazardous atmosphere.

Provide personal protective equipment for conditions found. [17]

Provide outside helper to watch, instruct, and guide operator entering tank, with capability to lift operator from tank in emergency. Install ladder in tank, Ladder slipping, Secure to manhole top or rigid structure.

Cleaning tank, Reaction to chemicals, causing mist or expulsion of air contaminant, Provide protective clothing and equipment for all operators and helpers.

Provide lighting for tank (Class I, Div. 1).

Provide exhaust ventilation.

Provide air supply to interior of tank.

Frequent monitoring of air in tank.

Replace operator or provide rest periods

Provide means of communication to get help, if needed.

Provide tow-man standby for any emergency.

3. Conclusions

Hazards and errors exist all over the world. And they can take place at sea due to perils of sea but they can be deleted or reduced if we were aware of them and they can be controlled before starting any task if we know about them .By training and studying we can control them and reduce the cost and save people and machinery.

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