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The plant ageing and the management of mechanical integrity: first results from the inspections carried out in Seveso plants and possible opportunities for improvement

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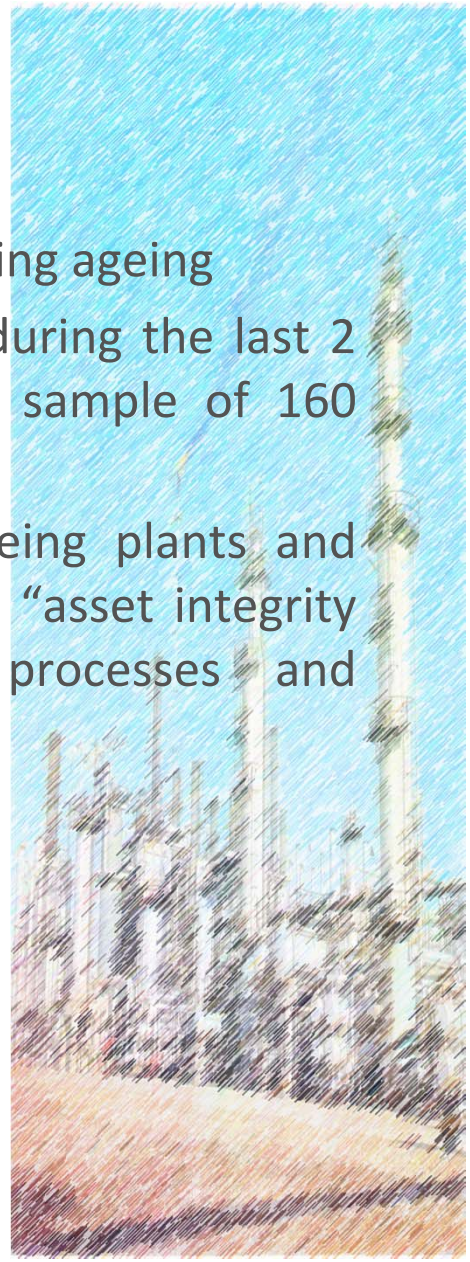
Summary

Scope of the presentation:

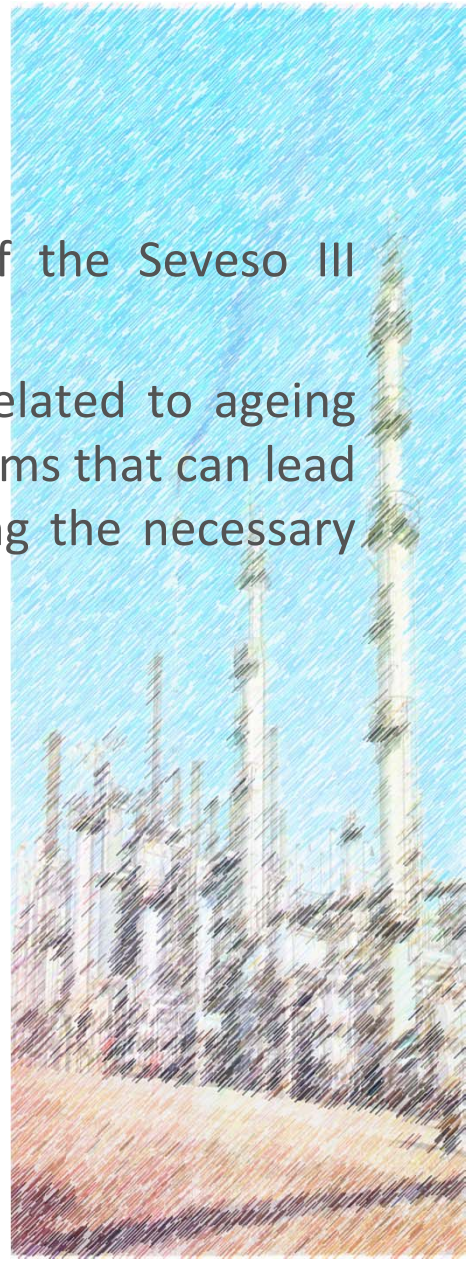
- overview of the Italian law and national standards concerning ageing
- examine the results of the SMS inspections carried out during the last 2 years, to highlight the weaknesses that emerged on a sample of 160 establishments
- give some examples on how organizations manage ageing plants and installations, through specific procedures oriented to the “asset integrity management”, with a brief description of the processes and methodologies implemented.



The standard

The Italian law and national technical standards:

- Legislative Decree 105/2015, on the implementation of the Seveso III Directive, and in particular Annex B-Operational control
- “To provide a plan for monitoring and control of risks related to ageing (corrosion, erosion, fatigue, creep) of equipment and systems that can lead to loss of containment of hazardous substances, including the necessary corrective and preventive measures”

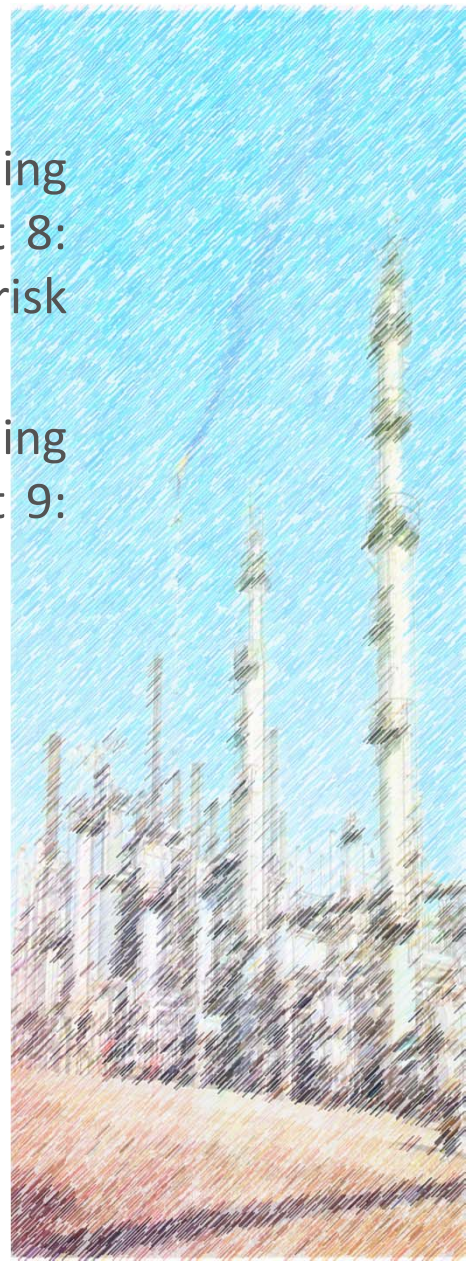


The standard

- The technical standards, present in Italy since the 90s and written to provide users specific tools for the implementation of an effective SMS:
  - UNI 10617: Major accident process plants: Safety Management System essential requirement
  - UNI 10616: Major accident process plants: Guidelines for the implementation of the UNI 10617
  - UNI 10672: Major accident process plants: Safety assurance procedures for design
  - UNI 11226: Major accident process plants: Procedures and requirements for safety audits
- Specifically mentioned in the decree transposing the Seveso Directive as “state of the art” in the field and are developed to meet both the requirements of the law, and also the structure of the other ISO standards

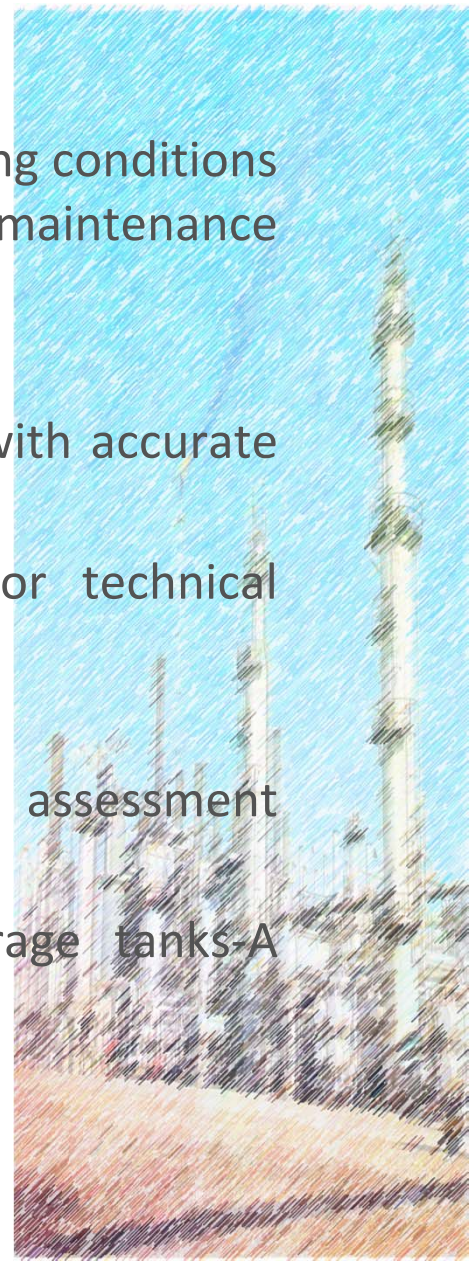
The standard

- UNI / TS11325-8 Pressure equipment - Commissioning and use of pressure equipment and assemblies Part 8: Planning of pressure equipment maintenance using risk based methodologies (RBI)
- UNI / TS11325-9 Pressure equipment - Commissioning and use of pressure equipment and assemblies Part 9: FFS (Fitness For Service)



The standard

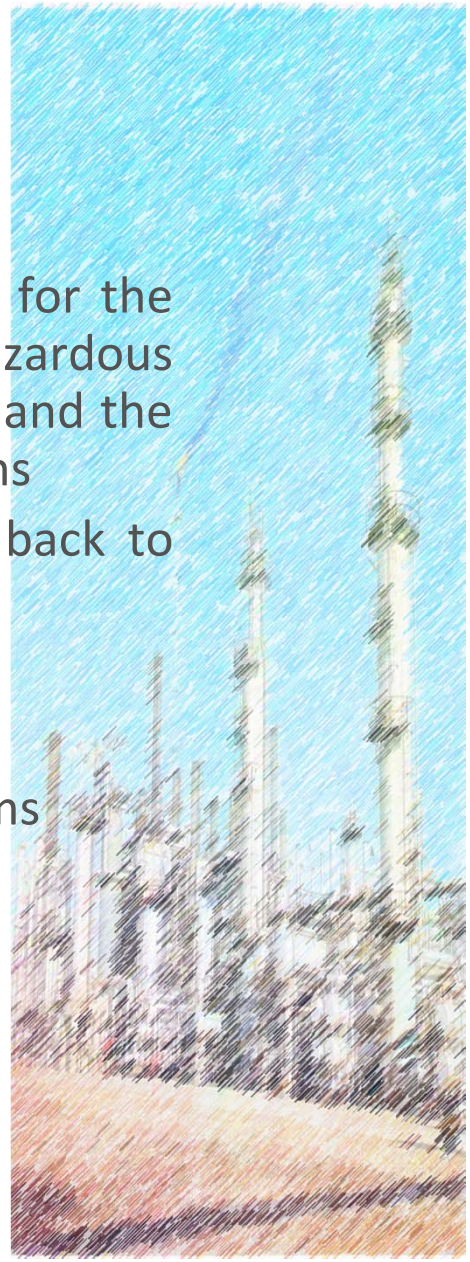
- Risk Based Inspection (RBI):
  - Inspection criteria according to the actual operating conditions of the equipment, for a targeted planning of maintenance operations
- Fitness For Service (FFS):
  - Methodology that allows to keep in operation, with accurate monitoring, the equipment that has defects/flaws
- RBI and FFS evaluation methods subject to sector technical regulations:
  - API RP 581 Risk-Based Inspection Technology
  - API 579 1/ASME FFS-1 Fitness for service assessment standard
  - EEMUA 159-Above ground flat bottomed storage tanks-A guide to inspection, maintenance and repair



Basic requirements

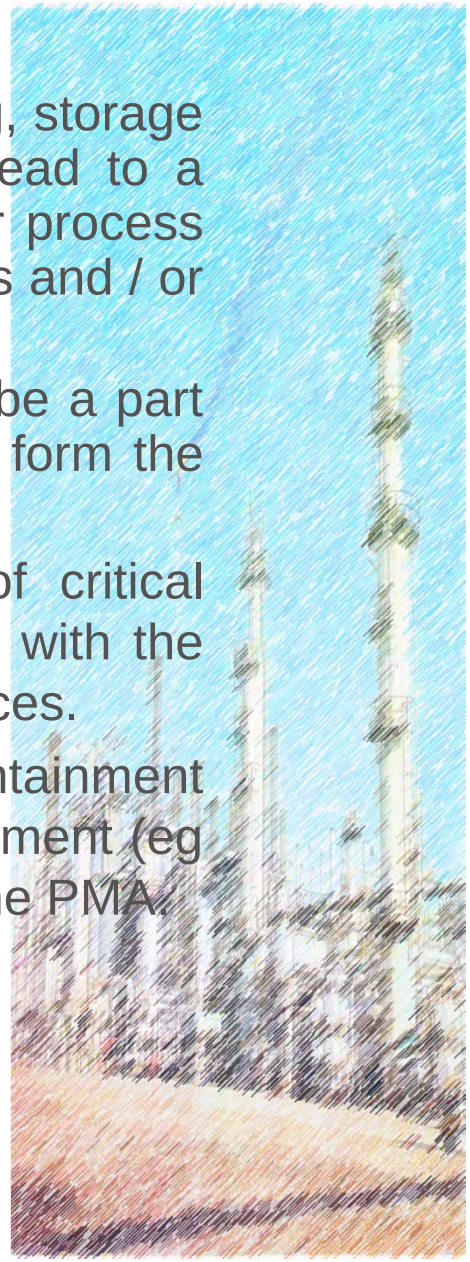
In particular:

- The integrity plan of critical systems and components for the PMA shall ensure both the containment of hazardous substances within the critical equipment and / or lines and the operation of the critical active and passive safety systems
- The different assets subject to ageing can be traced back to four basic types (HSE, 2010):
  - Primary containment systems
  - Control & Mitigation Measures, i.e. Safeguards
  - EC&I (electrical control and instrumentation) systems
  - Structures



Basic requirements

- Operational control of a plant from production, handling, storage and distribution of hazardous substances that may lead to a major accident (in case of accidental release and / or process anomalies) shall be carried out with specific procedures and / or operating instructions.
- The identification of equipment and critical lines shall be a part of the risk analysis or in the safety report and it shall form the basis of a specific inspection / control plan
- Preventive, Scheduled, or corrective maintenance of critical equipment or lines may be performed in accordance with the Risk Based Maintenance (RBM) Policies or Best Practices.
- Such maintenance shall minimize the risk of loss of containment of hazardous substances and the functionality of equipment (eg pumps, compressors and heat exchangers) critical to the PMA.



Basic requirements

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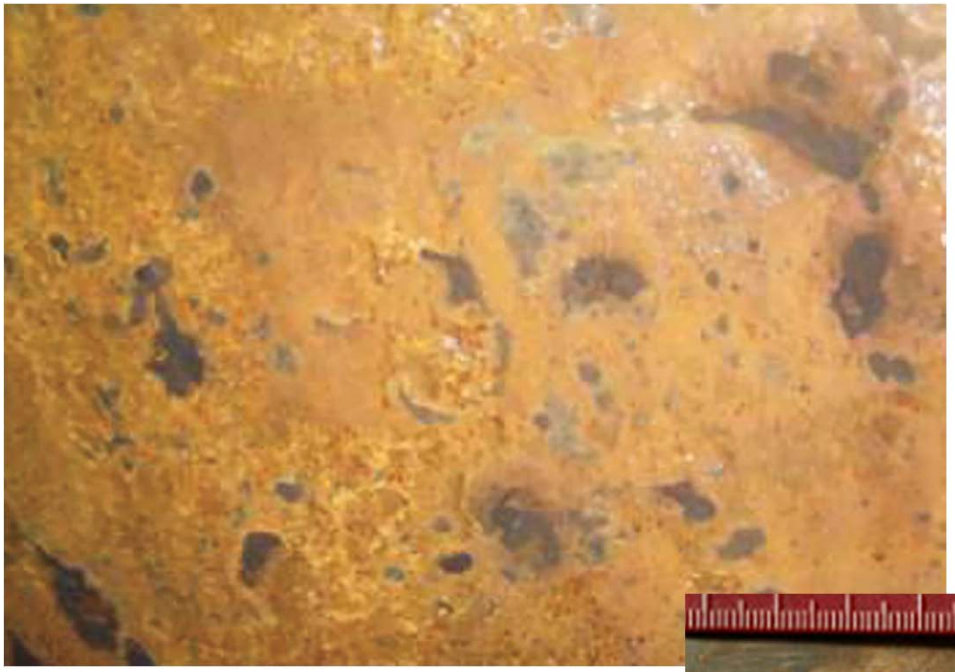
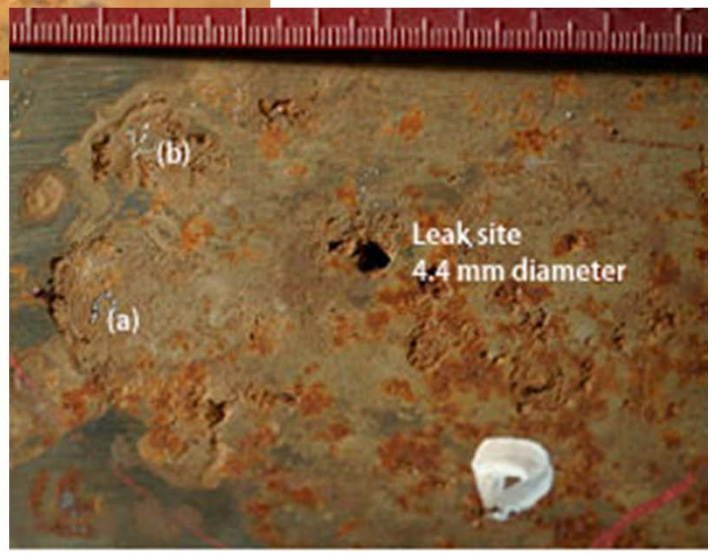
One is over 60 years old

Basic requirements



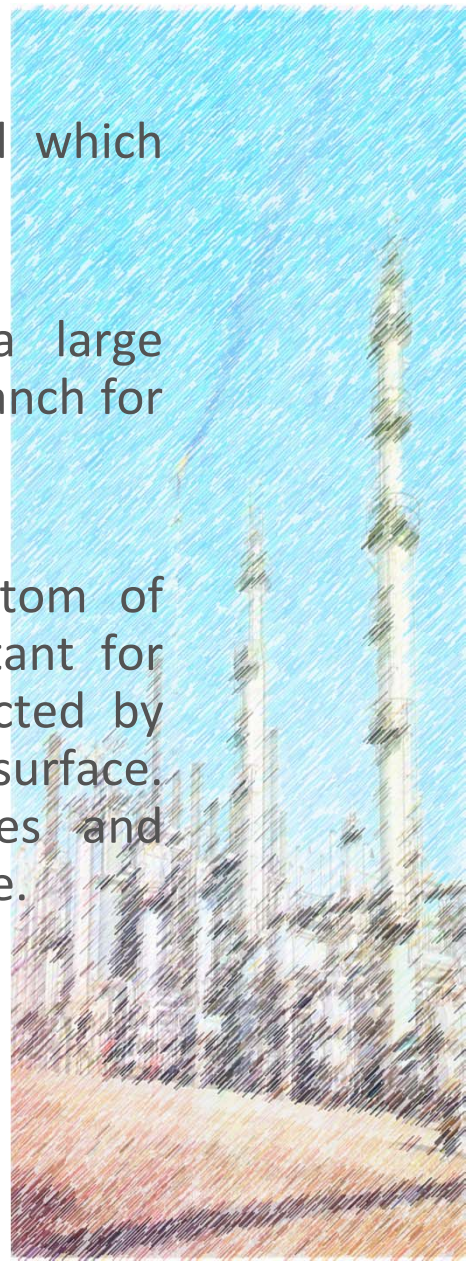


Basic requirements

Ageing is therefore not related to service time as such but rather to the “operational history" of the plant or equipment

Some examples

- Release of petroleum product from a pipeline and which affected an area of about 3,000 square meters.
- Release of hydrocarbons from the bottom of a large atmospheric tank, with involvement of the coastal branch for about 4 miles.
- Tank built in the late 90s: release from the bottom of petroleum products with the presence of supernatant for more than two hectares. Part of sheet metal affected by “pitting” corrosion spread over almost the entire surface. Detected a certain number of punctual damages and detected the presence of through holes of variable size.



The analysis

Recognition results

Examined 160 inspection reports

In 20% of the cases, problems with the correct management of mechanical integrity were found

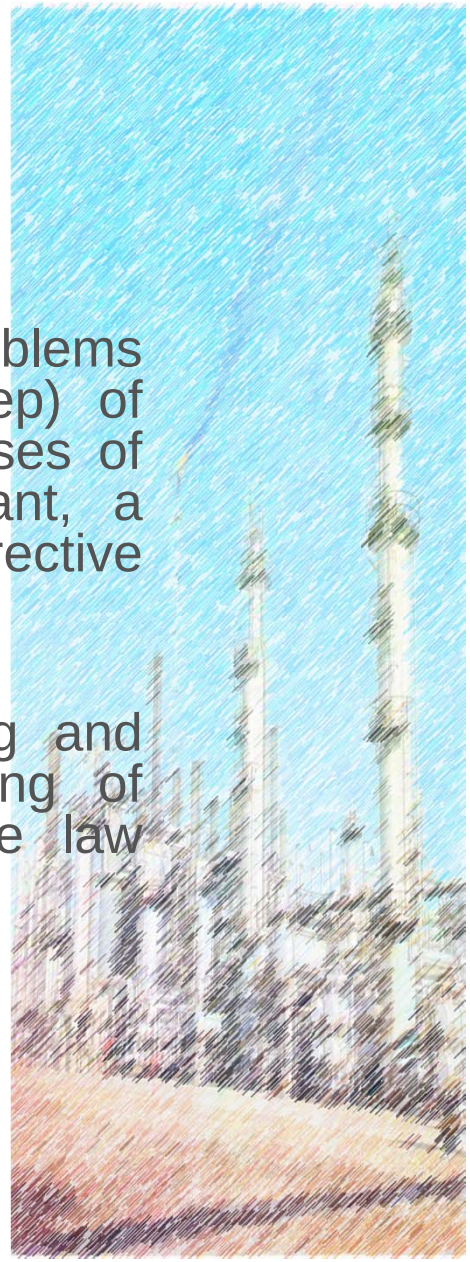
Can we say good? Bad? How much is the data influenced by inspectors' experience? We'll see…

The analysis

Some examples of nonconformities found

- It is necessary for the operator to analyze the problems of ageing (corrosion, erosion, fatigue and creep) of equipment and installations that can lead to losses of dangerous substances, including, where relevant, a specific monitoring plan And control, including corrective and preventive measures

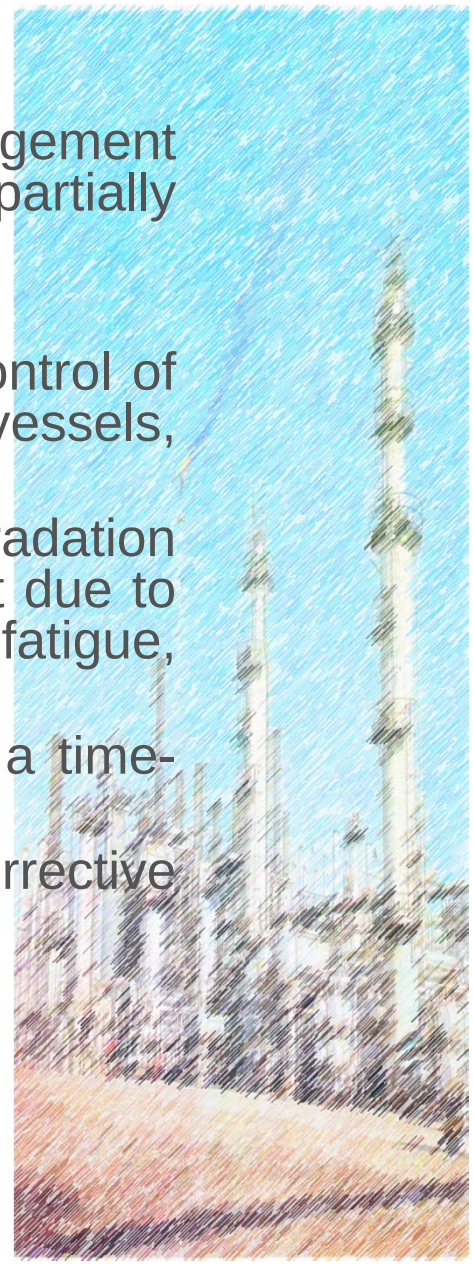
- There is no evidence of a plan for monitoring and controlling the risks associated with the ageing of equipment unless it is in accordance with the law obligations



The analysis

- Developed a well-structured Asset Integrity Management procedure, able to handle the issue of ageing, but partially implemented

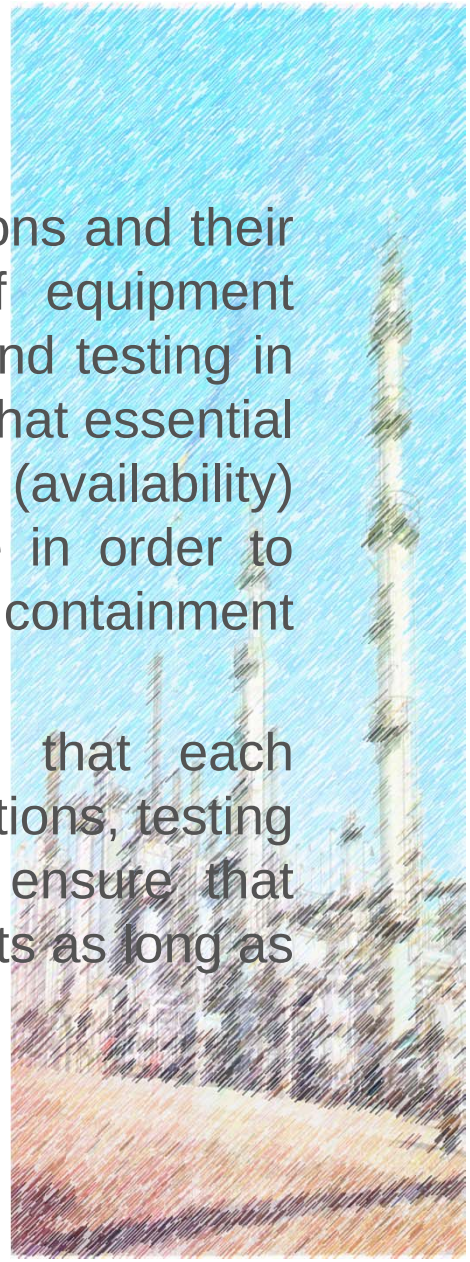
- Lack of a specific procedure for monitoring and control of ageing. The procedure for pressure equipment (vessels, pipes, etc.) shall contain for each equipment:
  - An analysis of existing or potential degradation mechanisms, a lifetime consumed assessment due to the identified damage mechanism (eg fatigue, corrosion, etc.)
  - A fixed-term monitoring plan or, alternatively, a time-tracking plan and the techniques to use
  - A reference to preventative actions and any corrective actions



Opportunities

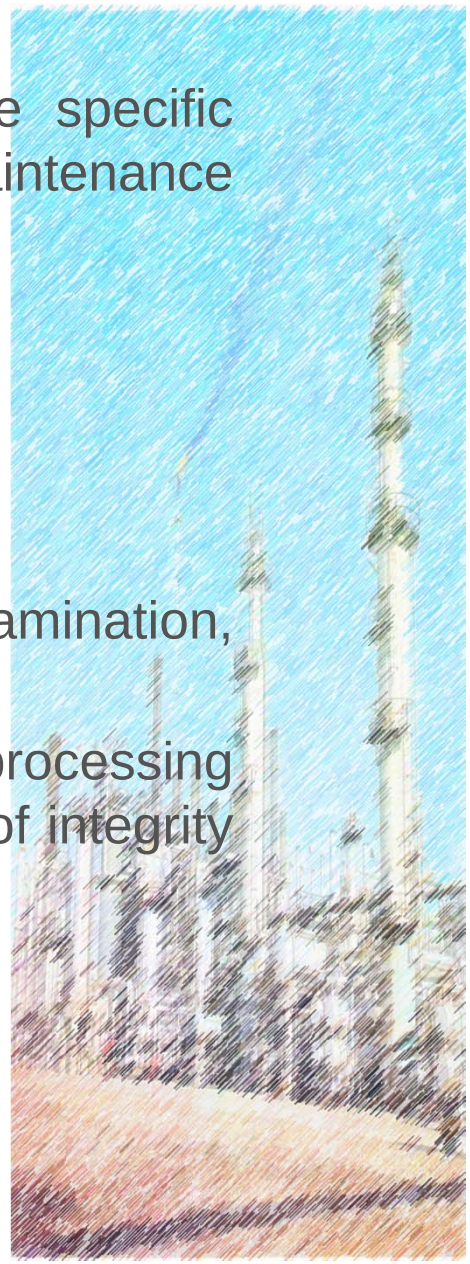
Conclusions and suggestions

- Ensuring sufficient mechanical integrity of site operations and their components requires systematic implementation of equipment controls, in particular, activities such as inspections and testing in order to verify in a timely manner (i.e., prior to failure) that essential operational components maintain their functionality (availability) and suitability for use throughout their operating life in order to prevent failure leading to the occurrence of a loss of containment of a hazardous substance.
- The safety management system should provide that each equipment and utility is subject to a program of inspections, testing and maintenance properly scheduled over time to ensure that these components continue to meet safety requirements as long as they are in service



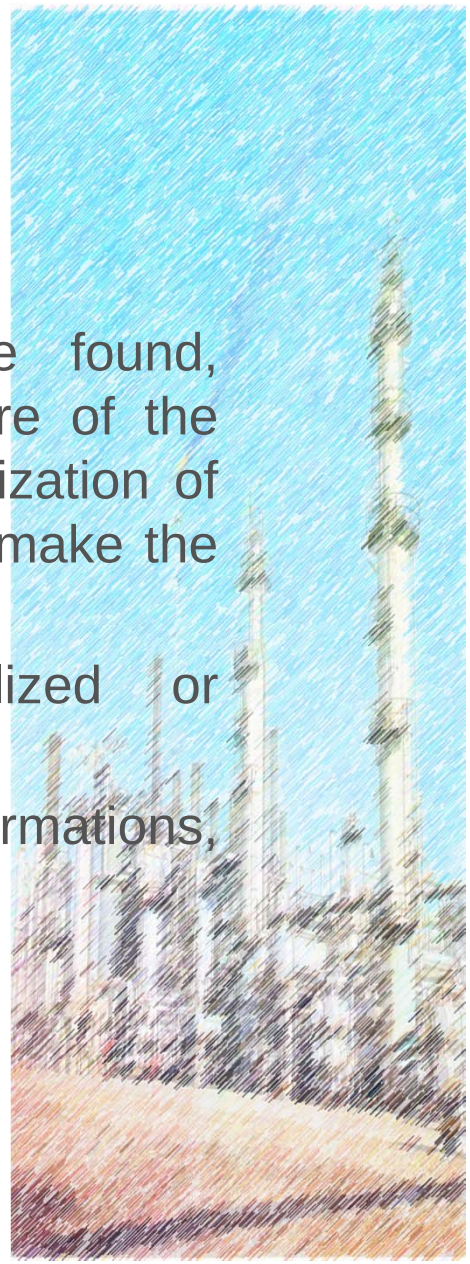
Opportunities

- The organization should establish and formalize specific criteria for the determination of the defined maintenance regimes, in particular:
  - preventive maintenance
  - condition-based maintenance
  - predictive maintenance
  - corrective maintenance
- Establish clear strategy; not just for periodic examination, but for the whole plant lifecycle
- This is especially important on sites storing and processing hazardous substances, where the consequences of integrity failure can be major



Opportunities

- **In particular, for primary containment systems:**
  - **To define the mechanisms of degradation**
  - The degradation mechanisms that can be found, depending on the type of tanks, on the nature of the stored fluids, which are the basis of the organization of the inspection activities. For example, you can make the following classifications:
    - Corrosion: internal or external, localized or generalized;
    - Mechanisms not related to corrosion: deformations, mechanical breaks, cracks on weld, yielding.



Opportunities

- **Defining and " personalizing " inspection technologies**
  - In addition to visual inspection, internal or external, the degradation mechanisms affecting both atmospheric tanks and pressure vessels can be identified by the NDT common techniques. For example:
    - Visual Inspection
    - Liquid penetrant testing
    - Magnetoscopy
    - Vacuum box test
    - Ultrasonic
    - Spark test
    - Long Range Ultrasonic
    - Acoustic Emissions

Opportunities

- **Determining the factors that need to be considered to determine the frequency of inspections, such as:**
  - Construction features
  - Repair techniques and materials
  - Nature of stored product
  - Conditions found at the previous inspection
  - Corrosion rates
  - Presence of corrosion prevention systems
  - Potential contamination of soil, water, air
  - Presence of double bottoms or other systems to prevent loss containment
  - Whether or not there are leak detection systems with operating tanks

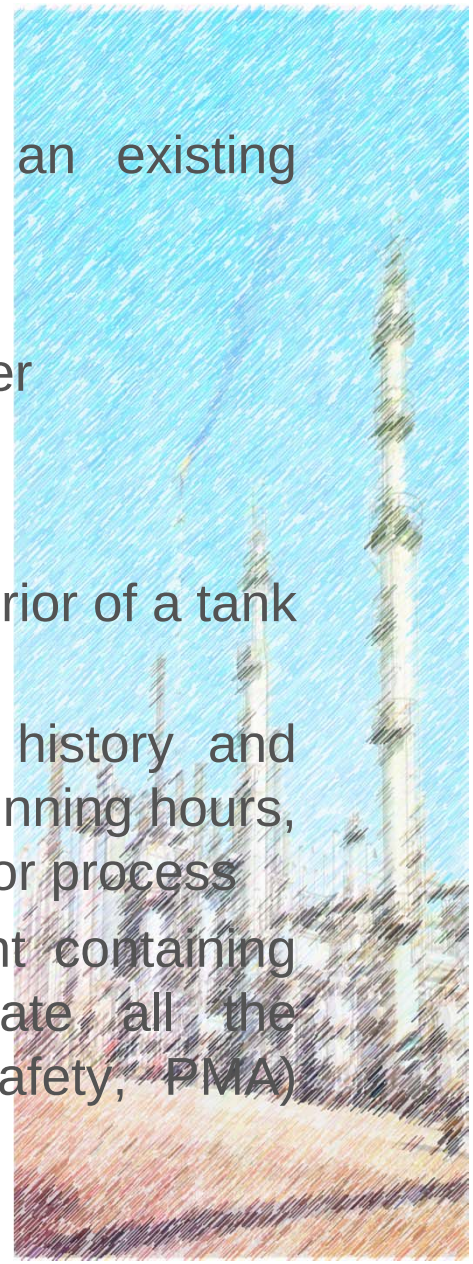
Opportunities

- Based on the Risk Based Inspection (RBI) method, which consists of specific inspection activities according to the actual operating conditions of the equipment, it is possible to schedule a targeted maintenance planning schedule, while through the Fitness For Service (FFS) method you can continue to maintain in operation, with accurate monitoring, equipment that has a structural degradation

- The "Management of Changes" element is crucial, considering the difficulty of identifying new corrosion risks for process and plant design changes and the possibility that other modifications may also have a lesser impact on corrosion risk and therefore not recognized (eg changes in the source of crude oil supply or an increase in production, especially temporary)

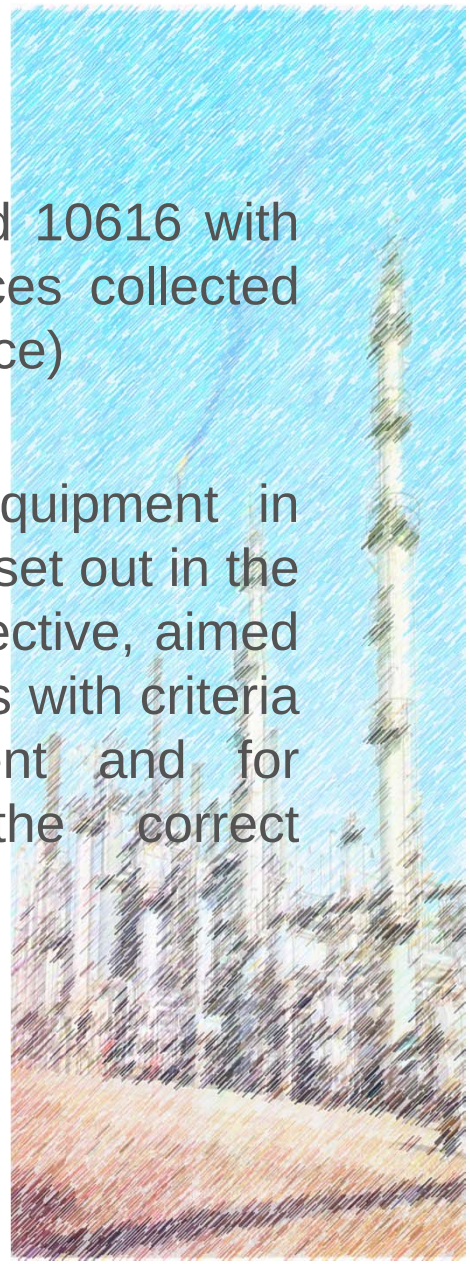
Opportunities

- **Examples of Modifications:**
  - Installing an additional nozzle (or enlarging an existing nozzle)
  - Installing an agitator to an existing vessel
  - Altering the tank / vessel to make it larger / smaller
  - Change of process conditions
  - Retro-fitting steam coils to heat the contents
  - Installing or removing insulation to / from the exterior of a tank / vessel
- It is important to keep records of the operating history and problems encountered during the life. For example running hours, duty cycles, operational excursions, changes in duty or process
- This means that to ensure the integrity of all plant containing hazardous substances, it's necessary to evaluate all the compliance (occupational safety, environmental safety, PMA) requested, especially the wider duties of COMAH



Opportunities

- **To support inspectors / site managers:**
  - Revision project of national standards 10617 and 10616 with specific in-depth studies on ageing (best practices collected around the world and based on historical experience)
  - Technical working group “ageing of critical equipment in Seveso establishments”, as part of the guidelines set out in the Decree on the transposition of the Seveso III Directive, aimed at developing a guideline to provide site managers with criteria for qualitative assessment of their equipment and for inspectors a methodology to evaluate the correct implementation of SMS



Opportunities

- **Index Method for the synthetic evaluation of the adequacy of the asset integrity management in Seveso plants**
  - In order to have an agile and specific instrument in the PMA field, the development of this method is based on a fishbone analysis, aimed at identifying the factors that have an inevitable accelerating effect on ageing and the factors that, have the effect of slowing or reversing the natural trend to degradation. As in the other index methods, the accelerating factors and the braking factors are identified into penalties and compensations respectively and the general evaluation of the system is given by an algebraic sum.

THANK YOU