RISK BASED INSPECTION

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ABSTRACT

Risk analysis as a concept, has been used in developed countries for a long time. Risk Based Inspection (RBI) programs have generated considerable interest in industry, but not yet in Croatia and neighbouring countries.
RBI is not exclusively an inspection activity, and requires the involvement of various segments of the organisation such as engineering, maintenance and operations departments. Implementation requires the commitment and cooperation of the total organisation !
Implementation of a Risk Based Inspection program extends the operating life of equipment, on safe and cost effectively way. RBI is accepted as good engineering practice for the implementation of inspection and maintenance programs and has its roots in Process Safety Management and Mechanical Integrity programs. In article, the objective, principals and practices of Risk Based Inspection are demonstrated and explained.
Main goal for this paper are to explain engineers, inspectors and managers who would like to understand what Risk Based Inspection is all about, what are the limitations and benefits, and how inspection practices can be changed to reduce risks, save costs without impacting safety, but even improve it.

1.INTRODUCTION

Risk based inspection, (RBI), is fast becoming the oil and gas industry standard mechanism for risk management of equipment integrity issues.
API RP 580 is one of the first national/international standards to have been published on this topic, and it is intended to supplement API 510 Pressure Vessel Inspection Code, API 570 Piping Inspection code, and API 653 Tank Inspection, Repair, Alteration and Reconstruction.
These API inspection code and standards allow owner/user latitude to plan an inspection strategy and to increase or decrease the code designated inspection frequencies based on the results of a RBI assessment.

Purpose of RBI programe

The purpose of a RBI programme is to; screen operating units to identify areas of high risk, estimate risk value, prioritise the equipment based on the identified risk, design an appropriate inspection programe, sistematically manage the risk of equipment failures.

Expected outcome

Important outcome from the application of the RBI proces should be the linkage of risk with appropriate inspection or other risk mitigation activities to manage the risk. The RBI proces should generate a ranking by risk of all equipment evaluated, and a detail description of the inspection plan to be employed for each equipment item. ...

Key elements that should exist in any RBI program

Management systems for maintaining documentation, personnel qualification, data requirements, documented method for probability of failure determination, documented method for consequence of failure determinantion, and finaly documented methodology for managing risk through inspection and other mitigation activities

The types of pressurised equipment and associated components include: Pressure Vessels, piping, storage tanks, rotating equipment, boilers and heaters, heat exchangers, preasure relief devices.

Structural systems, electrical systems, instrumentation and control systems, and machinery components (except pump and compressor casings) are NOT covered in RBI projects and appropriate standards.

Inspection Optimisation

Curve in Figure 1 presents reduction in risk that can be expected when the degree and frequency of inspection are increased. The upper curve represents a tipical programme. Where there is no inspection, there may be a higher level of risk, as indicated on y-axis. As inspection is increased, risk is significantly reduced, until a point is reached where additional inspection activity begins to show a diminishing return. If excessive inspection is

applied, the level of risk may even go up.
The key to developing an optimised inspection procedure is the ability to assess the risk associated with each item of equipment, and than to determine the most appropriate inspection techniques for that piece of equipment. This is illustrated by the lower curve in Fig.1, indicating that with the application of an effecting RBI programme, lower risk can be achieved with the same level of inspection activity. This is because, trough RBI, inspection activities are focussed on higher risk items and away from lower risk items.
Risk cannot be reduced to zero solely by inspection efforts. The residual risk factors for loss of containment include, but are not limited to the folowing: human error, natural disasters, limitations of inspection method, design errors,and unknown mechanisms of deterioration,..

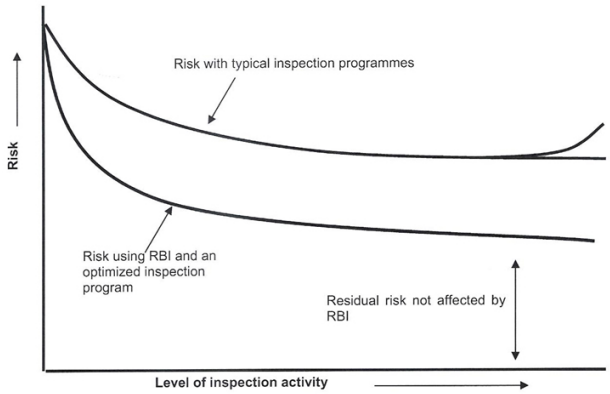

Figure 1: Management of Risk using RBI

2.METHODS

RBI is a system used to determine the probability of failure (POF), and the consequences of failure (COF). The likelihood and consequences are combined to produce an estimate of risk.
Risk = Likelihood of failure X Consequence

•Probability
- failure per year
- need to understand failure cause (at what point it fails).
•Consequence
- fatalities or cost.
- need to understand failure mode (how it fails, what will result from failure).
It groups static equipment (piping system, vessels and tanks) into High, Medium and Low inspection risk. This permits the elimination of unnecessary inspections, the postponement of certain inspections, and prioritization of essential inspections.

3.RESULTS

•Screen operating units within a plant to identify areas of high risk.
•Estimate a risk value associated with the operation of each equipment item
•Prioritize the equipment based on the identified risk
•Design an appropriate inspection programme
•Systematically manage the risk of equipment failures.

Expected results from the application of the RBI proces should be the linkage of risk with appropriate inspection or other risk mitigation activities to manage the risk.
RBI proces should generate a ranking by risk of all equipment evaluated. It should also generate detailed description of the inspection plan, to be employed for each equipment item, defining inspection method, extent of application, timing of inspection, risk management achieved through implementation of the inspection plan.

Essential elements of inspection planning based on risk analysis from the RBI proces are depicted in simplified block diagram shown in Figure 2.

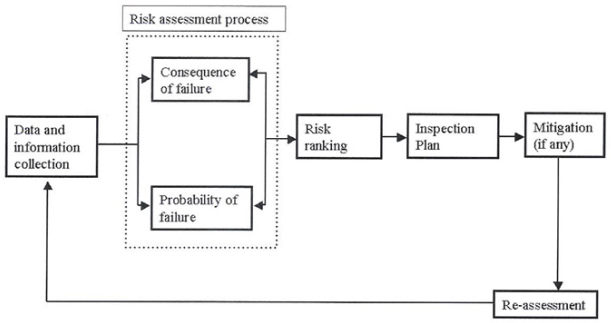

Figure 2: Risk – based Inspection planning process.

RBI assessment normally includes review of both POF and COF, for normal operating operating conditions, but start up, shutdown conditions, as well as emergency conditions should also be reviewed.
Systems with cyclic operation such as reactor systems should consider the complete cyclic range of conditions, while thay could impact the probability of failure due to some deterioration mechanisms (eg. Fatigue, thermal fatifue, corrosion under insulation, ..)

4.DISCUSSION

RBI is both a qualitative and quantitative process for systematically combining both the probability of failure and the consequence of failure to establish a prioritized list of pressure equipment basis total risk.Three levels of risk based inspection have been developed by API for prioritizing risk levels associated with individual pieces of pressure equipment. Level I Qualitative RBI which utilizes a simple, single-screen format to risk rank process equipment into a five by five risk matrix. Level II Semi-quantitative RBI, which is an intermediate method of quantitative RBI (Level III). Level II also uses a 5 X 5 risk matrix for displaying risk analysis results.

Level III Quantitative RBI which is more detailed (and more accurate) method of risk ranking individual pieces of equipment in a process unit. Level III calculates a specific consequence score, a specific likelihood of failure score and a specific risk score for each piece of equipment in a process unit. Typically, the user is expected to utilize Level III analysis for equipment that ranked up into the higher risk categories when prioritized by Level II analysis.

A risk assessment involves first establishing the current and anticipated condition of the equipment, by asking the following questions:
•What material degradations have been experienced or could be experienced?
•What are the likelihood (probabilities) of these degradations occurring?
•What are the consequences of these degradations?

Measure for consequences of failure usualy are costs, or affected area.
Consequence effect categories are; flamable events, toxic releases, releases of other hazardous fluids, environmental consequence.

The data from likelihood and consequences analysis can then be combined to produce an estimate of risk for each equipment item and piping system. The risk factor can then be ranked and used to determine inspection schedules.

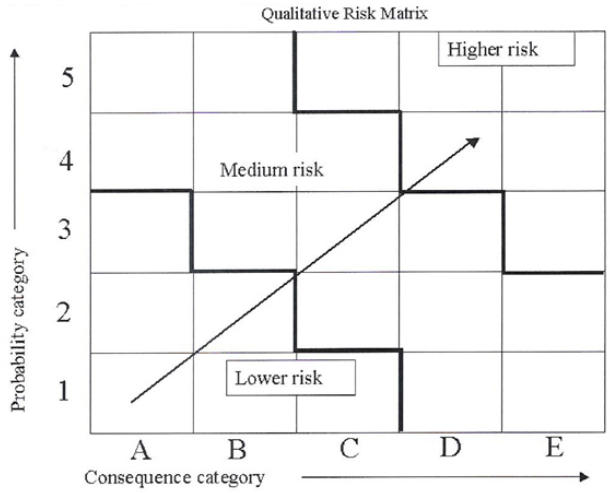

Figure 3: Example risk matrix using probability and consequence categories to display risk ranking.

RBI is Risk Based Management

RBI is really RBM (Risk-Based Management); though RBI is focused on risk mitigation through inspection activities, its application is much broader. Since RBI is a fully integrated methodology, the user also has the opportunity to reduce risk by means other than changing the inspection program. There may be a number of opportunities to strengthen process safety management systems and procedures.

Benefits

•Improved health and safety management
•Avoiding unnecessary inspection
•Cost saving – Equipment with no history of problems and no anticipated problems is inspected on longer intervals rather than just inspecting every few years as is the case with a time-based inspection program.
•Information from inspections on one piece of equipment can be utilized in determining the inspection intervals and scopes for similar equipment.
•The RBI program is totally dynamic: risks are updated after inspections or even the inspection of similar equipment
•The methods used to determine the inspection intervals and inspection scopes are documented and repeatable.
•Reliability and compliance with applicable Codes/ Standards
•Increasing plant availability and optimum repair and replacement scheduling
•Extended plant and equipment life

5.CONCLUSION

RBI provides a logical, documented, repeatable methodology for determining the optimum combination of inspection frequencies and inspection scopes. RBI objective is to ensure focus of inspection to areas with high risk, while inspection in areas with low risk will be reduced or excluded from the normal inspection program and therefore result in significant inspection and maintenance cost reduction.
Utilisation of RBI would be very helpful for Croatian Industry, because managing risk, and costs of inspection and understanding deterioration mechanisms, and mitigation procedures, would be developed.
Implementation of RBI would help in improving helth and safety, and minimize risk of environmental hazards, and develop documented system which can be constantly developed and improoved.
The managers knowledge about (RBI) would be very appreciated since it will allow application of RBI for the benefit of the safety and their owen benefit in saving of maintanance in industry and production. That must include some training of personell and slight changing of the procedures and responsibilities in quality system.

6.REFERENCES

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