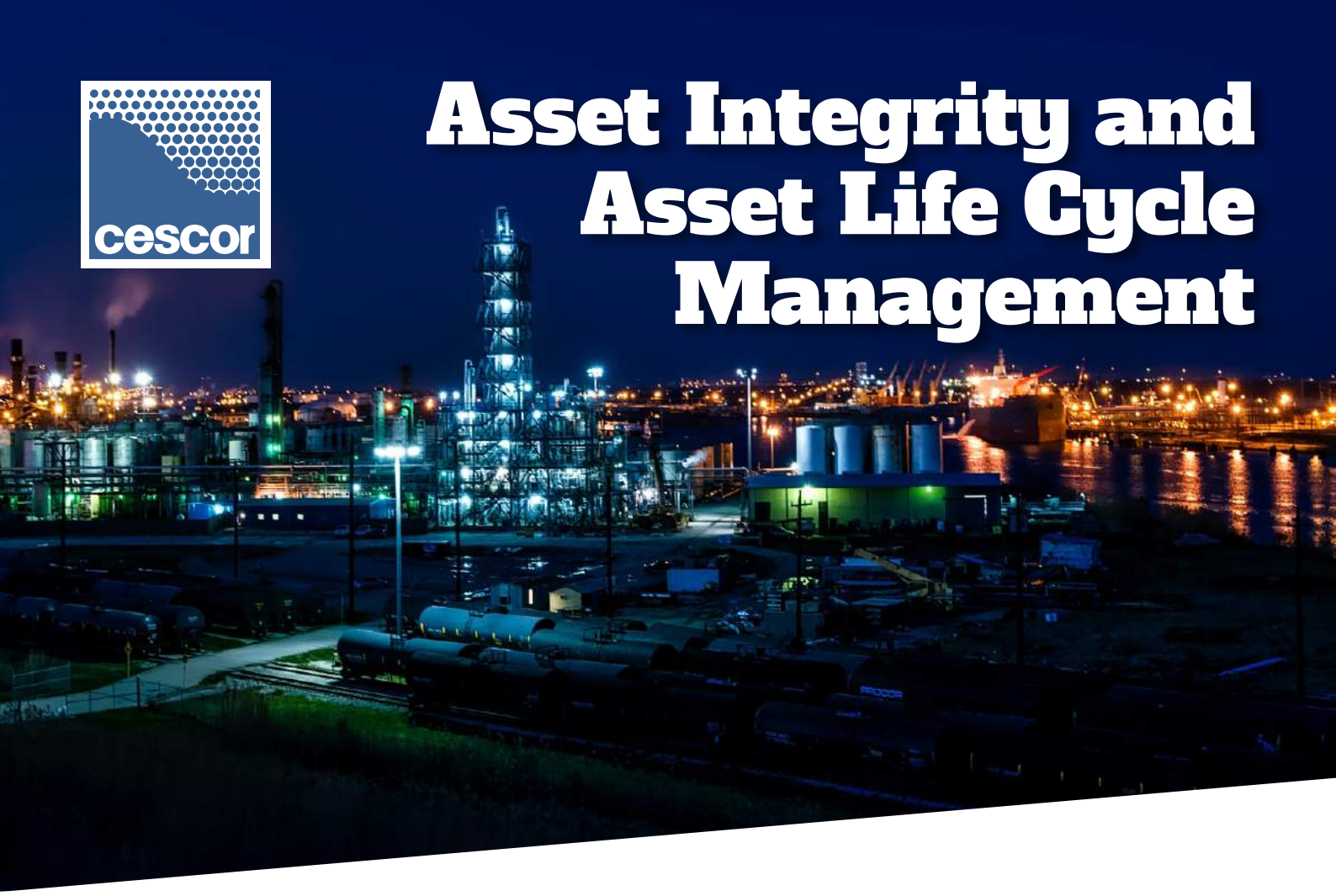
Asset Integrity and Asset Life Cycle Management



Asset Integrity in Oil & Gas and Energy Industry

Corrosion Integrity Management of oil & gas and energy assets is a systematic, comprehensive and multidisciplinary integrated approach with the aim to maintain a suitable state of fitness of an asset to perform its design purpose. Corrosion Integrity Management starts from the conceptual stage of a project and continues until the decommissioning of the asset, this activity requires permanent review and is subject to a continuous optimization, its purposes are:

- to ensure the operability of oil & gas assets
- to guarantee the safety requirements of assets
- and to prevent any environmental issues.

Key features for the integrity are:

- performance of materials in the operative environments
- an acceptable risk level
- applicable technologies and methodologies in order to reduce the integrity risk level
- statutory rules.

The assurance of the integrity of energy related assets along their design life is the key in a global sustainable perspective (Fig. 1).

Fig. 1 - Sustainability is one of the key values for asset integrity

Corrosion Risk Assessment

The Corrosion Risk Assessment (Fig. 2) provides a relative risk ranking of the considered items with respect to the probability of a failure which implies the leakage of the conveyed fluid and the entity of the consequences.

Corrosion analysis is the main activity of the corrosion risk assessment procedure, aimed to calculate or assess, for each item, the likelihood of a corrosion failure, expressed by the corrosion factor, FC.

The main output of the procedure is the risk matrix (Fig. 3).

The targets of corrosion risk assessment are:

- to witness the integrity status of the assets
- to provide input data for risk based inspections
- to provide recommendations on actions to be taken for reducing corrosion related risks

Cescor holds the experience to perform other types of risk assessment such as:

- FMECA (Failure mode effects and criticality analysis)
- FTA (Fault tree analysis).

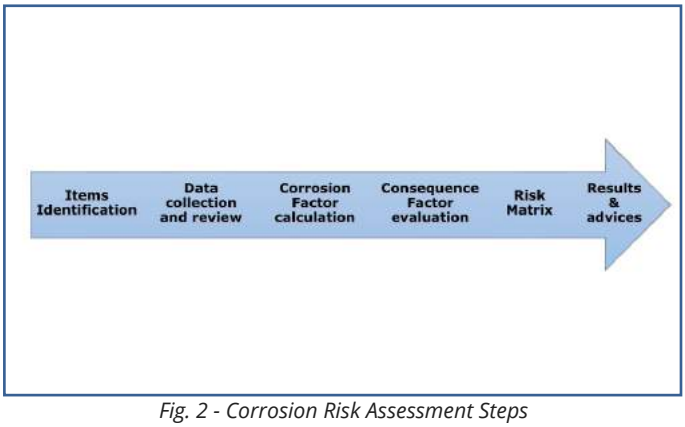


Fig. 2 - Corrosion Risk Assessment Steps

F_C \ F_{CO}	A	B	C	D	E
5	High	High	Medium High	Medium High	Medium
4	High	Medium High	Medium High	Medium	Medium
3	Medium High	Medium High	Medium	Medium	Low
2	Medium High	Medium	Medium	Low	Low
1	Medium	Medium	Low	Low	Low
<0	Safe				

Fig. 3 - Corriosion risk matrix

Risk Based Inspection & Inspection Plans

Risk Based Inspection (RBI) is a decision making technique for inspection planning based on identified risk (Fig. 4). It is a method to optimize the inspection activities performed on oil & gas production or other assets. The RBI approach is adopted according to international standards (e.g. API RP 580 and 581) and improves the management of the assets integrity reducing the overall costs for inspection and monitoring. Reference standard are API 581, DNVGL RP F116, DNVGL RP G101.

The Inspection Plan is the project document which defines the requirements for the inspection execution; it inherits results of the risk analysis and it takes into account the RBI targets and the specific context; the following issues shall be covered by the Inspection Plan:

- definition of inspection extent (items to be inspected) and targets
- ranking of items to be inspected based on risk class
- selection for each type of item (vessels, pipework, storage tanks, etc.) of the inspection methods
- extent and coverage of the inspections
- priorities for the inspection
- general requirements for inspection execution
- time schedule
- inspection drawings (recommended for main vessels)
- reporting requirements.

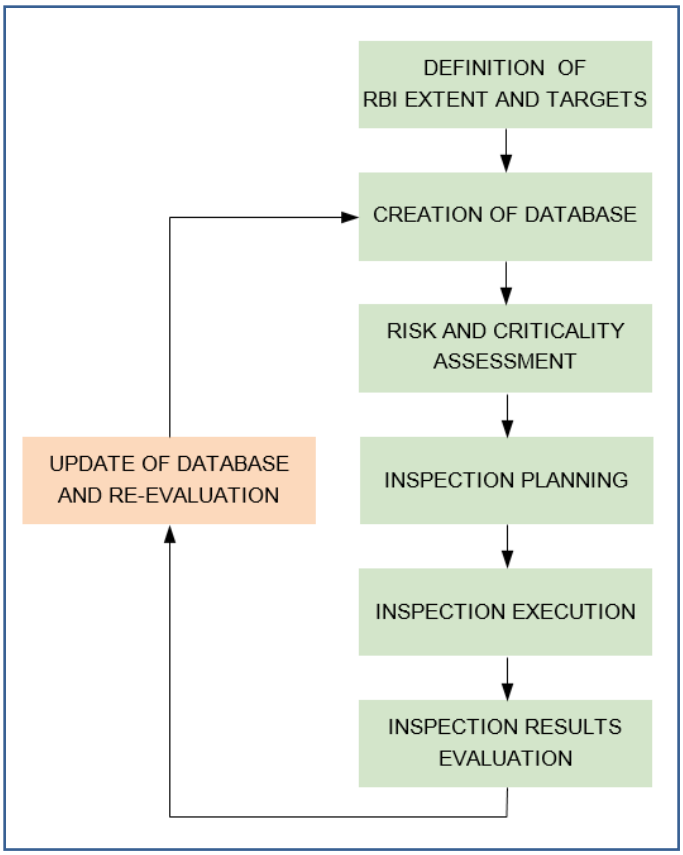


Fig. 4 - RBI Cycle

Integrity Assessment

Integrity assessments provide an overview on the overall status of the component with respect to the expected internal and external degradation mechanisms. It is based on item operative parameters, the specific environment and inspection results. It can be applied to a number of assets and components like:

- tank farms (API 653) (Fig. 5)
- aerial and buried piping (API 581)
- pipelines (ASME B31.8S, API 1160, DNVGL RP F116)
- pressure vessels (API 581)
- wind farms (DNVGL RP 0416).

Key features for integrity of energy assets are:

- performance of materials in the operative environment
- the acceptable risk level
- applicable technologies and methodologies available on the market to reduce the risk level
- regulatory rules
- Integrity Operating Windows as per API 584
- Fitness for service and remaining life assessment in accordance with API 579.

Fig. 5 - Tank farm

Inspection Data Analysis

Operators spend every year a significant amount of money to conduct NDT inspections on their assets. Inspection data need to be properly managed and assessed:

- To check the compliance with the requirements of the inspection
- To determine the status of the component with respect to the investigated corrosion mechanisms.

A statistical approach can be used if the amount of available data is huge.

Pipeline Integrity & Requalification

Old pipelines close to the end of the design life need to be reassessed and extension of their design life shall be evaluated and granted by a Competent Authority. The pipeline requalification process requires the preparation of dedicated internal and external corrosion studies to support the extension of the design life.

Pipeline Internal & External Corrosion Direct Assessment

Direct Assessment (DA) is a methodology developed to verify the corrosion integrity status of a pipeline and the associated risk. Direct Assessment can anticipate or integrate inspections with intelligent pigs and hydraulic tests. In case of non-piggable pipeline, it represents a valuable alternative to In-Line Inspection. ISO 12747 Recommended Practice for Pipeline Life Extension explicitly considers Direct Assessment as a method for pipeline requalification and life extension.
Direct Assessment procedures developed by CESCOR are in accordance with NACE Standards (SP0110, SP0204, SP0206, SP0208, SP0210, SP0502) and incorporate in-house developed expertise for corrosion prediction and modelling, and for integrity assessment of pipeline defects.

Pipeline Fitness for Service (FFS)

ASME B31G and DNV-RP-F101 Parts A and B allow to conduct FFS for corroded pipelines. Defect features measured during the ILI are used to determine whether each defect feature is critical or not at the time of the inspection. Internal and external defects related to corrosion will grow for corrosion and it is important to assess the time frame they will become critical. Expected future corrosion rates can be estimated by using:

- predictive models for internal and external corrosion rate predictions
- comparison between past and present ILI results (an average corrosion rate for each defect is calculated).

Corrosion rates are used to simulate the defect growth for corrosion.

Sour Service Resistance Verification

Reservoir souring is becoming more and more frequent in the oil and gas industry and old assets designed for sweet service may need to transport slightly sour fluids. A thorough verification of all the components of the system is necessary to understand whether the components are suitable or not for the safe transportation of the fluids. On the basis of the operating conditions and of the chemical composition of the fluid, the verification shall involve each component in contact with it through a complete review of all available parameters affecting the resistance to sour service, for base material and welds, including:

- chemical composition
- corrosion and mechanical properties
- manufacturing process and heat treatment.

Industrial Sectors

Asset integrity is a key issue in various industrial sectors:

FOSSIL ENERGIES

- Upstream Oil and Gas Production
- Oil and Gas Pipelines
- Storage tanks
- Refining
- Chemical / Petrochemical
- Regasification.

RENEWABLE ENERGIES

- Offshore wind
- Tidal energy
- Marine energy
- Floating solar.

INFRASTRUCTURES

- Reinforced concrete structures (bridges, viaducts, tunnels) (Fig. 6)
- Water transportation
- Railways
- Harbour Structures
- Desalination plants (heat exchangers).

Fig. 6 - Example of reinforced concrete structure

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