

Hazards31. IChemE

16-18 November 2021, Virtual conference

Analysis of Losses. 16/11/2021

Analysis of accidents and good inspection practices for the management of ageing of industrial plants

Romualdo Marrazzo

*Service for Risks and Environmental Sustainability of Technologies, Chemical Substances,
Production Processes and Water Services and for Inspections (VAL-RTEC)*

ISPRA - Italian National Institute for Environmental Protection and Research

The role of ISPRA for industrial control

- ISPRA has a national role as a **technical body supporting the Ministry of Environment** in the national implementing of the **Seveso Directives** for the prevention of major accidents
 - Definition of **technical contents of laws and decrees** to control Major Accidents
 - Set-up of the **National Inventory of major accident hazards establishments** and other related data-bases
 - **Inspections of upper-tier establishments SMS** on regular basis or after an accident
 - Support for **international activities** (EU, OECD, bilateral cooperation)
 - Technical coordination and **addressing of Regional Agencies** for the Protection of Environment (ARPA)
 - **Collaboration with other Authorities competent** for industrial risk (Ministry of home affairs – National Fire Brigades; Department of civil protection; Ministry of infrastructures)

Program and themes

- 1. Introduction**
- 2. Industrial accidents and plant aging**
- 3. Italian law, national standards and guideline**
- 4. An approach to good practices**
- 5. The analysis of inspections**
- 6. Conclusions**

- Introduction and background
- Risks related to ageing

1. Introduction

Introduction and background

- The **Italian** implementation of the **Seveso III directive** (2012/18/EU) is the **D.Lgs. 105/2015**, aiming at the **prevention of major accidents involving dangerous substances**
 - Site Operators are obliged to **take all necessary measures** to **prevent** major accidents a/o **limit** their consequences for **health and environment**
 - Depending on the **amount of dangerous substances** present, establishments are categorized in **lower and upper tier**

- As part of the **implementation of the Safety Management System for Prevention of Major Accident (SMS-PMA)**, the D.Lgs. 105/2015 imposes
 - **Monitoring** and control of risks related to **ageing of equipment and systems** that can lead to **loss of containment** of hazardous substances, including the necessary **corrective and preventive measures**

- Ageing mechanisms as potential contributors
- Some national cases

2. Industrial accidents and plant aging

- Main results of the **analysis of some industrial accidents**, which recently occurred on the **national** territory at **"Seveso" establishments** (refineries and chemical plants), identified
 - Mechanisms related to **aging**, as significant **causes**, both in **technical and organizational terms**

Fire and explosions in piping

Description	Causes	Actions	Expected/Planned
<p>Release of crude oil from transfer pipe in the underpass of the road that crosses the plant, that developed a fire by accidental triggering which subsequently involved the adjacent piping belonging to different operators and then a series of explosions (Domino Effect)</p>	<p>Age (over 25 years) and state of preservation of the pipe in relation to the progressive corrosion phenomena, which led to the pipe drilling</p>	<p>Visual inspection and basic design of corrective actions. Necessary reconstruction activities.</p>	<p>Specific risk analysis. Planned and/or required compliances following Competent Authorities examination. Check of the pipeline inspection plan</p>



Leakage through the tank bottom

Description	Causes	Actions	Expected/Planned
Leakage of oil through a large lesion at the bottom of a floating roof tank and subsequent release of the total amount of oil inside the containment basin	High corrosion and deteriorated area	Tank insulation . Transferring the product to another tank with temporary pipes	Tank out of service . Carrying out the remediation and maintenance of the basin and the tank. Double bottom insertion



Spill of sulphuric acid from a supply pipe in an underground channel

Description	Causes	Actions	Expected/Planned
<p>A spill occurred in the buried channel housing the pipeline connecting 6 storage tanks of sulphuric acid. This spill of H2SO4 in the subsoil caused the structural failure of one tank and the relative rotation of the base of the containment basin</p>	<p>Advanced corrosion in a section of this pipeline not accessible to the controls. It has been supposed a duration of the spill in the subsoil of about 40 days, for a total of H2SO4 spilled from the pipe equal to about 45 t</p>	<p>H2SO4 tank emptied of the product. Supply lines intercepted and further tank isolated. Monitoring and verification of the deformation of structures. The perimeter wall of the containment basin has been reinforced, in order to ensure the seal of the basin itself</p>	<p>Scheduled maintenance on H2SO4 tanks. Monitoring of corrosion of these tanks and of the loading pipes, for the calculation of the corrosion rate in the short and long term and of the residual life (new procedure)</p>

Presence of diesel in piezometers near a storage tank

Description	Causes	Actions	Expected/Planned
<p>Following the sampling at 2 piezometers, located near a storage tank containing diesel, the presence of a supernatant hydrocarbon product of the same type in the tank was found. Spill of about 1000 cubic meters of diesel in the subsoil, following a leak from a storage tank</p>	<p>Corrosion in the single bottom of the tank, although this had been subject to maintenance work on the bottom in the previous 2 years (application and welding of overlapping sheets on the existing bottom)</p>	<p>Construction of a draining trench north of the tank and commissioning of new piezometers. Update of the operational protocol for the hydro-chemical and piezo-metric monitoring of groundwater</p>	<p>Implementation of the double bottom on all tanks of hydrocarbon products, with viscosity lower than 12 ° E at 50 ° C, with a single bottom. Review of the aging management program of the tanks</p>

- National and technical standards
- Supporting for ageing evaluation

3. Italian law, national standards and guideline

National and technical standards

- Tools for the **implementation of an effective SMS** (UNI 10617, 10616, 10672, 1226)
 - “**State of the art**” in the D.Lgs. 105/2015 and meet the **requirements** of the **law** and the **ISO standards**
- Technical **standards**, specific for **pressure equipment** (UNI/TS 11325-8, 11325-9)
- **Risk Based Inspection (RBI)** and **Fitness For Service (FFS)** methodologies
 - A targeted **planning of maintenance** operations and accurate **monitoring**

Supporting for ageing evaluation

- Development of a **method for a base evaluation** of the adequacy of **ageing consideration** in the frame of the **asset integrity management**
 - It is useful for **site managers** (**qualitative** assessment) and for **inspectors** (evaluation of the **implementation**)
 - Role of **Public Administration** in **addressing** the control of **risks** associated with **aging**

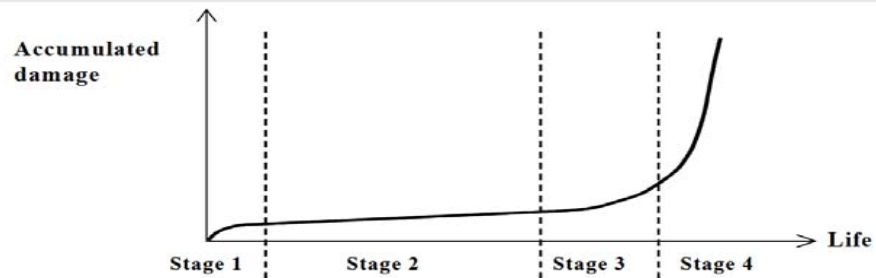


- Implementation of maintenance standards
- Influence of ageing on equipment
- The primary containment system

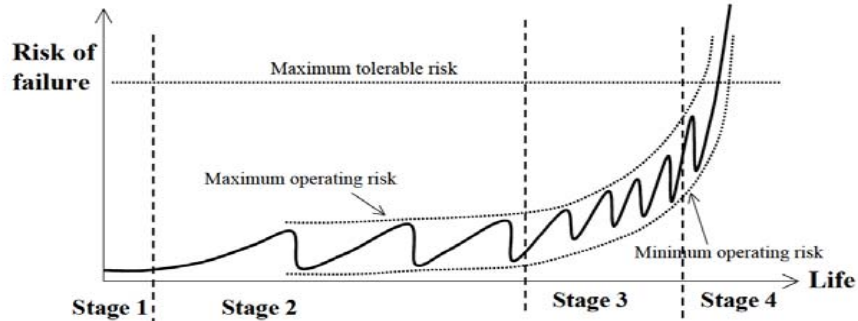
4. An approach to good practices

- Preventive, scheduled, or corrective **maintenance of critical equipment or lines** may be performed in accordance with the **Risk Based Maintenance (RBM) Policies/Practices**
 - They shall **minimize the risk of loss of functionality**
- **Ageing** is not strictly related to the age of the equipment, but to its **changes over time**
 - It can lead to significant **deterioration and/or damage to initial conditions**, compromising functionality, availability, reliability and safety

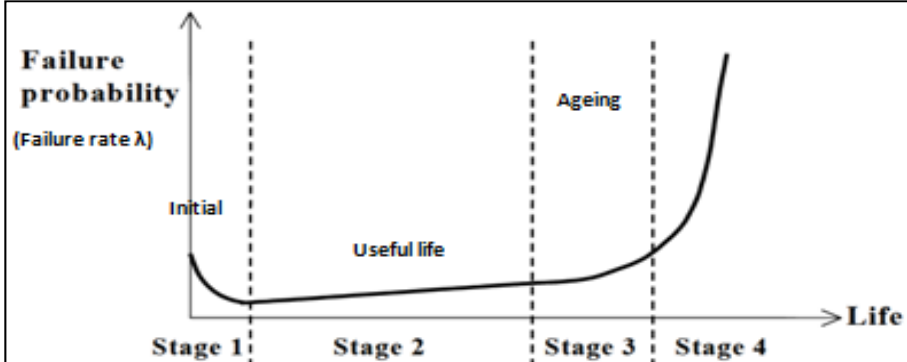
Influence of ageing on equipment



Variation of accumulated **damage** during the service



Effect of **periodic maintenance** on the risk of failure, varying **between tolerable risk and operating risk**



Model for the **probability of failure** of a population of equipment: the “**bathtub curve**” shows the typical **four stages of the progressive ageing**

The primary containment system

- A possible **approach** to ensure **mechanical integrity**
 - i. Defining the **degradation mechanisms**
 - ✓ *Corrosion / Mechanisms not related to corrosion*
 - ii. Defining and personalizing **inspection technologies**
 - ✓ *Liquid penetrant testing / Magneto-scope test / Vacuum box test / Ultrasonic (long range) / Spark test / Acoustic Emissions*
 - iii. Determining the **frequency of inspections**
 - ✓ *Construction / Repair techniques and materials / Stored product / Previous inspection / Corrosion rates / Corrosion prevention systems / Potential contamination / Double bottoms or other systems / Leak detection systems with operating tanks*
- In addition, the "**Management of Changes**" is crucial
 - It is important to **keep records of the operating history** and problems encountered **during the life**

- Non-compliances found on SMS

5. The analysis of inspections

Non-compliances found on SMS

- The main **findings of the inspections** on the SMS, conducted in the **last three years in Italy**
 - **Critical issues** emerged regarding the **aging and asset integrity problems** of industrial installations
 - ✓ *Need to consider and **analyze the problems of ageing** (corrosion, erosion, fatigue) of equipment (no procedure)*
 - ✓ *No evidence of a **plan for monitoring the ageing**, unless it is in accordance with **law obligations***
 - ✓ *Developed a **well-structured Asset Integrity Management** procedure, but **partially implemented** (no evidence)*
 - ✓ ***Lack of a specific procedure** containing: Analysis of degradation mechanisms; A fixed-term monitoring plan; Preventative and corrective actions*

- Risks of plant ageing and SMS implementation

6. Conclusions

- Plants are subject to **degradation phenomena** and the **effects of operational changes**
 - It is useful to know the **performance decay rates** to plan adequate **maintenance activities**, and to identify the most **suitable NDTs** for assessing the damage
- The **correct implementation of the SMS** plays a considerable role, in order to ensure **safe operational continuity of equipment**
 - The **RBI and FFS** methodologies can constitute a valid response in the **management of asset integrity** issues and its correlation with **aging phenomena**

Questions...???

romualdo.marrazzo@isprambiente.it

Thanks for the attention!