

Review: Advance of Well Integrity Management

David Ernesto Castellanos Barajas
EMSEP-HOKCHI

Libramiento 2 bocas S/N, Col Limón, Paraiso
CP 86600 Tabasco México

Javier Alexander Suárez Barajas
Universidad Autónoma Metropolitana-
Azcapotzalco

Av. San Pablo #180, Col. Reynosa-Tamaulipas
, CDMX, P.C. 02200
México

Ludwing Alfonso López Carreño
ECOPETROL S.A

Km 7 Vía a Piedecuesta - Santander
Piedecuesta / Santander
Colombia

ABSTRACT

Well integrity is becoming one of the most relevant issues in Oil & Gas industries, requiring the integration of multidisciplinary teams in areas of subsoil operation, corrosion engineering, maintenance, and production to define and apply the integrity management strategy.

Until 2013, the reference in well integrity had been the NORSOK D010 standard, which describes the minimum requirements for operation and performance of the well integrity barriers in the whole life cycle of the asset. On the other hand, operating companies have generated better management practices that were consolidated in the ISO 16530 standard issued in 2017. It was promoted after the Macondo well tragedy in the Gulf of Mexico and became the mainstay of well integrity management.

This work does a descriptive review of corrosion, materials, and risk papers within the well integrity management with two objectives. Firstly, to be a tool for the advancement of knowledge, dimensioning the barriers of the implementation of strategy, and describing some available gear. Secondly, to establish requirements for risk assessment and management with generic guidelines to allow the quantification of risk and mitigation actions, and so help the continuous improvement of the well integrity according to the conditions of design, construction and operation.

Key words: Testing Facilities; Well Integrity; Risk Assessment; Failure Analysis.

INTRODUCTION

Well integrity management is based on the fundamental principle of the continuous search for technical, operational, and organizational solutions, aimed at reducing the risk of uncontrolled fluid discharges

throughout the life of the well. The normative base is contained in the Norsok D-010 ¹ and ISO 16530 ^{2, 3} standards.

Well integrity management started its regulatory process with the NORSOK D10 standard, which is still in force. This standard clearly describes the concept of barriers and the trees of possible events, avoiding the presence of an uncontrolled discharge. This standard was developed by the Norwegian oil industry, although it was scarcely implemented by the oil and gas industry until 2010, the date of BP's Macondo failure.

After this event, most oil companies began to look at well integrity management as a fundamental asset to guarantee the sustainability of operations. Thus, starting a process that continues to evolve with a long way to go and, above all, many environmental liabilities to be resolved throughout the useful life of the wells.

During the years of this process, companies have been carrying out their own in-home developments for the management of well integrity, these are basically based on two visions:

- The first vision was based on the guidelines for the integrity management of surface equipment, where a risk-based inspection methodology was transferred to this asset. It began with the prioritization of wells according to relevant variables (corrosion, production, location, etc.). Then, it focused on the high impact wells. A risk analysis of failure probability was performed based on the event tree methodology used in root cause analysis. Finally, the mitigation and monitoring strategy was established.
- The second vision focused on evaluating the structural integrity of the well barriers with intrusive inspections in the field (measurement callipers). These contribute to establish the maximum permissible operating pressures in each of the wells, then perform surface monitoring of the pressure conditions in the annulars to monitor loss of each of the barrier containments. These conditions are extrapolated to similar wells. After that, the risk level criteria are established based on the pressures of the different monitored annulars on the surface.

Both guidelines improved the control of the different damage mechanisms that affect the integrity of wells. However, the design of international standards was promoted due to the global impact of the Macondo well accident in the Gulf of Mexico. The most relevant contributions were compiled in the ISO. Under these standards, the general guidelines were established to guarantee the well integrity during their entire life cycle; and as per the ISO 16530 standard, well integrity was implemented ^{2, 3}.

Other important normative standards in well integrity management are discussed in their applicable context in Wilson's work ⁴.

Well Integrity Management System (WIMS) should be seen as an applied model to the prevention of failures. These multiple methodologies for evaluating the past, present and future of the asset must be implemented in ^{1, 2, 5, 6, 7}.

This research presents a review of the studies that have been carried out in the management of well barrier failures.

WIMS DEVELOPMENT

Well integrity has always been looked for, being addressed as a philosophy that is involved in the entire life cycle of the asset. However, that philosophy is not united in a short term and it requires structured and systemic work to ensure it as an integrated process into the organization. In Colombia, ECOPETROL (Empresa colombiana de petróleo) has been working on this purpose for more than 12 years. When the

need to establish strategies that would ensure the integrity of the most important asset (the well) was visualized, the first thought was to establish a risk identification and assessment methodology through the implementation of the principles that leveraged this activity for surface infrastructure. Which means following the guidelines of international norms and standards such as the Norsok D010 standard. Although it had its application niche in offshore wells and its centre has been focused in the double barrier concept in all faces in well run life, its context can describe the minimum requirements for operation and performance of well integrity barriers at all stages of the asset's life.

This methodology was developed and implemented in the wells of the different managements of Ecopetrol throughout the Colombian geography. A semi-qualitative analysis of the main variables that affected the well integrity was basically carried out there. However, it was not until 2018 when it was possible to strengthen an entire strategy of Well integrity driven by senior management due to two important events. First, an internal event affected the well integrity, and secondly, an international guideline was established by the ISO 16530 standard issued in 2017. After this group force consolidation, it was possible to structure a solid work team with roles and responsibilities with representatives in the different operational areas. It finally began to visualize the expression of well integrity management as part of the tactical and operational processes.

Among the principles to materialize the basis of the well integrity strategy are:

- Guide definition of the well integrity management system (WIMS).
- Structuring a work team with leadership from the tactical and strategic direction and leaders of underground integrity in the operational areas with role definitions and responsibilities and establishment of performance indicators.
- Standardization of the risk assessment methodology and identification of the risk baseline for each of the company's wells. This methodology allows establishing the failure probability of well barriers in a semi-quantitative technique, the occurrence probability of an uncontrolled discharge event, interpretation of the possible consequences, qualification of the risk level, and definition of mitigation actions.
- Strengthening of competences in strategic and operational issues to monitor, control and ensure the well integrity.

In the immediate and medium-term future, it seeks to lay the foundations of this process throughout the company and continue to ensure the positioning of this philosophy with the strengthening of the competences required in all the personnel involved, as well as looking for the risk assessment with more quantitative analysis and well integrity control and assurance definition strategies.

Asset management focuses on controlling the failures present in the assets through the implementation of methodologies that allow their optimal management, Figure 1.

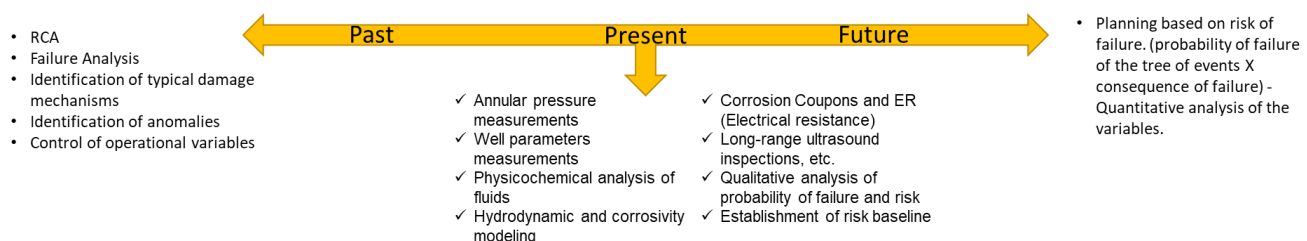


Figure 1: Methodologies for asset failure management.

WELL INTEGRITY MANAGEMENT GUIDELINES