Using Cloud collaboration groupware to build compliance, Integrity and risk-based inspection systems

John Fletcher, Tony Sovar, Mukund Ramanan

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Abstract
This document aims to throw light on an alternative approach to Asset Integrity Management using Cloud collaboration tools to not only keep up with the ever changing and evolving technologies and the way we work, but also enhance efficiency and productivity.

I. INTRODUCTION

In a world where Uber owns no cars, and Facebook creates no content, Alibaba carries no stock and the world's largest accommodation provider, Airbnb, owns no property.

Could an Integrity management system and a Risk-based analysis tool be built using a proprietary cloud collaboration tool and make it adaptable, and affordable without the costs associated with current RBI software tools for small to medium sized companies (SME's) to implement?

And how would this cloud collaboration groupware application help build compliance, Integrity and risk-based inspection?

Key elements to include /requirements:

a. Use a propriety cloud collaboration tool
b. Charging minimal upfront cost (if bought outright), and no yearly license fees.
c. Owned by the client company,
d. Be transparent,
e. Documented using a quality management system (QMS) to capture the RBI methodology, adapted to the local, National and International requirements of the client.
f. Provide an extractable table of equipment next inspection / test date, including the scope of work.
g. Provide a list of non-compliant equipment.
h. Be flexible enough so that either the client is 100% involved (with some training and coaching) or 50/50 build (we work as part of your team), or 100% and we run by external consultants.

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II. COMPLIANCE REQUIREMENTS TO AS3788 AND AS4343 (OR LOCAL REGULATION - SPECIFIC STANDARDS)

The Australian standard AS 3788 requires the pressure equipment owner/user to,

Inspect by qualified personnel when:

a. Commissioning (i.e., on-site authorization to use and register)
b. Periodic in-service (shutdown or online)
c. Inspection following serious excursion or damage
d. Inspection for proposed changed process in-service conditions
e. Inspection following repair or alteration.
f. Inspection of idle equipment
g. Inspection for remaining life determination or purchase.

Store design and Inspection records

a. Evidence of original design and construction
b. Details of detected defects (visual or NDE)
c. Details of degraded material (By visual NDE sampling and operating data)
d. Details of deficiencies in protective equipment or controls.

Inspection assessment

a. Comparison with code requirements for acceptance
b. Determine if defects or degraded material are acceptable.

Furthermore, AS 3788 requires owner users to store:
Pressure equipment[12] information files shall contain details of all significant maintenance, inspection and related activities on each item of pressure equipment. The activities for which detailed records shall be kept include the following:

a. External inspections.
b. Internal inspections.
c. Pressure-relief valve and other safety-related equipment tests.
d. Non-destructive examinations, such as thickness measurements, weld acceptance and pressure testing.
e. Significant pressure equipment maintenance, repairs, and alterations carried out.

Pressure equipment information files shall contain the following data:

a. Equipment[12] registration number or unique identification number or unique plant number or stamped/engraved unique identifier as detailed in AS 3788 Clause 8.3.
b. Location of markings.
c. As-built and design-verified drawings and calculations, manufacturer's data
d. report, including hydro test report. Manufacturer's documentation or certification for each individual safety valve or pressure relief device shall be obtained and retained.
e. Design verification certificate.
f. Repairs, alterations, or re-ratings to original design and related records. Service conditions and hazard classification to AS 4343.

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PRESSURE RELIEF DEVICES

A documented system[13] shall be set in place that includes controls and procedures for each pressure relief device. The system shall include, as a minimum, the following information on each pressure-relief device:

a. Manufacturer's data (e.g., type, serial number, size, set point).
b. Identification of valve (e.g., unique plant number).
c. Location.
d. Inspection records.
e. Maintenance test and inspection intervals.
Record of adjustments and authorizer.

The question should now be, "how do I store, retrieve and analyze all of this data required by AS3788 and mandated by law, efficiently and effectively?"

III. REQUIREMENTS OF AN RBI SYSTEM AS PER API 580

The API 580 framework of the RBI process includes:

a. Understanding the design premise (Written strategy created outlining legal and company commitments to workplace health and safety with respect to pressure equipment).
b. Planning the RBI assessment (choose a pilot plant for the initial trial)
c. Data and information collection (Clients' records and/or Inspection contractors).
d. Identifying damage mechanisms and failure modes (Corrosion engineer). e) assessing the probability of failure (POF),
e. Assessing the consequence of failure (COF), possibly using Aloha / Cameo or other)
f. Risk determination, assessment and management
g. Inspection activities (inspection scope (ITP) and timing) developed and CMMS
h. inspection PM's timing updated
i. Other risk mitigation activities (i.e., pressure or temperature process limits, raw feedstock quality).
j. Completion of integrity inspection of pressure equipment (Client execution of ITP)
k. Review and assessment of pressure equipment inspection result and updating of scope and timing of next inspection (Client to appoint Integrity responsible position). Operations Manager (or equivalent) to sign off on changed inspection frequencies prior to implementation.
l. Roles, responsibilities, training, and qualifications
m. Documentation and recordkeeping.

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IV. TEAM APPROACH

"Alone, we can do so little; together, we can do so much" Helen Keller – American Author, Activist, and Lecturer.

During the design and construction phases of the plant, massive amounts of data is produced, i.e., drawings, forms, photographs etc.; however, these are usually handed over to the business as an afterthought. During the design life of the equipment (i.e., 20 years) the unit will be operating 24-7, and this data/reference documents will be referred back to constantly during that time in order to operate the plant safely, effectively, efficiently, and without environmental harm.

Note: State or national regulations may require owners/operators (as is the case in Australia) to have a document management system and to keep all relevant documentation, i.e., compliance and In-service inspection reports (AS3788 in-service inspection standard).

However, the use of email is endemic, especially those that have excel spreadsheets, photographs and signed test certificates attached. This unstructured/non-archived data is ineffective, is even worse, stored on a windows filing system with the wrong title.

Now, if you are fortunate, your project team will produce all such mentioned reference documents to the projects/operation handover as "proof" of compliance (all of this data will still need to be archived and kept safely). The question remains, therefore, "would it not have been more efficient if they had uploaded them directly into the cloud for archiving and sharing".

The missing link, therefore, is an "easy to use", affordable, central database in which to store the data for assessment, checking and verification. This cloud collaboration approach, therefore, revolves around teams having and using the right collaboration tools in an efficient, accurate and precise manner.

V. REGULATORY COMPLIANCE

The requirements of compliance will depend on your state or national requirements and to which standard you adhere. In essence, this will be an authoritative/governmental audit of your pressure equipment, i.e., design drawings, pressure safety equipment, piping and vessel data etc., looking for evidence that inspection and testing activities have been carried out in a prescribed, methodical way, to ensure the health, safety and the protection of the environment. This task appears simple "in theory", but there is typically a difference between theory and practice. The compliance team can consist of as few as 2 to 3 people, i.e., field-based personnel, database manager and project manager; collecting data would be required for this task.

Note: "A compliance audit is an independent evaluation to ensure that an organization is following external laws, rules, and regulations or internal guidelines, such as corporate bylaws, controls, and policies and procedures."[13]

AS3788, the in-service inspection standard requires effectively achieving legal and regulatory compliance, i.e., "Owners responsibilities[12]: There shall be a management system sufficient to ensure the continuing Integrity and safety of items of pressure equipment.

Such a system shall be documented to a level determined to be appropriate in consultation with a person competent in pressure equipment inspection. In determining the appropriate level of documentation, issues including the Hazard Level, location, physical condition, maintenance practices, service history, number of items to be covered, and any other relevant issues, shall be considered".

VI. RISK BASED INSPECTION

Risk-based inspection is used during the operating phase of the plant, in order to focus inspection attention towards the most critical parts of the operation. It identifies the inspection technique, scope and frequency of inspection in order to mitigate potential degradation threats.

AS3788 states[13]: "Risk management techniques may be used to achieve the objectives of the pressure equipment inspection program. In order to operate pressure equipment at an acceptable level of risk, the extent and frequency of inspection, the quality of process control and monitoring and the potential consequence of failure shall be taken into account". This vital risk analysis requires expertise in corrosion, Integrity and inspection. The RBI may be either qualitative / semi-quantitative or fully quantitative as outlined in API580.

API 580[9] states that depending on the application, some of the disciplines listed below may not be required. Some team members may be part-time due to limited input needs. It is also possible that not all the team members listed may be required if other team members have the required skill and knowledge of multiple disciplines. It is usually useful to have one of the team members serve as a facilitator for discussion sessions and team interactions.

The team could consist of[9] :

a. Team Leader or Facilitator
b. Equipment Inspector or Inspection Specialist (who is familiar with the pressure equipment items to be considered for RBI)
c. Corrosion Specialist
d. Process Specialist
e. Operations and Maintenance Personnel
f. Management
g. Risk Analyst
h. Environmental and Safety Personnel
i. Financial/Business Personnel

In a small business, it would be conceivable that one person would cover several roles.

Note within Australia and the state of Queensland. An RPEQ engineer is required to be the technical owner of the process/document. The Operating Company owner/ user/ COO or equivalent is required to approve the document for implementation at the facility.

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VII. STORING YOUR DATA ON A WINDOWS PC.

As previously mentioned, most corporate data is kept in a file structure that is based upon the concept of a filing cabinet. A computer running a Microsoft Windows operating system organizes its data like you would organize files in a file cabinet. Each cabinet has multiple drawers. Each drawer contains folders. Each folder contains important papers that you need to file away. The Windows file system structure parallels this type of organization. Data kept like this is just an archive for data. Using windows filing structure, finding what you want when you want is time-consuming. With a relational database, you can drill through the information, and find links and lists of related data within seconds.

VIII. LOW-CODE AND THE DEMOCRATIZATION OF PROGRAMMING

Therefore, all stages of the pressure equipment life, produces vital data which needs to be stored and referenced, risked and compliance proven.

How would we do this in an efficient, effective and economical manner?

In the past, the Windows file manager has been used to store documentation on a PC and later on the web, such as Microsoft OneNote. However, the file names used may not describe their actual content and will require many man hours, opening and renaming them for them to be useful. This may include .jpg .png files for photographs, .doc and .pdf files for text documents and .xls for excel files. Without a robust archiving system, most of the documents are useless.

However, data stored on spreadsheets[10] have, in fact, enabled a whole generation of people to use computers, most of whom have never used any other programming language and wouldn't have wanted to learn a more "formal" programming language. Excel, then is a good example of low code enables engineers to use computers without learning a formal programming language. At the other end of the scale from low code were programming languages like Java and C++, which were intended to be used on larger projects involving collaboration between teams of programmers. These RBI, compliance and archiving programs may take months or even years to develop and run to millions of lines of code.

It makes sense, therefore, that the new low-code platforms provide non-programmers with drag-and-drop solutions for creating everything from consumer-facing apps to internal workflows via templated approaches.

What low / no code applications are doing is allowing people with minimal coding skills to make connections between libraries, archive documents and photographs, build RBI systems and store all of the required by legislation in a cost-effective manner.

IX. SMALLER INDEPENDENT PRODUCERS

Smaller operators do not have the large maintenance budget that major oil and gas companies have at their disposal, but that does not mean that they can afford to be non- compliant, especially concerning pressurized equipment inspection and pressure safety valve calibration.

As we are probably aware, all pressure equipment has legal requirements and regulations regarding manufacture, installation and use. Smaller operators sometimes find these legal regulations onerous, especially the periodic in-service inspections (e.g., Australian AS3788 in- service inspection table 4.1).

Smaller independent producers such as:

a. Petrochemical
b. Fertilizer
c. Oil and Gas
d. Chemicals

Smaller independent producers can now afford advanced applications which solve these archiving, risk analysis and inspection issues. In fact, anyone managing pressure equipment can now build or have built the same systems that previously were only affordable to large multinational corporations.

Their Integrity database management system (IDMS) used for compliance and even the RBI assessment are sometimes carried out as paper-based systems or on Microsoft Excel spreadsheets which is slow, costly and difficult to update.

Hence the requirement for an open framework compliant IDMS and RBI program based upon Low / no code, web-based, relational database platforms. Which can store text and numerical data, carry out advanced mathematical functions as well as store documents and images. The data can now be attached directly to the pressure equipment, systems, units and facilities using relationships and links.

X. SPREADSHEET VERSUS A DATABASE

So, what's the difference between a spreadsheet and a database? A relational database doesn't just store data, it stores relationships/links between that data, for example, all of the vessels in your plant with categories such as inspection reports, design documents, repairs and MOC's.

This is required for the ongoing integrity program for the facility/plant and can have a low no-code solution created for it. Using low / no code technology, it is also possible to learn how to build an RBI analysis tool with no coding experience and minimal training for the user. With the database relationships, it is possible [3] to use those relationships to answer questions you have. Whereas storing related data together in a single spreadsheet can be unwieldy and invite errors when you try to sort and compare it, but with a database, for example, you could easily filter by "Air compressor" in the title without modifying your database itself. A basic rule of thumb is that a database is more suited to organize a large amount of information, and spreadsheets are the best fit for running calculations.

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XI. INFORMATION STRUCTURE

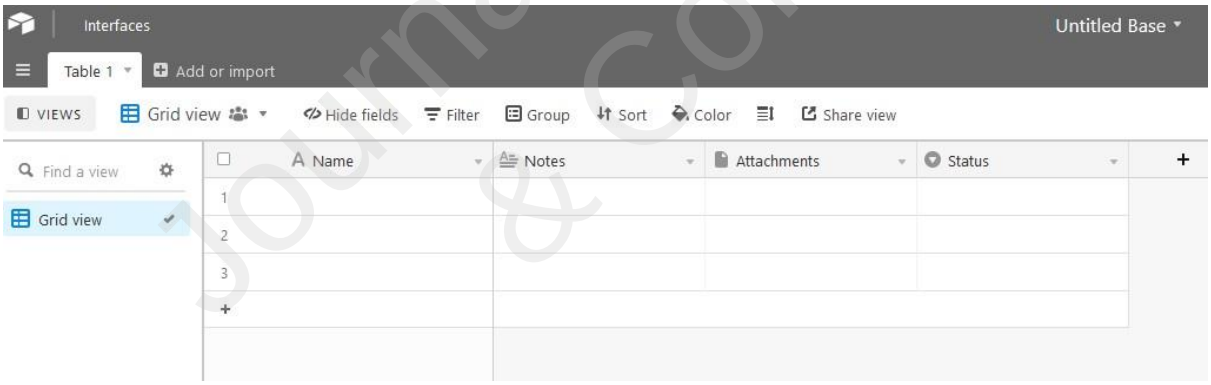
Information architecture gives meaning to the mass of unrelated needs, words, and pictures. It fits them together (like a jigsaw), so they are now useful. The skill is in the knowledge of framing and structuring the data. Organizations need people who can extract information from those who have it, put this information in a structured form and maintain or refine it over time.

The people who can do this are the architects of that business's information. Modern business strategists believe that organizations can manage layers of knowledge (processes, procedures, technologies, messages, figures, experience) in a "living design" mode.

XII. ENTER THE CLOUD COLLABORATION TOOLS

Cloud collaboration[4] services use a spreadsheet-database hybrid, with the features of a database but applied to a spreadsheet. This makes it a lot more understandable and less intimidating for Excel users. The fields in the table are similar to cells in a spreadsheet but have types such as 'checkbox', 'phone number', and 'drop-down list, and can reference file attachments like images. Application builders like Airtable, bubble, knack and the SAP- owned Appgyver are affordable and user-friendly.

Users can create a database, set up column types, add records, link tables to one another, collaborate, sort records and publish views to external websites, and everyone can see it as it happens. Cloud collaboration is a method of sharing and co-authoring computer files via cloud computing, whereby documents are uploaded to a central "cloud" for storage and where they can then be accessed by other users. Cloud collaboration technologies allow users to upload, comment and collaborate on documents and even amend the document itself, evolving the document. Businesses in the last few years have increasingly been switching to the use of cloud collaboration.



Shows an (Airtable) cloud collaboration relational database columns

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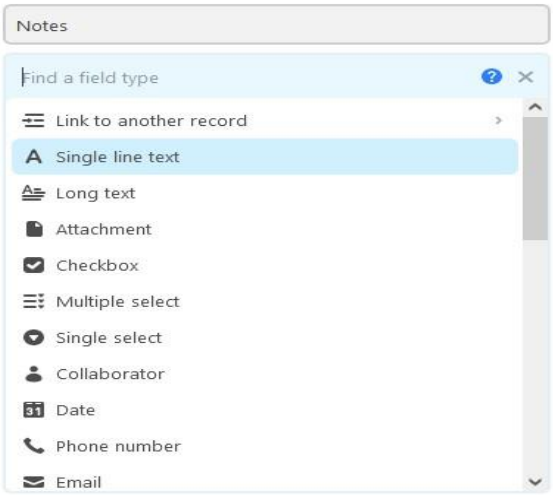
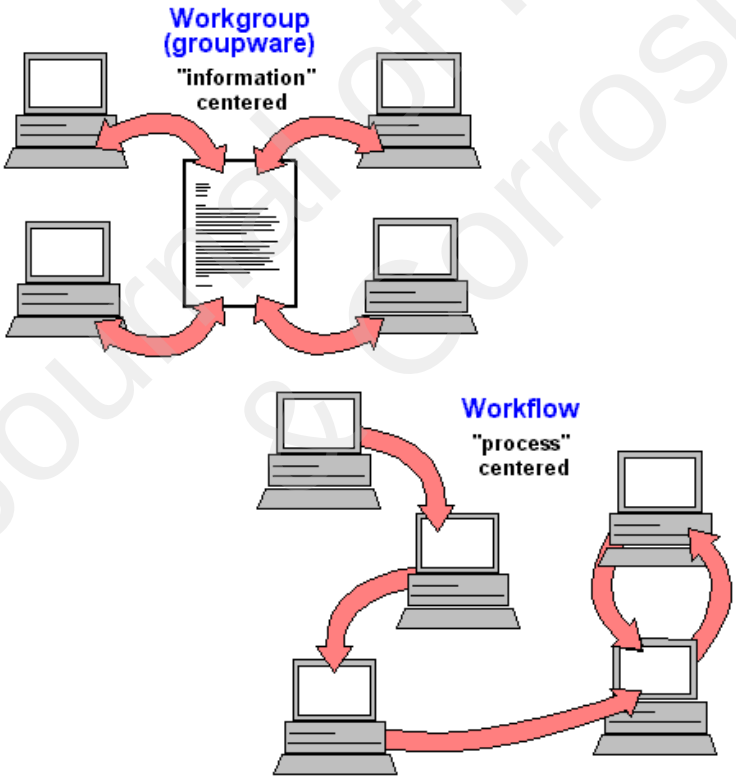


Shows some (Airtable) column header types available (note link to another table at the top of the list).

XIII. ONLINE WORK COLLABORATION (GROUPWARE) RELATIONAL DATABASE

Wikipedia states that collaborative software or groupware "is an application software designed to help people working on a common task to attain their goals. One of the earliest definitions of groupware is "intentional group processes plus software to support them".



Using groupware, the technician in the field, the Senior Integrity Engineer and the COO see the same information in real-time. Decisions can be made and shared almost immediately. The speed of business decisions increases.

Building a collaborative, groupware relational database focuses “like a laser beam on the issue at hand”. Sharing the database with the team also means everyone is up to speed, onboard and facing in the correct direction.

Security features of the online database:

a. requires individuals to login with their password
b. the administrator can allocate levels of authorization within the database, for example, some users will be “Read only.”
c. all changes to the database are automatically logged with the username and action

XIV. COST, QUALITY AND TIME

We have therefore solved the management triangle, where cost, quality and time are balanced and where it is said you can only have 2 of the 3 well, we can now have all 3.

However, because you only build the essential items that the customers require (focused RBI/compliance), it can be done at speed (most projects can start the same week). The process can be documented, and the database built (from template onwards) to achieve the Cost/time/quality triangle.

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XV. OUR EXPERIENCE

Since 2016 we have developed and implemented a comprehensive database that includes Pipelines, Compressor stations, PSV’s and field well sites for a Brisbane-based oil and gas company. What started as a simple reorganization of data for several pipelines in New Zealand (for government audit purposes) has now become a company-wide reorganization of pressure equipment data, which now helps produce monthly Vessel and PSV compliance reports for management. The required inspection or test date is updated in the CMMS for future planning.

The company has now analyzed and managed the compliance of over 500 Vessels and PSVs. This cloud collaboration approach allows for:

a. Analysis can be carried out on all vessels. (Using formulas, last inspection, issues found etc.).
b. PSV's test certificates capture and analysis of "PSV pop" tests for compliance and safe operation.
c. CMMS audit making sure we have captured all of the equipment and ascertained the correct inspection frequency and technique.
d. ITPs for vessel inspection are stored in the database linked to the appropriate equipment.
e. Compliance audit tool.
f. Plant audits, photographs taken of each Vessel/ PSV and documents stored on the database.
g. The Integrity database is a complementary tool to the CMMS package, which has the WO's / PM's details to plan and schedule the associated work required to be completed to enable the integrity inspection/tests to be performed. The results are reviewed by appropriately qualified individuals who provide details for any
h. additional work scope to be performed as well as set the date requirement for the next integrity inspection.
i. The Integrity database is the "Integrity Engineers Analysis Assistance Tool" to ensure compliance, process safety and optimization of the pressure equipment within their company/plants.

XVI. DOCUMENTED SYSTEM

We use a structured documented Integrity system that explains our methodology/approach and describes all calculations used, assumptions made, and evidence provided (in the form of photographs, pdfs and word documents) to name but a few.

This could easily be audited and updated at any time via internal or external bodies. Using the above approach and information, we can plan, coordinate and control the company's inspection and PSV testing data, produce monthly compliance reports and answer any questions set by the regulator. If anything should happen to our company, then the data is safe, and owned by the Operating Company, and external staff could easily pick up the analysis if required.

XVII. STRUCTURED DOCUMENTED INTEGRITY SYSTEM IDMS AND RBI

We have constructed a database which includes all required Integrity engineering information to enable decisions to be made for scope of inspection ITP's, frequency on application of ITP's, assessment of inspections and storage of the reports. Review and updates of the ITP's and frequency of inspection shall be based on the evidence gathered from the previous inspection as well as the relevant inspection standard for the pressure equipment.

The RBI methodology was constructed as a template and paperwork system that is adaptable and customizable for any situation. The RBI methodology is based upon the combined approaches of API 580, API 581, RIMAP, ASME CPR18E. It is an open template that is used in conjunction with the client to understand, capture and implement the analysis approach. This stops anyone from claiming that the approach is in any way a black box.

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The RBI information is added to the IDMS database of the selected equipment, where additional value can be gained by the Operating business. This is an open, respectful, scientific method that is an auditable, transparent analysis.

XVIII. TRANSPARENT AND ADAPTABLE

Because of this transparency and flexibility, we can incorporate already existing information and systems used, such as DNV Phast software or ALOHA®. This is part of the United States Environmental protection agency CAMEO® software. ALOHA® is the hazard modelling program for the CAMEO® software suite, which is used widely to plan for and respond to chemical emergencies. Also, Hazard and Operability (HAZOP) study, MOC's, and Hazard Identification Studies (HAZID) can be stored correctly for future use.

XIX. QUALITY MANAGEMENT FRAMEWORK (SUGGEST THIS IS THE LAST SEGMENT PRIOR TO THE CONCLUSION)

Using a quality management system (QMS) approach the following steps are taken.

PART A - TOWARDS COMPLIANCE

Step 1 Foundation: Pressure Equipment Integrity Strategy document outlining the legal requirements of pressure equipment (including PSVs) which are in the facility/s to be compliant to National Regulations as well as Health and safety regulations. Senior management sign-off of this Pressure Equipment Strategy with agreed resources is required to meet these requirements.

Step 2 Initial kick-off: constructing procedures on agreed goals, standards to work to, company policies etc. Commitment to National compliance regulations and safety standards (e.g., AS 3788).

Step 3 Data collection: plant audit and database entry. P&IDs, PFD's design drawings. Missing items, repairs and equipment replacements, MDRs and process chemistry.

Step 4 Review Data:

a: (If no or very limited inspection reports available) Inspection data collected on the pressure equipment, reports reviewed, and ITP scope updated as well as next inspection date confirmed. Overdue/missing inspections to have CMMS updated to perform inspections as soon as practical.

b: (If multiple inspection reports are available for pressure equipment, then these can be considered for RBI) Continue to Part B.

PART B START OF THE RBI ASSESSMENT (IF REQUIRED)

Note: This Part cannot be implemented until statistically significant evidence has been collected on the pressure equipment which RBI is required to be applied.

Step 5 RBI Pilot: Agreement on RBI standard to be used, 580, 581, DNV, Rimap.

Select pressure equipment which has high potential fracture/failure mechanisms or requires to remain in-service for as long as practical to maximize production.

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Step 6 RBI corrosion circuits: Review and update Corrosion circuits (these are required for compliance), showing damage mechanisms constructed (as per API584 if required). Missing process information/pressures and temperatures and process chemistry to be updated.

Step 7 RBI analysis: Semi-quantitative RBI analysis carried out by RBI team.

Step 8 RBI results: RBI results with ITPs reviewed/updated, the timing of next inspection requiring CMMS inspection PM's timing to be updated.

Step 9 RBI Continuous Improvement: Continue inspection process, review reports, update ITPs and next inspection date, and repeat with continuous improvements. Consider next priority pressure equipment to have RBI analysis applied to.

XX. STANDARDS USED.

Compliance requires use of the local regulation specified standard or if no standard is specified then recommend implementing the requirements of AS3788 and associated standards. Most countries shall have a "Workplace Health and Safety" regulation which requires Operating companies "to provide a safe workplace". The best way to provide a "Process safe workspace" of mechanical pressure equipment is to follow the requirements of the AS3788 and associated standards.

Any RBI standard the customer requires can be utilized (national constraints can be accommodated), i.e., API 580, API 581, API 584, ASME-PCC-3, RIMAP and the "Red book" plus other standards have been used in our methodology. API is great for petrochemical plants such as refineries; however, it runs a little short for most other sites. It may fall short for your industry, your national standard, or other international standards that you are already using.

You may already have the personnel, well experienced in dealing with your niche-specific industry and your plant, and you should utilize them first.

XXI. QUALITATIVE V QUANTITATIVE.

The outer edges of the qualitative/quantitative scale are pure qualitative (no calculations used) and quantitative (pure mathematical algorithms), with anything in between being regarded as semi-quantitative. It could be argued that all of the RBI analysis tools fall into the category of semi-quantitative.[9] API 580[9] states that a spectrum of complementary risk analysis approaches (qualitative through fully quantitative) can be considered as part of the inspection planning process.

It is also important to understand the difference between precision and accuracy when it comes to risk analysis. Accuracy is a function of the analysis methodology, the quality of the data, and the consistency of application, while precision is a function of the selected metrics and computational methods.

API 580 states that "risk presented as a precise numeric value (as in quantitative analysis) implies a greater level of accuracy when compared to a risk matrix" (as in a qualitative analysis). In fact, the use of a risk matrix implies some qualitative element has been used. However, the implied linkage of precision and accuracy may not exist because of the element of uncertainty that is inherent with probabilities and consequences. So, what is the point of this distinction between accuracy and precision? A good quality quantitative analysis is yet to be seen in oil and gas.

XXII. BESPOKE AND CUSTOM

Traditionally coded RBI systems are not easy or quick to implement and usually take years to fruition. Bespoke and Custom are not slower; it just means it fits. This is a co-built system where our customers are asked what they want. It is not a “one size fits all” off-the-shelf solution. But it will fit and grow and evolve with your team and your business. Using the “low-code platform”, your team will be able to find data fast, more accurately and efficiently than before. We have already helped build systems like this that our customers love and find the single point of truth much more efficient. From that single point of truth, many other factors can be seen at play.

XXIII. CONCLUSION

We have proven over several years that it is possible to construct an IDMS and RBI analysis tool using international standards with a quality control methodology over a wide range of equipment.

We did all of that without paying for an RBI package and license fees and claimed no IP for the work done. The work is easily updated (as per API 580) and provides a single source of truth for all users. We also plan, analyze and store all of the required data and documents for government audits and produce an efficient, effective Integrity Management tool and RBI system.

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XXV. AUTHORS

First Author – John Fletcher, Principal Integrity Engineer, RPEng (Environmental) CMEngNZ, IntPE, APEC Engineer, CEng MIMMM (UK)
Second Author – Tony Sovar, Lead Rotating Equipment & Reliability Engineer, CPEng.
Third Author – Mukund Ramanan, Senior Integrity Engineer, MEngg Tech.

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