



**Linde Gas Singapore
Jurong Island Vision Zero (JIVZ) Cluster Forum**

Dynamic Risk Assessment – Must Need for Pressure Vessel Maintenance

Making our world more productive



Pressure Vessel and Its Life Cycle



- **What is Pressure Vessel**
 - For process plants, pressure vessel in simple terms means a container which contains process gas or liquid at a pressure more than atmosphere and carry a potential health, safety, environment hazard in case of loss of containment. It can be a vessel, column, exchanger, direct or indirect steam generator, reactor, furnace, etc
- **Life Cycle of Pressure Vessel and associate hazards**
 - **Design** – Selection of material, thickness, process specification
 - **Fabrication** – Material procurement, rolling, welding, nondestructive testing, pressure testing, transportation
 - **Installation** – Soil testing, Piling, Foundation, Lifting, Levelling, Grouting, Insulation, Piping connections, torquing
 - **Operation** – Purging, Commissioning, Operation
 - **Maintenance** – Cleaning, Repair, Pressure Test, Modification
 - **Re-Rating** – Making suitable for different process condition
 - **Scrapping/Disposal** – End of life handling

Maintenance on Pressure Vessel



- Pressure Vessels are an integral part of process industry, and they have to be maintained as per manufacturer and or industrial specifications in order for us to operate them safely and reliably
- **Different Maintenance activities** are required on pressure vessel based on the different driving factors such as
 - Statutory Requirement
 - Operation Requirement
 - Requirement from Risk Based, Time Based or Condition Based Maintenance Program
- **Maintenance could be of several types**
 - Only ‘Visual Inspection from manhole
 - Internal cleaning and inspection (Visual + NDT) by taking confined space entry
 - Cleaning, Inspection and Pressure Test
 - Inspection, Repair by hot work, Pressure test

Maintenance on Pressure Vessel and Risk Assessment



Typical Risk Assessment for Planned Maintenance on Pressure Vessel

Part 2 – Hazards		
Question	Answer	Is there a risk to those who will work in the area?
What is/was stored in the confined space?		
Are there any chemical residues?		
Are there materials or substances likely to enter from adjacent processes?		
What are the dimensions of the confined space?		
Are harmful or explosive substances likely to be present?		
Are flammable or toxic gases or vapours likely to be present?		
Can power supplies be isolated?		
Is there a danger of explosion?		
Will sources of ignition be introduced?		
Can work take without the need for PPE/RPE?		
Will any combustible materials be present?		
Will there be extreme temperatures or humidity?		

Part 3 – Emergency arrangements		
Are there arrangements for safe access and exit?		
Is suitable rescue equipment provided?		
Can the alarm be raised in the event of an emergency?		
Are fire extinguishers provided where there is a risk of fire?		
Can nearby plant and equipment be isolated?		
Are there suitable first aid arrangements?		

Pressure Vessel Maintenance : Need For Dynamic Risk Assessment



- Risk Assessment has to be **dynamic** because in actual practice, maintenance on the pressure vessel need to accommodate new findings (discovery jobs) which leads to change in either or combination of the following
 - changing environment
 - scope of work
 - method statement of execution
- At this juncture, there is a maximum possibility of lapse in our work processes which can increase our exposure to process safety risk in short term or long term
 - Urgency of meeting schedule
 - Not enough time spent on modifying work package, method statement
 - Bypassing/Trimming procedure of Engineering Management of Change
 - Not involving subject matter experts before making decision

No Job is So Urgent Which Can not be done Safely

Pressure Vessel Maintenance : Need For Dynamic Risk Assessment



What can go wrong if Risk Assessment is not reviewed for Discovery Jobs

– Personal/People Safety Aspect

- Blinding, Ventilation Plan, Rescue Plan
- More than pre-defined contractors, personals in the confined space
- Certifications of Work at height arrangement

– Maintenance & Integrity Aspect

- If vessel is under statutory requirement, MOM/authorized inspectors must be informed, repair method statement needs to be approved before starting the job
- If vessel is ASME certified and site wants to maintain certification, authorized ASME inspector must be involved, and only certified contractors must be chosen to carry out the task
- Vessel GA Drawing, MDR needs to be verified before attempting any hotwork for repair (Cladding, Strip Lining, Weld overlay)
- Any heat treatment requirement must be considered – Residual stresses can impose process safety risk in medium to long term
- In case of welding, WPS must be reviewed by SMEs and make sure execution team adheres to all the requirements
- After ad-hoc repair, if pressure test is required, detailed review must be done on media, test method, pressure etc (Inaccurate pressure test can give false security of safety or it can over stress weld joints and make the vessel weak)
- While rushing to complete maintenance, do take extra care if pneumatic test is considered, get the arrangement approved from relevant expert

Pressure Vessel : Let us Operate & Maintain Safely



All of Us can play our part and avoid such failures in Jurong Island





Thank you for your attention.

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