CONSULTING ASSET INTEGRITY & CORROSION MANAGEMENT

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GazNeft Morgan FZE
Oil & Gas Asset Integrity and Corrosion Management
CONSULTING ASSET INTEGRITY & CORROSION MANAGEMENT

RBI Risk Based Inspection

Plant maintenance and inspection resources should be used preferentially on high-risk assets as they have the potential to cause serious disruption in plant operations or cause an unplanned shutdown. The priority treatment of high-risk assets must be balanced by providing sufficient maintenance and inspection for other lower-risk equipment to avoid the emergence or growth of problems over time.

GazNeft Morgan’s approach recognizes that a relatively small percentage of plant equipment accounts for a very large percentage of disruption, shutdown and safety risk. Risk-based inspection (RBI) begins with identification of high-risk assets followed by assessment of equipment condition, evaluation of maintenance and inspection programs, study of operating protocols and estimation of life consumption of these priority assets. This process takes into account the likelihood and consequences of mechanical failure. This information is then used to modify and optimize inspection and maintenance programs, audit procedures, operating limits and safety information.

Our solution includes the following aspects:
- Inspection program optimization
- Implementation of RBI software – a versatile, RBI solution framework and database management system
- Preparation of inspection and maintenance plans and manuals
- Analysis of condition and failure data
- Statistical analysis of inspection data
- Extreme value statistical analysis
- Detailed, risk based planning of shutdown activities and management of shutdown inspections
- Materials engineering
- Advanced inspection
- Expert technical support
- Experienced reliability engineers and shutdown managers
- Structural integrity experts
GazNeft Morgan’s Fitness-for-Service (FFS) engineering assessment is a multi-disciplinary approach to evaluate structural components to determine if they are fit for continued service. The typical outcome of an FFS assessment is a "go/no-go" decision on continued operation. An evaluation of remaining life or inspection intervals may also be part of such an assessment, along with remediation of the degradation mechanism.

GazNeft Morgan has substantial FFS engineering assessment experience and has applied its approach on a wide range of assets. Our staff has been heavily involved in the development of the API 579-1/ASME FFS-1 FFS standard, and many serve on the committee that maintains this document.

GazNeft Morgan’s advanced creep testing service provides accurate and reliable life assessment of components prone to creep damage. This service provides a higher level of accuracy in life assessment techniques based on actual creep property of components, enabling operators to determine effective inspection intervals and plans, avoid premature failure and underutilization of equipment, identify optimized operating conditions, and extend component life.

**Fitness-for-Service Engineering Assessment Flaw Type and Damage Mechanism Experience:**
- Brittle fracture
- Corrosion
- Fatigue
- Creep
- Stress corrosion cracking
- Hydrogen embrittlement
- High-temperature hydrogen attack

**Fitness-for-Service Assessment Applications**
- Fired heaters
- Boiler tubes
- Pipelines
- Reformers
- Turbines
- Power lines
- High-energy piping
- Headers
- Storage tanks
- Pressure vessels
Corrosion Management & Corrosion Control

The worldwide search for oil and gas is becoming more and more challenging, and produced fluids are increasingly more corrosive. The Material Selection process is facing several critical factors like severe sour conditions, highly corrosive and aggressive fluids, extreme operating conditions in terms of temperature, pressure, flow velocity and mechanical solicitations. Asset integrity today represents a key issues in all phases of a project, from early conceptual and feasibility phase, to the design, construction and commissioning phases and onwards during operations up to de-commissioning.

For **Corrosion Management** of Oil & Gas Production Systems, GazNeft Morgan provides the engineering services for:

- Corrosion Assessment and Material Selection
- Fluid Treatments with Chemicals
- Corrosion Monitoring
- Coatings
- Corrosion Management
- Corrosion Risk Assessment
- Corrosion Matrix
- Key performance indicators and % of compliance
- Life extension and Requalification
- Direct Corrosion Assessment
- Risk-Based Inspection
Corrosion Management & Corrosion Control

The Selection of Recommended Materials and Viable Alternatives are established with the primary intention to provide solutions suitable for the Design Service Life. The recommended materials shall be cost effective provided Safety and Environmental Requirements were respected.

The Material Selection Task consists of the following activities:

- Fluid corrosivity evaluation based on fluid characteristics and operating conditions.
- Selection of recommended materials for each item for the required Design Life, based on corrosivity assessment, code requirements, costs vs. benefits, market availability, minimization of safety & environmental hazards, industry expertise & track record.
- Definition of viable material options.
- Additional requirements for Sour Service, Low Temperature and Welding.
- Requirements for corrosion control methods, including: injection of corrosion inhibitors and other chemicals; internal & external coatings and linings; cathodic protection.
- Requirements for corrosion inhibitor qualification, selection, laboratory and field testing.
- Requirements for corrosion monitoring, which include: selection of the most suitable corrosion monitoring methods, positioning of the monitoring probes, chemical analysis, corrosion data management.
Corrosion Management & Corrosion Control

The State-of-the-art Knowledge for Corrosion Prevention and Control is incorporated into a number of approaches, techniques and material solutions which, if correctly selected, designed and applied, allow to mitigate and control the corrosion mechanisms and thus guarantee the integrity of the components during the whole project execution, at the right time, at the right place and with cost effectiveness. The main techniques are:

• Corrosion allowance for Carbon Steel items.
• Corrosion Resistant Metallic Materials (CRA).
• Composite Materials (GRE/GRP).
• Fluid Treatment with Chemicals, including: corrosion inhibitors, glycols, biocides, oxygen scavengers, H2S scavengers.
• Metallic Coatings (cladding or weld overlay).
• Internal Organic Coatings and Linings.
• Internal Cathodic Protection.
• External Coatings and External Cathodic Protection for external protection.
Corrosion Management & Corrosion Control

The Corrosion Management Strategy is the route for the implementation of corrosion management activities to accomplish the targets established by the corrosion management policy. It comprises the following subjects:

- Identification and review of the corrosion threats.
- Identification of corrosion control measures.
- Identification of corrosion control matrix.
- Identification of KPI and related % of compliance.
- Corrosion Risk Assessment / Risk Based Inspections.
- Implementation of corrosion monitoring and inspection, corrosion control measures and their effectiveness.
- Identification and implementation of corrective actions, repairs, changes.
- Auditing and assimilation of lessons learnt from operational experience.
GazNeft Morgan establishes maintenance and inspection plans through RCM & FMECA; RCM is an engineering framework that enables the definition of a complete maintenance regimen. It regards maintenance as the means to maintain the functions a user may require of machinery in a defined operating context. As a discipline it enables machinery stakeholders to monitor, assess, predict and generally understand the working of their physical assets. This is embodied in the initial part of the RCM process which is to identify the operating context of the machinery, and write a Failure Mode Effects and Criticality Analysis (FMECA). The second part of the analysis is to apply the "RCM logic", which helps determine the appropriate maintenance tasks for the identified failure modes in the FMECA. Once the logic is complete for all elements in the FMECA, the resulting list of maintenance is "packaged", so that the periodicities of the tasks are rationalized to be called up in work packages; it is important not to destroy the applicability of maintenance in this phase. Lastly, RCM is kept live throughout the "in-service" life of machinery, where the effectiveness of the maintenance is kept under constant review and adjusted in light of the experience gained.

RCM can be used to create a cost-effective maintenance strategy to address dominant causes of equipment failure. It is a systematic approach to defining a routine maintenance program composed of cost-effective tasks that preserve important functions. The important functions (of a piece of equipment) to preserve with routine maintenance are identified, their dominant failure modes and causes determined and the consequences of failure ascertained. Levels of criticality are assigned to the consequences of failure. Some functions are not critical and are left to "run to failure" while other functions must be preserved at all cost. Maintenance tasks are selected that address the dominant failure causes. This process directly addresses maintenance preventable failures. Failures caused by unlikely events, non-predictable acts of nature, etc. will usually receive no action provided their risk (combination of severity and frequency) is trivial (or at least tolerable). When the risk of such failures is very high, RCM encourages (and sometimes mandates) the user to consider changing something which will reduce the risk to a tolerable level. The result is a maintenance program that focuses scarce economic resources on those items that would cause the most disruption if they were to fail. RCM emphasizes the use of Predictive Maintenance (PdM) techniques in addition to traditional preventive measures.
CONSULTING ASSET INTEGRITY & CORROSION MANAGEMENT

RAM Reliability Availability Maintainability

GazNeft Morgan RAM modeling assesses a production systems capabilities, whether it be operation or still in design phase. The results from RAM modelling will identify possible causes of production losses and can examine possible system alternatives.

RAM modelling can simulate the configuration, operation, failure, repair and maintenance of equipment. The inputs to RAM modelling will include the physical components and maintenance schedules in a system and the outputs can determine how productive the system can be over the plant life. RAM studies will generate sufficient data to base decisions for possible systems changes that may increase system efficiency and hence project profits.

The key benefits of RAM modeling includes:

- Detecting failures in the early part of design;
- Optimising maintenance schedules;
- Adequately allocating the spares inventory;
- Increasing the effectiveness of logistics; and
- Identifying equipment priorities on failure.

Our reliability engineers will liaise with the client to identify their needs and develop the basis for the RAM model. Once the basis is agreed a model of the system is created.

Analysis of the model generates results and recommendations for improvement of the design or of the operating results.

Communication during all stages with the client and the reliability engineers is continuous and ensures maximum results.
GazNeft Morgan performs Root Cause Analysis (RCA) as a structured process that uncovers the physical, human, and latent causes of any undesirable and latent causes of any undesirable event in the workplace. Benefits: Indispensable component of proactive and reliability centered maintenance, Uses advanced investigative techniques, Apply correctives, Eliminates early life failures, Extends equipment lifetime, Minimizes maintenance. A Root Cause Analysis will disclose:

- Why the incident, failure or breakdown occurred
- How future failures can be eliminated by:
  – changes to procedures
  – changes to operation
  – training of staff
  – design modifications
  – verification that new or rebuilt equipment is free of defects which may shorten life
  – repair and reinstallation is performed to acceptance standards
  – identification of any factors adversely affecting service life and implementation of mitigating actions.
RCA analysis, how to approach:

- Data collection
- RCA method: STEP, FMEA, FAILURE TREE.
- RCA report including:

1. **Description of the Incident(s)**
   
   An incident is the event that precedes the loss or potential loss. This section should include a description of what happened. Include all aspects related to the incidents, like outage time, cost of repair, people involved, tools in use, operational status, weather conditions etc.

2. **Immediate Cause(s)**
   
   The immediate causes of an incident are the circumstances that immediately preceded the contact and can usually be seen or sensed. For example, if the incident is an oil spill, the immediate cause could be a broken sealing. The Immediate Causes often are the same as the failure codes registered in Maximo.

3. **Basic Cause(s)**
   
   Basic Causes are the real causes behind the immediate causes: the reasons why the substandard acts and conditions occurred, the factors that, when identified, permit meaningful management control. In case of an oil spill caused by a broken sealing, the Basic Causes could be that the sealing used was of wrong type, it had a design failure or it might be installed wrong.

4. **Lack of Control**
   
   Lack of Control means insufficient oversight of the activities from design to planning and operation. Control is achieved through standards and procedures for operation, maintenance and acquisition, and follow-up of these. If an oil spill has occurred because of wrong installation of a sealing, the Lack of Control could be related to inadequate procedures for checking after maintenance.