Capability Statement Plant Integrity and Maintenance Services

iicorr
Greenbank Place, East Tullos, Aberdeen, AB12 3BT
Tel: +44 1224 898282. Fx: +44 1224 898202
Email: info@iicorr.com
Web: www.iicorr.com

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1 Introduction

This capability statement outlines iicorr's skills and experience in the area of process plant integrity and maintenance. This is only one of a wide range of areas where iicorr provides industry leading integrity and assurance services.

iicorr are specialists in integrity, inspection and corrosion, providing consultancy, management, engineering and operational support in the Oil & Gas, Process, Utilities and Marine Industry sectors. We aim to bring best practice from our global experience to provide the most cost effective solutions to meet our client's corporate aims.

iicorr is a knowledge based company with a high technical skills base in corrosion, erosion and materials degradation processes and mechanisms. We apply our knowledge, skills and experience to provide solutions and systems that will optimise the safety, integrity and life cost of our clients' assets. We can provide a total integrity management service or a specialist niche application and all stages between depending on client needs. iicorr professional skills and experience deliver real value benefits consistent with clients' objectives for safety, asset availability and statutory compliance.

iicorr are a learning organisation, continually pushing back boundaries and developing skills. This is reflected by investment in R&D programmes and by the creation of innovative new products and systems such as the **Questar®** application, a risk assessment protocol. iicorr believe that the strength of any company lies in the individuals within that company. Graduate staff are developed to Chartered status on a scheme accredited by the Institute of Marine Engineering Science and Technology (IMarEST). The iicorr team comprises over 100 people worldwide and covers a broad range of professional skills.

iicorr Quality Management System is certified ISO/IEC 17020 (BS EN 45004) and ISO 9001:2000. The Company is committed to Health, Safety and the Environment as reflected in our HSE Policies.

2 Risk Based Inspection and Maintenance

Overview of Questar®

Risk Based approaches are the accepted method of minimising inspection and maintenance costs by focusing effort and resources on the process items, which have the most critical bearing upon the overall asset integrity and performance.

iicorr has developed the Questar® suite of Risk Based methods to respond to industry's demand for high quality, minimum cost RBI solutions. The Questar® system currently covers Structures, Process Plant, Pipelines, Subsea Facilities, Mechanical equipment, Pressure Safety Valves and Downhole tubulars.

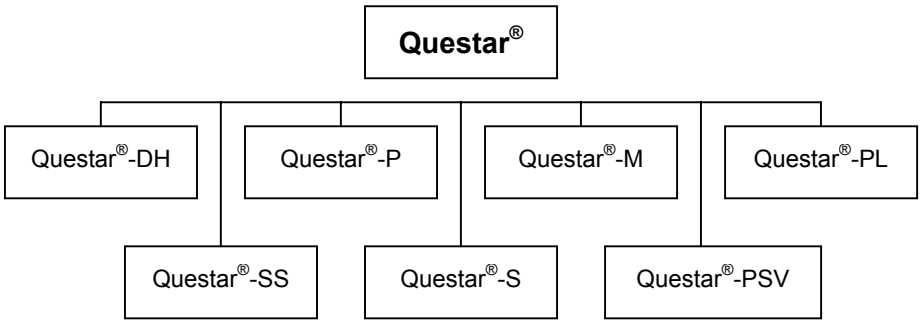

Fig 1: The Questar® Risk Based Inspection Family

All Questar® Risk Based methods are designed to develop inspection plans which:

- Comply with all local legislation
- Reduce Personal, Environmental and Financial Risk to a level As Low As Reasonably Practicable (ALARP),
- Minimise the cost and resources required to demonstrate and maintain this level of Risk.

The following sections briefly outline the approaches used for risk based assessment of plant, PSV's and rotating/mechanical equipment. Further information on our capability with respect to structures, pipelines and subsea facilities can be found in Appendix 1.

Questar® -P

Questar®-P is the name given to the Questar® module concerned with Risk Based Inspection of Process Plant and facilities. It has been designed to minimise the cost/effort required to produce a fully accurate RBI study, by targeting study resources according to the type and magnitude of risk posed by defined sections of the process.

The Questar®-P process RBI methodology and software has been verified by Lloyds Register Integrity Management during a 3rd party audit.

The latest version of Questar®-P is a state-of-the-art RBI package that has the following features:

Phased Approach

Questar®-P has a phased approach that minimises the cost and effort required to produce a fully detailed RBI study, by tailoring the level of detail in each item's assessment according to the risk posed by the item.

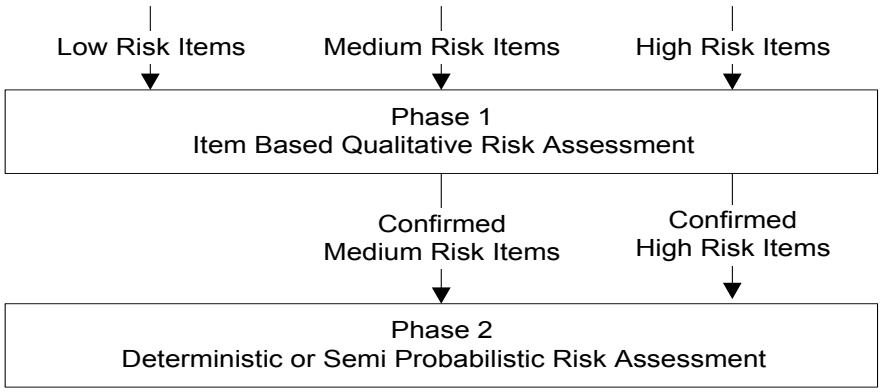

Fig 2: Questar-P Process Overview

All items are subjected to a *Phase 1 Qualitative Risk Assessment*, which reviews and categorises risks on a judgmental basis. Those items judged to be medium or high risk are passed forward to *Phase 2,* a more detailed *Deterministic or Semi-Probabilistic Risk Assessment*.

Failure Mode Type Categorisation

Questar®-P removes the resource overhead of conventional risk-based approaches by avoiding re-iterative and judgmental risk assessment processes at the front end.

Questar®-P uses a highly efficient methodology for categorising the Risk Type at the pre-assessment phase.

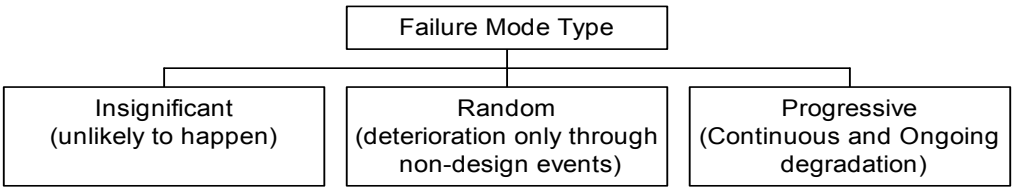

Fig 3: Risk Categorisation

The Failure Mode Type not only determines the criticality of the failure mode, but guides the subsequent assessment methods and risk management resources.

Equivalence Based Consequence Assessment

Questar®-P recognises that there are many more types of consequences associated with a major failure than generally recognised. This method includes assessments of Safety, Environmental, Economic and Political, Reputation, Public Relations consequences, and any other deemed necessary by the client's specific circumstances.

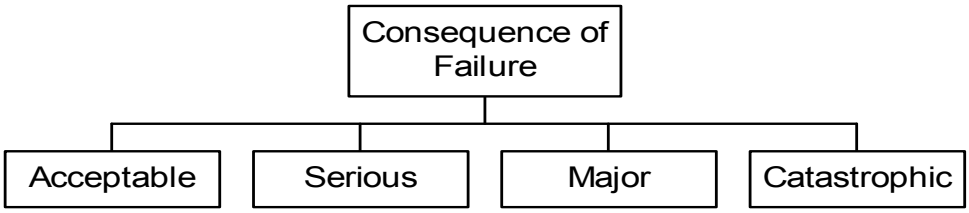

Fig 4: Consequence Categorisation

Questar®-P uses equivalent "categories" of consequence, equating a certain level of safety risk with an equivalent level of environmental risk, with an equivalent level of economic risk

and so on. These are assigned to the generic (but defined) levels of “Acceptable”, “Serious”, “Major” and “Catastrophic”.

The Failure Mode Type and Consequence are presented on a 3 x 4 Qualitative risk matrix, and a criticality figure assigned.

Stability Based Inspection Intervals

Questar®-P uniquely uses the predictability, or *“stability”* of the failure mode as the correct method of assigning risk and calculating inspection intervals.

This method uses a combination of the *Stability* of the process and the *Consequence of Failure* to set the inspection or retiral interval in a 4 x 4 risk matrix as a proportion of the predicted remaining life – the higher the risk, the lower the proportion of the remaining life before the next inspection or retiral.

Inspection /Retiral period = Inspection Safety Factor x Remaining Life

The *Inspection Safety Factor* remains constant throughout the life of the item (unless the *Consequence of Failure* or process *Stability* changes). This provides superior advantages and efficiencies compared to more conventional risk-based methodologies.

Comprehensive Risk Modelling Capability

Questar®-P lists all the failure modes, and assigns a Risk and Criticality to each.

Questar®-P comes loaded with modules for CO_2 corrosion, measured corrosion, general predicted corrosion, erosion, sulphide stress cracking and other sour service risks. Other modules may be easily added to model client and application specific failure modes, resulting in a comprehensive, customised product.

Flexibility

Questar®-P is administered by a custom built **iicorr** software package. As such, the method and calculation modules included in the software can be customised and tailored to specific client needs.

The software allows modelling of many process configurations, including historical or future process changes, and the effect of periodic shutdown and layup

Questar®-PSV

Questar®-PSV is the name given to the Questar® module concerned with Risk Based Inspection of Pressure Safety Valves (PSVs). RBI has a proven record of effectiveness in life of field cost reduction.

The application of a risk-based methodology to PSV re-certification is therefore a logical progression of the previous tried and tested methodology. The main difference is that it is applied specifically to PSV re-certification.

It is not the intent of this method to stop re-certification but rather to concentrate effort in a considered approach by focusing on those Safety Valves that pose the highest risk if they fail to function.

The method involves a Failure Risk Assessment (FRA) to predict the likelihood and consequences of failure of installed PSVs. Failure is considered to be either lifting below 90% of CSP (Cold Set Pressure), failing to lift above 110% of CSP or unacceptable passing. A detailed methodology is used for the determination of both the probability and consequences of a PSV failing.

Previous intervention reports and records are analysed to ensure that adequate cognisance is given to actual service conditions. Gaining a full appreciation of the relief system design as a whole by using P&IDs and process information enhances this. Validity checks are

carried out at each stage in the assessment to ensure that all items have been considered and that a consistent approach is being maintained.

Risk-Based re-certification involves the preparation and development of a proactive re-certification programme based on the results of a FRA. This technique assists in replacing rigid re-certification programmes with a more cost-effective, methodical and flexible system. The methodology is particularly effective in embracing the intent behind the legislative shift from prescriptive to considered and reasoned legislation, to achieve the highest standards of safety.

Questar®-M

Questar®-M applies the principles of Risk Based Integrity Management to the maintenance of plant and equipment. It provides a consistent approach to identifying critical plant and re-directing maintenance resource. The net result is improved operational safety, an optimised maintenance strategy and enhanced financial returns.

The method targets maintenance activity based on the risk and criticality of equipment failure, in order to elongate the product life and/or maintain equipment efficiency. Cost savings are achieved through the optimisation of maintenance interventions, coupled with a reduction in disruption and lost or deferred production.

Phase 1 of the methodology is centred around a multi-tiered series of assessments based on facility risk and compliance. Phase 2 looks at critical equipment items and their components with the aim of optimising maintenance expenditure.

Phase 1

The first assessment tier is a 'system level' qualitative risk assessment, which aims to determine and rank critical process systems. Having identified the critical systems and by using a semi-probabilistic risk assessment, the second tier seeks to determine and rank sub-system criticality.

Having identified sub-system criticality, a third tier risk assessment is performed in order to identify and rank equipment in order of criticality. It is at this level that equipment criticality is coupled with current maintenance compliance levels in order to produce an Equipment Compliance and Criticality List (ECCL).

Phase 2

Using the ECCL, a Failure Mode and Event Criticality Analysis (FMECA) is performed. The FMECA seeks to identify potential component failure modes and their effect on neighbouring components, equipment and systems. This process allows component criticality to be assessed and subsequent preventive maintenance activity identified and scheduled.

The final deliverable of each QUESTAR® - M solution, is a Risk Based Maintenance (RBM) plan, that defines optimal maintenance intervention frequencies. The plan is aimed at maximising equipment output and life, minimising downtime and life-of-field costs, while at the same time maximising safety, reliability and total life integrity.