WHAT IS RBI BEST-PRACTICE & HOW TO IMPLEMENT IT SUCCESSFULLY

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ABSTRACT

Best practice Risk Based Inspection (RBI) Technology brings immense benefits to a plant site. However it is emphasised that there is no short cut to effective implementation of RBI in order to ensure improvement in plant reliability and safety, whilst optimising inspection requirements and inspection intervals of static equipment items of plant.

As a word of caution, when it comes to implementing RBI successfully at any plant site, it is the reliability of the RBI technology process used as well as the comprehensiveness of the team study method and the people involved in this from the plant site which deliver the set objectives and goals and not the RBI software”. The software must not be used to drive the best practices in RBI technology process or team study method; instead it is a supporting tool.

It is critical therefore the senior management at plant site must be committed to support the best practices in RBI and provide the required resources from site and the time allocation for the RBI team study and implementation of the output.

This requires the plant site fully understanding the implications of implementing RBI and most importantly recognising the role it will play in confidently achieving a company’s overall strategic goals.

This paper describes a proven technology process which is believed to be at the leading edge of best-practice in RBI technology application and outlines the established procedures for successful implementation and subsequent management at plant sites.

Many of the plant sites where this RBI technology process has been implemented have reported attaining benefits beyond their initial expectations in terms of improvement in reliability and safety and the net return on financial investment. Additionally, it has been recognised by those plant sites as an ‘excellent tool’ to help reliably identify root causes and resolve complex item technical issues (e.g. reactors, crackers, converters, fired heater & furnaces, strippers, reformers, etc.), thus facilitating the inspection de-bottlenecking process confidently in order to achieve the desired plant run-length time between TAs.

The topics covered include:-
1. Industry status on RBI technology
2. Plant Site Management Commitment & Obligations
3. RBI technology and Implementation process – best practice
4. Selecting the most appropriate RBI service provider
5. The role of NDT inspection methods

1. INDUSTRY STATUS ON RBI TECHNOLOGY

Globally, during the last 10 years, many plant sites which produce oil, gas, chemical, petrochemical and fertilizers products including some of the power generation and desalination plant sites have migrated to implementation of RBI technology and have used it to optimise inspection requirements and inspection intervals for equipment items of plant as well as de-bottleneck overall plant inspections in order to extend plant run-length times between inspection turnarounds. Why?, experience has shown that traditional inspection practices employed at prescribed fixed intervals for managing integrity of static equipment in service are
not necessarily conducive to ensure safety and reliability and can contribute to high operational costs. Experience has also shown that lack of adequate knowledge of applicable damage mechanisms, their causes and where they occur in each equipment item together with a lack of understanding of their risk profiles have led to:-

- In some cases, failures of plant items with unacceptable consequences, because either inspection methods and inspection locations were not matched to all active and potential damage mechanisms applicable to an item or they were not carried out at appropriate time.

- In most cases, unduly restrictive plant run-length times and/or costly individual item inspection plans (particularly unnecessarily frequent inspection of many items). It may be worth noting that unnecessarily frequent inspections do not necessarily improve safety or reliability; it is the inspection methods and inspection locations that match the active and potential damage mechanisms together with the timing of such inspections based on risk and consequences of failure, which deliver improved reliability and safety.

In progressive responsible companies, the traditional inspection process is therefore regarded now as reactive rather than proactive.

However, a word of ‘caution’, RBI is still a developing technology and therefore various methodologies are available in the market place. As such, those companies who have already implemented RBI at the plant sites have reported varying outcome from implementation. It is emphasised therefore that the chosen technology process must be robust and reliable. It must be supported by a consistent & comprehensive study method involving an experienced multi-discipline team in order to have confidence in the end results and reap the benefits from RBI.

For these reasons, both API & UK Health & Safety Executive have issued guidance for RBI implementation to help achieve consistency. Importantly, the RBI technology process must have the methodology to reliably assess the ‘probability of failure’ and the ‘risk profiles’ of the damage mechanisms applicable to an item. Without this, the confidence in the inspection interval derived for each item of plant is fundamentally questionable.

1.1. PP SIMTECH – The Difference

The RBI technology process by PP SIMTECH has successfully resolved the critical uncertainties in the assessment of risk profiles of damage mechanisms and the resulting inspection intervals. As a result, when this RBI technology which is supported by our comprehensive multi-discipline team study method and the subsequent management process is implemented at a plant site, it has been shown to reliably deliver:-

- A comprehensive and optimised inspection plan based on acceptable damage mechanisms risks for each item. The contents and scope of the inspection plan, as preferred by the inspection engineers at plant sites, are outlined in Section 3.3.

- Enhanced integrity for each plant item (improved reliability and safety) through better understanding of ‘active’ & ‘potential’ deterioration mechanisms and vulnerable locations.

- Reliable knowledge of ‘risk profile’ for each of the ‘active’ and ‘potential’ damage mechanisms applicable to an item. As a result, a reliably optimised inspection interval and a more focused inspection plan for each equipment item of plant.
- Reduction in number of items inspected during each turnaround, through extended inspection intervals for items which are found to be over inspected, and replacement of intrusive inspections with non-intrusive techniques for items where this is reliably feasible.

- Formally justified opportunities with recorded evidence to increase plant run-length time between TAs (de-bottleneck inspections) and optimise inspection TA times.

- Reduction in unexpected deteriorations usually found during turnaround inspections which in turn leads to reduction in unplanned repairs, thus avoiding over-run of TA period.

- Better defined operational limits, maintenance activities and integrity management strategies to reduce equipment failure risks.

- Knowledge of items which restrict achievement of desired plant run-length time between TAs. In order to de-bottleneck inspections of such items, recommendations are made on any need for remaining life calculations or special Fitness-For-Service assessments to make decisions on “run as is / monitor”, or “repair” or “replace” or “upgrade material”. The results are fed back to the RBI study and inspection intervals adjusted accordingly.

- Improved ‘working together culture’ and ‘asset care’ at plant site and improved self-assurance on perceived reliability and safety.

In order to appreciate what is required from an RBI study output, as an example, outlined below is a summary of the damage mechanisms and the important finding from a recent RBI project. These are in addition to the detailed & optimised inspection plan for each item based on the damage mechanisms risk profile. The contents of the inspection plan output are summarised in Section 3.3.

**Summary of Damage Mechanisms – identified by the RBI study team**

<table>
<thead>
<tr>
<th>Damage Mechanisms at Plant Units – A &amp; B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Ash Corrosion</td>
</tr>
<tr>
<td>Sulphidic Corrosion</td>
</tr>
<tr>
<td>Naphthenic Acid Corrosion</td>
</tr>
<tr>
<td>Localised Corrosion</td>
</tr>
<tr>
<td>Crevice Corrosion</td>
</tr>
<tr>
<td>Pitting Corrosion</td>
</tr>
<tr>
<td>General corrosion</td>
</tr>
<tr>
<td>Shielding Corrosion</td>
</tr>
<tr>
<td>Galvanic Corrosion</td>
</tr>
<tr>
<td>Wet H₂S Corrosion</td>
</tr>
<tr>
<td>NH₄HS Corrosion</td>
</tr>
<tr>
<td>HCl Corrosion</td>
</tr>
<tr>
<td>Dew Point Acid Corrosion</td>
</tr>
<tr>
<td>Erosion</td>
</tr>
<tr>
<td>Erosion Corrosion</td>
</tr>
<tr>
<td>Corrosion under Insulation (CUI)</td>
</tr>
</tbody>
</table>
### RBI Team Study Critical Findings in Plant Units – A & B

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Damage Mechanisms (all items total)</td>
<td>1157</td>
</tr>
<tr>
<td>Potential Damage Mechanisms (all items total)</td>
<td>945</td>
</tr>
<tr>
<td>No. of items LOW HSE Risk</td>
<td>288</td>
</tr>
<tr>
<td>No. of items LOW Business Risk</td>
<td>239</td>
</tr>
<tr>
<td>No. of items MEDIUM HSE Risk</td>
<td>180</td>
</tr>
<tr>
<td>No. of items MEDIUM Business Risk</td>
<td>225</td>
</tr>
<tr>
<td>No. of items HIGH HSE Risk</td>
<td>14</td>
</tr>
<tr>
<td>No. of items HIGH Business Risk</td>
<td>18</td>
</tr>
<tr>
<td>No. of items with RBI defined Operating Limits</td>
<td>239</td>
</tr>
<tr>
<td>No. of items with Recommendations / Actions</td>
<td>212</td>
</tr>
<tr>
<td>No. of items where Major Inspection Interval increased</td>
<td>378</td>
</tr>
<tr>
<td>No. of items where Major Inspection Interval decreased</td>
<td>45</td>
</tr>
<tr>
<td>No. of items where Major Inspection Interval unaltered</td>
<td>59</td>
</tr>
</tbody>
</table>

### 1.2. PP SIMTECH RBI Technology Background

RBI technology provides many benefits, however it must be recognised that there is no shortcut to effective implementation of RBI. The **technology process must be robust and the implementation team study (using a multi-discipline team) must be performed competently and comprehensively in order to ensure improvement to safety and reliability, whilst optimising the inspection requirements, inspection intervals and plant run-length time between TAs.** This is the approach adopted by PP SIMTECH from the very beginning of this technology development in the late nineties.

The process incorporates our breakthrough technology to reliably assess or calculate the risk profile of an item (based on its ‘active’ and ‘potential’ Damage Mechanisms), which in turn ensures that the resulting inspection interval for the item is reliably optimised. It is also supported by our comprehensive and transparent team study method. It includes pertinent key guidance from API 580/581 and the UK Health & Safety Executive (pressure equipment regulatory body). The combination of these criteria (which is integral to effective implementation of RBI at a plant site), has been shown to deliver, with increased confidence, quantified improvements to reliability and safety of plant items.

As a result, the RBI technology, the team study method and the implementation process originated by PP SIMTECH is now considered by those plant sites currently using it, as **unparalleled in its application and is believed to be at the leading edge of best-practice** in RBI technology. Many are reporting improvement to reliability and safety as well as financial benefits beyond their initial expectations. It has given increased self-assurance to plant inspection, operations and process engineers at site.

Additionally, where it has been implemented, this RBI technology process supported by the comprehensive team study method is recognised by these companies as an **‘excellent tool’** to use in the identification process of root causes and help resolve complex item technical issues (e.g. reactors, converters, crackers, fired heaters & furnaces, strippers, reformers, etc.).
It has also proved successful in assessing the effect of any process de-bottlenecking or other operational changes on the integrity of relevant equipment items, thus ensuring plant reliability and safety are not compromised as a result of these operational changes.

As a background note, in 2001 this RBI technology process was further improved jointly with British Petroleum (BP). The fully auditable and transparent software system rbiAsyst\textsuperscript{TM} was also jointly developed with BP. It was designed to fully reflect this technology process and the comprehensive RBI team study method, facilitate the study updates and successfully support the implementation of best practices in RBI technology at any type of plant site.

2. PLANT SITE MANAGEMENT COMMITMENT & OBLIGATIONS

The RBI cash challenge has become one of the key site strategy and objectives of many progressive companies. However, it is emphasised that there are no short cuts to effective implementation of best practices in RBI technology. For example, **compromising the quality of the RBI team study by not providing sufficient study time in order to reduce project costs or project timescales will have a detrimental effect on the confidence that can be placed on the RBI study output.** As such, the claimed outcomes in improvements of plant reliability, safety and financial benefits are questionable and so is the management decision to buy into this output and implement it in the hope that they are going to achieve these claimed benefits.

For plant sites wishing to successfully embark on RBI implementation, the following criteria must be met as a minimum:-

- The chosen RBI technology process must be robust & reliable in assessing the risk profile of active and potential damage mechanisms and optimum inspection interval for each item.
- The team study method applied to each item must be comprehensive for self assurance in the study output.
- The RBI study team composition must include inspection, process and operation engineers from the plant site, in addition to external consulting engineers (for e.g. RBI specialist engineer and metallurgist/corrosion engineer).
- The software system must fully support the team study and be transparent and auditable.
- The RBI implementation must be managed as a project in order to progress the team studies on a regular basis and to successfully embed the output into site practices.

**It is critical therefore that senior management at plant sites fully understand these minimum requirements and are committed to providing the required resources and time allocation for the RBI team study.**

The onus is therefore placed on the Site Leadership Team of any plant site to initially establish the following as a minimum:-

a) What is the desired plant run-length time between inspection / maintenance turnarounds and the financial gains that can be achieved by implementing RBI?
b) How do we ensure to achieve improvement on current reliability and safety, particularly if we also wish to achieve the desired plant run-length time (i.e. extended) between TAs?

c) Who would provide a robust and reliable RBI technology process, a comprehensive, transparent and auditable team study method and the implementation support that would competently deliver both (a) and (b) above and provide the required self-assurance and confidence to plant site? See also Section 4 – “Selecting the right RBI service provider”.

d) What is the best way to implement RBI and who should be in the RBI study team and what should be the output as a minimum, in order to ensure success at the end?

e) What are the requirements of a project plan to implement RBI technology successfully across all plants at site including resource requirements and commitment?

f) How do we implement the RBI team study output? What is the procedure for subsequent updates of the study as a result of future inspection findings or operational changes?

g) What are the Key Performance Indicators (KPIs) to monitor progress of the RBI implementation project, performance and benefits attained?

h) Based on (d) to (g) above, who at the plant site should be assigned with Single Point Accountability (SPA) for managing effective delivery of the project?

These are some of the key questions which need to be addressed before embarking on RBI implementation. There may be other specific questions which are unique to a plant site and have to be addressed. Some useful information is provided in Sections 2.1 and 2.2 below for plant sites wishing to embark on RBI implementation, with the view to help them understand and identify the potential benefits which can be attained and therefore help set the site objectives and appropriate KPIs.

Fig.1 below outlines the basic considerations involved in setting up the site RBI strategy, management commitment and their obligations in supporting the process.

![Fig.1. Plant Site RBI Strategy – Management Commitment & Obligations](image-url)

Having established the strategy for RBI implementation, it is important for the plant site to ascertain the implementation process. Fig.2 below outlines the key tasks for the nominated person at plant site with ‘Single Point Accountability (SPA)’ for RBI Implementation.
2.1 RBI induced Safety & Reliability Improvements

There is no doubt (as proven by positive evidence) that the RBI technology process described in this paper will deliver significant measurable improvements to the current level of safety and reliability of equipment items at any plant site as a direct result of the RBI team study output and once these are correctly implemented. See Section 1.1 for details of the study output and project deliverables.

2.2 RBI induced Cost Benefit to a Plant site

In addition to the above, the following outlines how the net cash benefit can be assessed by a plant site, i.e. The cost of RBI implementation vs. cash gained:-

1. Savings from inspection related costs for items where current inspection intervals can be extended (project this over a period of say for the next 12 years and 25 years).

2. Increased production (number of days) based on technically justified extension to plant run-length times between inspection turnarounds (project this over a period of say for the next 12 years and 25 years). For e.g. from a 2 year run to a 3 year run.

3. Increased production by minimising unplanned shutdowns caused by unexpected failures. This is achieved by improvement in reliability and safety of all static equipment items of plant (assessment of this can be based on comparison with past history over last 5 years).

4. Increased production due to better optimisation of turnaround time (projected over a period of say for the next 12 years and 25 years).

5. Increased production due to avoidance of unexpected over-run of turnaround time through better knowledge and planning of anticipated repairs and replacements in advance (see RBI Study Output – Section 3.3, clauses C & E). i.e. less unexpected shockers at TA shutdown.

3. RBI TECHNOLOGY AND IMPLEMENTATION PROCESS – BEST PRACTICE

Implementation of RBI technology requires information on design, construction, operational fluid streams details and inspection history of equipment items of plant including past operational changes. Based on this information the integrity risk assessment is carried out using a competent multi-discipline team study process and it particularly focuses attention on the identification of all ‘active’ and ‘potential’ damage mechanisms, which could affect an item. This is followed by an evaluation of integrity risk profiles for each of the identified...
damage mechanisms (DMs) applicable to the item, which is based on DM failure mode, consequences and probability of failure and the inspection interval for an item is reliably optimised and the inspection plan redefined comprehensively. If relevant, operating limits (e.g. temperature, composition, flow rates) and/or monitoring requirements of relevant process streams and critical maintenance activities are better defined to prevent increase in damage rates or initiation of a new DM. Other measures are also specified by the RBI study team to mitigate identified risks.

Best practices in RBI technology implementation demand responsibilities assigned for plant operations chemical engineers to manage RBI study defined operational parameters within the agreed limits. Additionally, the initial RBI study and the inspection plans for equipment items also require reviews and updates after inspection or when operational changes are made. Procedures and responsibilities therefore must be set up and embedded into existing site practices to successfully implement it and manage the process effectively at a plant site. The dynamics of this RBI technology process is shown in Fig.3 below.

3.1 The multi-discipline RBI Study Team

The RBI study must be carried out by a competent multi-discipline team the members of which each have suitable qualifications and experience. Normally the team membership would be covered by five core disciplines:

- RBI team study Facilitator (RBI and Fitness-for-Service assessment expertise)
- Plant Inspection Engineer
- Plant Mechanical (or Maintenance) Engineer
- Plant Operations and Process Engineer
- Metallurgist (or Corrosion Engineer)
It is imperative that experienced engineers assigned to the RBI study team and representing core disciplines such as inspection, operations and process must be none other than from the plant site. Industry experience clearly shows that without their commitment and input to the team study, RBI cannot be successfully implemented and managed subsequently. RBI specialist engineer / team study Facilitator and Metallurgist can be from the RBI service provider. For audit reasons, team member names should be recorded in the study of each item.

3.2 The RBI Team Study

It is emphasised that RBI is a methodology to improve equipment reliability and safety and optimise inspection activities based on integrity risk assessment. As such, the RBI team study is a critical process itself, which must be performed comprehensively and competently. The senior management at plant site must therefore be committed to providing the required resources and time allocation. The key elements of the RBI team study are shown in Fig.4.

**Fig.4. Key aspects of our RBI Team Study™ process for each item ©**

3.3 The Output of the RBI Team Study must include …..

A. Risk based inspection plan (RBI plan) for each static equipment item of plant, as finalised by the RBI study team. Essentially, for **each item** the RBI plan details …..

1) **Optimised** Major Inspection interval (definition of Major Inspection is where all the identified Damage Mechanisms (DMs) applicable to an item are inspected for).

2) Inspection type (where appropriate, advantage is taken of suitable non-intrusive inspection techniques to optimise Major Inspection interval. Non-intrusive NDT inspection is usually implemented as an Intermediate Inspection at a suitable date between Major Inspections, for example, to inspect for any critical DM. This is usually carried out without entering the item, when the plant is on-line or off-line).
3) Inspection methods to match the identified damage mechanisms (DMs). Note:- where relevant, NDT parameters (effectiveness and capability) are defined for the selected NDT methods, in order to improve confidence in inspection results.

4) Inspection coverage and locations which highlight the likely areas for damage occurring for each of the identified DMs.

B. Operational limits (e.g. temperature, composition, flow rates) and monitoring requirements of relevant process streams including maintenance activities are better defined to prevent increase in damage rates or initiation of a new DM, thus ensuring validity of (A) above.

C. Anticipated repairs, upgraded material or replacements at the next shutdown Turnaround.

D. Other measures to be actioned to mitigate identified risks which may lead to leakage or failure of equipment items.

E. Recommendations on any need for special Fitness-For-Service assessment calculations to make decisions on “run as is / monitor”, or “repair” or “replace” or “upgrade material”. The results are then fed back to the RBI study and inspection intervals adjusted.

This output consisting of A to E above ensures that the identified risks are managed within defined acceptance levels, thus providing best-in-class mechanical integrity assurance and reliability at optimum costs to the plant site.

3.4 RBI Implementation – ‘best practice’ key points

Based on the foregoing Sections, the following points list the various mandatory elements, in order to provide an overview to what are considered the best-practice aspects of successful RBI implementation:-

- A reliable RBI technology and comprehensive team study method, which would provide the required self-assurance to plant inspection, process and operations engineers at site.

- Inclusion of pertinent guidance from API and HSE (UK).

- The RBI study must be comprehensive & carried out by a competent multi-discipline team.

- Training must be given to all engineers involved in implementation of the RBI process.

- The RBI methodology and team study process must be clearly defined and transparent. The application of the methodology and resulting documentation must be recorded in such a way that the study process, key discussions and decisions made are fully auditable and future reviews / updates are carried out easily and efficiently.

- The RBI study data for each item (including design conditions, operating loads / fluid streams data and historical changes, inspection history) must be accurate.

- The methodology and team study process must be comprehensive to have high confidence in determining all ‘active’ and ‘potential’ damage mechanisms for each item.

- The failure mode for each of the identified damage mechanisms should be determined in order to evaluate realistic ‘consequence of failure’.

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The methodology must ensure reliable assessment of ‘probability of failure’ and the risk profile for each of the ‘active’ and ‘potential’ damage mechanisms identified for an item. From the assessment of the risk profile for each of the damage mechanisms, the optimised inspection interval for the item must also be reliably evaluated against an acceptable risk profile and predefined time frame.

Specific ‘ground rules’ must be set within the team study process to ensure consistency in application of the RBI technology and the output.

The operational limits of key process parameters and maintenance activities (e.g. paint coatings, fire-cladding, insulation seal) must be defined and implementation audited.

The study must consider confidence levels the team has in the assessment, which may be reduced, for e.g. owing to limited availability of data. The inspection interval must be adjusted accordingly.

The RBI team study must also include for the development of a detailed inspection plan with consideration and specification of reliable NDT methods linked to the damage mechanisms. This inspection plan must consider NDT capabilities & effectiveness.

The process must manage the transfer from current inspection plan to RBI driven inspection plan with consideration of the requirements of governing local legislations.

For high consequence items, speculative inspections and inspection sampling should be considered within the overall inspection programme in order to allow for the unexpected.

Procedures must be put in place at plant site to ensure that the RBI study output and the management of future reviews and updates are embedded into the site practices.

3.5. The supporting software system:

This must have adequate functionality and details to facilitate the team study and support the best-practice aspects described above. Many of the functionalities specified are classed as mandatory to help updates of the study. The following are considered to be a minimum:

- Needs to support the RBI technology process & the multi-discipline team study method described in Fig.4 and the resulting output as outlined in Section 3.3 for each item.
- For each item, facility for recording team discussions, logic, judgement and decisions.
- Needs to be transparent on how the Damage Mechanisms (DMs) integrity risk profiles for an item are reliably assessed.
- Needs to be transparent on how the optimised inspection interval for an item is reliably derived, based on identified DMs and the risk profile of each DM.
- Facility for reporting inspections carried out on each item and the findings to match the applicable DMs, so that updating of the RBI studies and resetting of the inspection intervals can be carried out effectively with minimum resource commitment.
- All of the above records needs to be fully auditable, including RBI study data used, the initial RBI study and output, team members, subsequent Reviews and Updates.
The foregoing facilities in the RBI software has been proven to provide documented evidence on improved reliability, safety and a reliably optimised inspection interval and inspection requirements for each item of plant. Additionally it also provides an effective process to carry out reviews and updates of the RBI study as a result of inspection findings or process operational changes.

4. SELECTING THE RIGHT RBI SERVICE PROVIDER …..

It is crucial that the selected RBI specialist company must be able to provide a reliable RBI technology process which also incorporates the industry best practices. Essentially, the selected RBI technology process and the team study method must be able to reliably assess equipment item risk profile based on identified damage mechanisms. This is critical to the whole process because the evaluation of optimised inspection interval for an item clearly depends on the risk profile of the identified damage mechanisms.

The team study is an important part of RBI implementation process itself, which must be performed comprehensively and competently. This is fundamental to ensuring that the end financial benefits as a result of RBI implementation are achieved with improved confidence in equipment integrity and reliability. Additionally, satisfying these requirements would help provide the required self-assurance to plant inspection, operations and process engineers at site for effective implementation of RBI.

4.1 The key aspects of the selection criteria that should be considered include:-

1. How comprehensive is the RBI team study process to ensure that ‘active’ and ‘potential’ Damage Mechanisms (DMs) applicable to each item are competently identified?

2. What is the membership of the multi-discipline RBI study team (see section 3.1)?

3. How reliable is the assessment of ‘probability of failure’ and the ‘risk profile’ for each of the identified DMs applicable to an item and how is this information translated into a reliably optimised inspection interval for an item?

4. How comprehensive is the inspection plan & other critical output from the study for each item (RBI Study Output – Section 3.3) which would support effective implementation?

5. What is the process used for the RBI study of interconnected piping in a plant and how efficient and effective are the team study and the assessment process used?

6. How transparent is the team study supporting software system in order to ensure audit trail of data used by RBI study team, team study process, DMs status and risk profiles, key decisions and supporting reasons, study output as per Section 3.3, team members, etc?

7. Does the software system provide adequate facilities to record the RBI studies? Does it also allow facilities for study and inspection plans updates as a result of future inspection findings or operational changes?

8. What support is provided for effective implementation and migration of the RBI technology process into the site practices?

9. Fitness-For-Service (FFS) assessment is a technology that is used to calculate or evaluate optimum remaining life of deteriorating equipment and as such it has become integral to
the RBI process. Does the RBI Service Provider have the expertise to correctly identify and apply FFS technology where relevant and assist the plant site accordingly?

10. Does the offered RBI technology, team composition and study method as well as the rest of the package necessary for effective RBI implementation provide the required self-assurance to plant operations, process and inspection engineers?

5. THE ROLE OF NDT INSPECTION IN RBI PROCESS

When RBI process is used to justify extended inspection intervals, in particular for high consequence items, or extended plant run-length times between turnarounds, the role of NDT inspection and the accuracy required of the inspection results cannot be underestimated.

5.1 NDT inspection plan – need to match the Damage Mechanism (DM)

- Define purpose of NDT – [to detect DM or to assess DM rates or both].

- When selecting NDT method, optimise balance between risk, effectiveness and cost, which depends on consequence and complexity. Define which components of the item, what methods, what coverage and required accuracy of results.

- Capability and Effectiveness of the technique and Reliability of results is key.

- Define how to inspect – Invasive or Non-Invasive Inspection (NII)?
  - Consider feasibility and benefits.

- Implementing Non-invasive Inspection [NII]
  - Decide in accordance with industry best practices.
  - Need a structured decision process to have confidence in NII technique and results.
  - Who will do it? – need proven record on degradation types / locations and experience.

- More responsibility is placed on the NDT Engineers
  - Expected to be more proactive when defects are detected.
  - Qualification and experience relevant to DMs.
  - Accuracy of results – need to check calibration and question the findings at the time of inspection. If in doubt ASK. (It is too late when the plant is back on line after a TA).
  - Better reporting of results to help update RBI study output and future inspection plans.
  - Need clear procedures and inspection briefing to narrow reliability gap between NDT engineers’ performance, so that confidence in results and repeatability is improved.

CONCLUSION

This paper described a robust and proven RBI technology process, which is believed to be at the leading edge of RBI best-practice.

It is clear that there is no short cut to implementing RBI successfully and ensure improvement in plant reliability and safety are achieved. It is critical therefore the senior management at plant site must be committed to providing the required resources and time allocation for the RBI team study. For any plant site wishing to successfully embark on RBI implementation, the chosen technology process must be robust and reliable and the team study method for each item must be comprehensive in order to have self assurance in the study output. The supporting software system must be transparent and auditable.
Equally, the RBI study team composition must include inspection, process & operation engineers from the plant site, in addition to any external consulting engineers. The RBI implementation must be managed as a project. A suitable person with Single Point Accountability (SPA) must be nominated by plant site in order to progress the team studies regularly and to successfully embed the process into the site culture and technical practices.

On a final note, when it comes to implementing RBI successfully at any plant site, it is the reliability of the RBI technology process used as well as the comprehensiveness of the team study method and the people involved in this from the plant site which deliver the set objectives and goals and not the RBI software. The software must not be used to drive the best practices in RBI technology process or team study method; instead it is a supporting tool.

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