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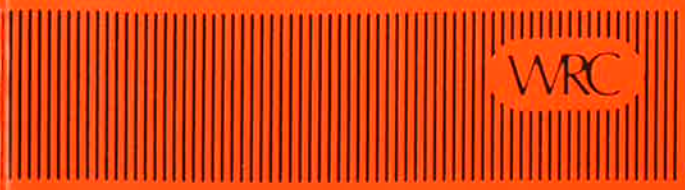

Welding Research Council
bulletin

THE ROLE OF WELDED JOINT VULNERABILITY AND VARIOUS DAMAGE MECHANISMS ACTIVE IN PROCESS AND PETROCHEMICAL PLANTS: RELIABILITY ANALYSIS WITH RISK BASED INSPECTION (RBI) APPROACH

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The Role of Welded Joint Vulnerability and Various Damage Mechanisms Active in Process and Petrochemical Plants: Reliability Analysis with Risk Based Inspection (RBI) Approach

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FOREWORD

With growing regulatory acceptance, industry is now applying the concepts of risk-informed decision making, especially in the area of in-service inspection i.e. risk-based inspection (RBI). It is no secret that welds are principal areas of concern, are potentially subject to complex failure modes, and generally inadequately understood. However, RBI must be done using defensible, systematic approaches that yield reasonably uniform results independent of the performing party, often an outside vendor.

Often today there are wide variations in the work products. RBI requires modeling damage accumulation and consequences. Some good work has been done. However, caveat emptor – buyer beware – with the buyer at a serious disadvantage. It is the responsibility of the owner/operator to ensure that underlying assumptions and technology are capable of producing reliable RBI results and predictions.

RBI must sit on a strong technical foundation of models and accompanying documented technology. Data acquisition and analysis require rigor. Responsible engineers must do an effective job of identifying, predicting and quantifying potential damage modes and contributing factors. NDT is in need of major upgrading and understanding in consideration of the unique failure modes associated with welds. Damage models, materials properties and consequence models must be justified. Computerized assessment procedures must be continuously improved, updated and the underlying technology made more transparent. Terminology must be uniform and fully understood.

This WRC Bulletin *The Role Of Welded Joint Vulnerability And Various Damage Mechanisms Active In Process & Petrochemical Plants: Reliability Analysis With Risk Based Inspection (RBI) Approach* is an important reference work in the process of assessing weld reliability. It provides an in-depth look at the approach to RBI of WRC's sister organization, Istituto Italiano Della Saldatura in Genoa, Italy with extensive experience in the area

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Executive Director

Welding Research Council

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ABSTRACT

Most equipment in process plants and energy production is fabricated by welding. Welding is also extensively used to repair, modify and overlay plant equipment during shutdowns. The statistics of failure show weldments to be one of the most vulnerable areas. Risk Based Inspections (RBI) methodology in the area of asset integrity and risk management focuses on prioritizing and optimizing inspection strategies and should look at the vulnerability of welded joints taking into account mechanical behavior, and damage mechanisms including corrosion and stress-corrosion degradation. This WRC Bulletin provides a survey of the interaction between potentially active damage mechanisms and welded joints and describes the RBI approach to rank the criticality of such an interaction for the purpose of inspection and risk management.

1 INTRODUCTION

This WRC Bulletin was written with the aim to present an overview of the possible influence that the welding process, which has historically been essential to the manufacture of pressure equipment, may have on reliability during the life cycle of process plants.

Welding technology has played a significant role in the stormy technological development of recent years. The improvement of welding techniques allows not only for the sudden increase in the size of plants, but also for the development of completely new designs. On the other hand, it is not surprising that with such development, material and manufacturing problems have been encountered, especially with the new and high performance materials which are more sensitive to the presence of a welded joint (i.e. Cr-Mo-V low alloy steels, duplex stainless steels, nickel alloys, etc.).

In such an industrial context, it has been seen that the recently developed, complex pressure equipment risk management and monitoring tools have to deal with the presence of welded joints and with all the problems they entail in terms of reliability and inspection issues. The interest in such asset integrity management tools for pressure equipment has been mainly dictated both by the progressive and inevitable aging of process plants, and by the growing awareness of safety, financial savings, and environment-related issues.

The Risk Based Inspection (RBI) approach is the methodology for assessing, monitoring and mitigating risk that most takes into account the complexity of the chemical and physical aspects of the multiple, and often synergistic, damage mechanisms active in process plants. It also takes into account the best inspection methods to evaluate these mechanisms in the field, while trying to move forward along these lines as quantitatively as possible.

In the early days of Risk Based Inspection the term risk-informed inspection was sometimes used. This was first introduced by the US Nuclear Regulatory Commission in order to emphasize the link – but not a direct correlation – between risk and inspection. If risk based inspection is understood to be inspection planned on the basis of information obtained about the risk, then the two terms are synonymous.

Generally speaking, Risk Based Inspection involves the planning of an inspection on the basis of the information obtained from a risk analysis of the equipment. Within this article, the term inspection refers to the planning, implementation and evaluation of examinations to determine the physical and metallurgical conditions of equipment in terms of Fitness-For-Service (FFS). On the other hand, the purpose of risk analysis is to identify potential degradation mechanisms and threats to the integrity of the equipment, and to assess the consequences and risks of failure. The resulting inspection plan can then target the high risk equipment and can be designed to detect potential degradation before FFS is an issue.