

Robust Well Barrier and Well Integrity Management

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There is an increased focus and emphasis on managing well integrity with smarter, more integrated and cost-efficient tools, systems, and solutions.

The words “well integrity” and “digitalization” have become common buzzwords in the oil and gas industry. Many discussions have centered on combining these words to create better solutions to safeguard our wells. However, how do we measure well integrity in the most effective manner? And what do we measure well integrity against?

To start with, we need a clearly defined yardstick or basis for measuring the integrity of our wells. We need to know what is in the well. Furthermore, we need a set of parameters to measure against.

A principle objective is to define the well barriers and to visualize how to best safeguard our wells to reduce risk and avoid accidents. This can be done by using an integrated well integrity management system that includes—as a foundation—clear and consistent well barrier illustrations and tables containing information of each well barrier element. This is the logical starting point for creating and retaining well integrity.

It is important to understand that the technical well barriers play a vital part in managing well integrity and reducing risk. Figuratively speaking, 90% of well integrity is about the technical well barriers, which have the capability and strength to contain pressure and hydrocarbons. The organizational, operational, and functional solutions are merely the “lubricants” in the “machinery” that help make the wheels turn in achieving and maintaining well integrity.

Well barrier elements alone cannot hold anything in place. However, when these are placed together as a chain of components, they will form an envelope that can withstand the pressure.

Two-Barrier Philosophy

One of the principles that is applied to mitigate risk is the two-barrier philosophy, where you have a primary barrier, which is backed by a secondary barrier. NORSOK, the Norwegian organization that sets standards for the offshore exploration and production sector, defines well barriers as envelopes of one or several dependent well barrier elements that prevent fluids or gases

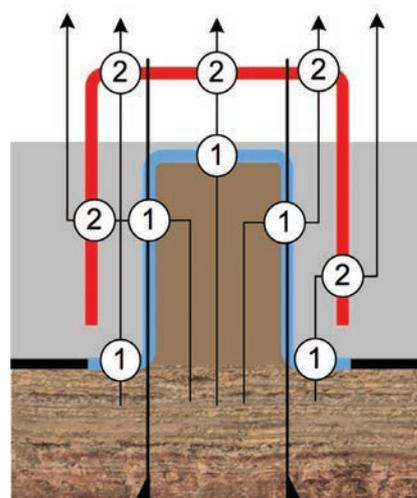


Fig. 1—The two-barrier principle (hat-over-hat arrangement) refers to having two barriers to help operators safeguard well activities and reduce risk.

from flowing unintentionally from the formation, into another formation or to surface.

As part of the two-barrier philosophy, formation pressure is contained by a caprock. The moment the caprock is removed, it needs to be replaced with a primary barrier. This barrier will have to function inside and outside of any casing that is run in the well.

A secondary barrier to support the primary barrier needs to be established. The secondary barrier envelope is independent of the primary barrier. This well barrier prevents flow from a breach of the primary barrier envelope (Fig. 1).

The main benefit of applying the two-barrier principle (the hat-over-hat arrangement) is that whenever pressure escapes from the well, we will always have protection behind us. This provides an assurance of “a belt and braces,”



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He holds degrees in mechanical engineering from Telemark University College and in petroleum engineering from Stavanger University College in Norway.

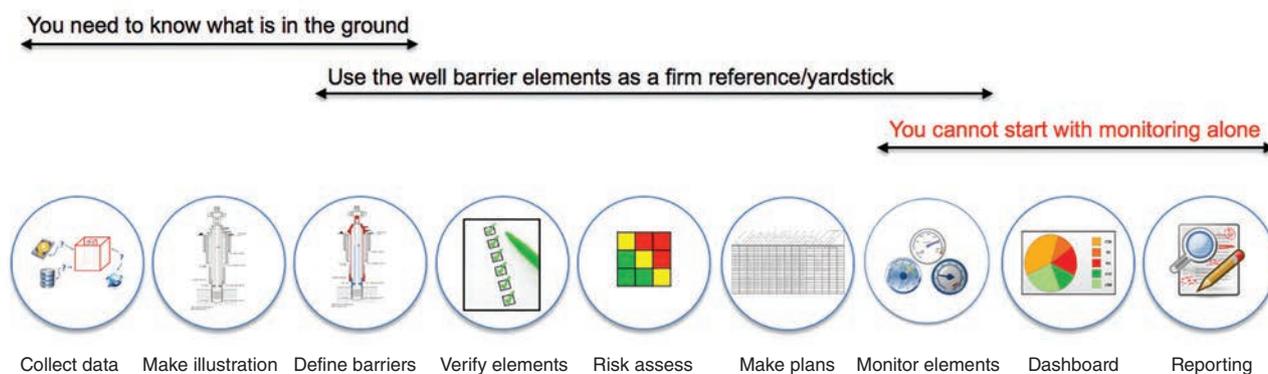


Fig. 2—Build a robust well integrity value chain to manage your wells.

giving us a reliable design to safeguard well activities and reduce risk.

It is important to remember that people make mistakes, equipment will fail, and Mother Nature will trick us from time to time. The two-barrier philosophy will allow incidents to happen without escalating into accidents.

The Well Integrity Value Chain

Managing wells consists of several elements, with well barrier illustrations being used as a core for several outputs in different contexts. As we go through the life cycle of the well, the well barrier elements change as we transit from planning to execution, then to operation, to intervention, and finally to plug and abandonment. An integrated well integrity value chain is required.

The first step toward effectively managing wells is to know what is in the ground. Obtaining this knowledge is done via collecting data, creating well barrier illustrations, and defining your barriers.

Engineers at any time of the well's life cycle should understand and see what barriers are put in place. The objective is to reduce risk and give stakeholders a clear and common understanding on how to maintain the integrity of their wells. Having clear and consistent well barrier illustrations in one common digital repository will help all discipline engineers to visualize, communicate, and document their wells and well integrity.

Secondly, to help you measure the integrity of your wells, you should use the well barrier elements as a firm reference or yardstick. After your barriers have clearly been defined, you need

to verify the well barrier elements, risk assess, and then make plans.

When assessing risk on a portfolio of wells, the critical questions are:

- ▶ What is the actual condition of the wells?
- ▶ What can go wrong, and what are the consequences?
- ▶ How should you prioritize risk reduction?

There are some critical challenges to risk assessment. "Risk" is not an exact science. Furthermore, the number of subjective factors in traditional risk analysis can be challenging. Make sure that you have a risk assessment tool that removes subjectivity from risk assessment by using the well barrier elements as the basis for evaluation. Make use of a failure mode, effects and criticality analysis to identify—component by component—what, precisely, can go wrong, and what the possible consequences are.

Finally, you cannot start with monitoring alone. When you know what is in your wells and you have your well barrier elements as a firm reference, then you can begin monitoring your well barrier elements. Then, you can communicate information available to all stakeholders, and have reporting mechanisms in place (Fig. 2).

The foreseen outcomes of this integrated well integrity management approach will be that organizations will

- ▶ Spend significantly less time when searching for well information
- ▶ Know and understand where to find the latest and most accurate well information available in the digital library. All discipline engineers are using the same

repository, so there will be an inherent quality assurance function through active use.

It is important to emphasize that this type of repository will not be the data source of well data. The original data source will often be core engineering programs or databases used by different discipline engineers. These systems will, however, be tied in and the core and shareable data will be available to the end user in an easy and effective manner.

Conclusion

The industry needs to take a holistic view on the process of the well integrity management. This can be achieved by using the technical well barrier envelopes and elements as a logical starting point and having a common digital workspace where we can break down silos. One common digital well integrity management repository will enable well discipline engineers to work together to visualize, communicate, and document their wells and well barrier information, with related qualifying and monitoring requirements.

If we can manage risk in terms of identifying, capturing, predicting, and mitigating the aspect in each of the elements in the value chain, as well as in the wellbore, this will be a step change toward looking at the well and system holistically. The design basis must be safe to operate, reliable, and enabled for future intervention to maximize well potential.

The value of well integrity management is in the technical knowledge. Manage your well barriers, and you manage your business. **JPT**