SPE-231685-MS

# A Decade of Casing Drilling in Argentina: What We have Learned After 3.4 Million Meters and 3,100 Strings Installed

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This paper was prepared for presentation at the SPE Latin American and Caribbean Petroleum Engineering Conference held in Rio de Janeiro, Brazil, 9 - 11 June 2026.



This paper aims to summarize and analyze the operational, technical, and digital evolution of Casing while Drilling (CwD) in Argentina over the past decade. The objectives are to quantify the impact of CwD on drilling efficiency, well integrity, and risk mitigation, drawing on the experience of drilling over 3.4 million meters in both conventional and unconventional fields. The study reviews field data and operational records from major operators with the perspective of the casing manufacturer, covering more than 3100 strings in Vaca Muerta and Golfo San Jorge. This paper includes comparative analysis of conventional versus casing drilling methodologies, with highlights of the most important technical adaptations that enhanced the technology value. The methods also encompass the evaluation of time savings and improvements in wellbore stability. We will dedicate a special attention to the casing connections failures and the methods adopted to reduce them using real-time torque and vibration monitoring powered by artificial intelligence.

Casing Drilling in Argentina has evolved to a mainstream technique delivering consistent value in unconventional reservoirs and mature fields where cost reduction is paramount. Currently, casing drilling is applied in more than 80% of the wells in Vaca Muerta saving from 10 to 24 hours of drilling time. Additionally, casing drilling consistently delivers value through the reduction and elimination of NPTs related to wellbore stability issues when heavy mud losses, influx and other wellbore stability problems are present, saving operators several days of operation. In the Golfo San Jorge basin more than 600 production sections have been drilled breaking records in both depth deeper than 3000m and time savings that reach several days. We will further discuss the technological advancements that have led to a consistent reduction of casing connection failures. Even the technology has proven to be reliable enough to be used in the whole well. In particular we will mention the use of double casing drilling to drill more than 60 wells in a mature field environment. This work presents the first integrated review of a decade-long, large-scale CWD experience in Argentina, highlighting the transition from operational experimentation to digitalized, standardized factory drilling. The adoption of AI-powered real-time monitoring for torque and vibration represents a novel approach to risk mitigation and performance optimization. The lessons learned and technical solutions developed in Argentina provide a roadmap for further efficiency gains and risk reduction in both conventional and unconventional drilling worldwide.

## Casing Drilling in Argentina

The last decade has shown the growth of Casing Drilling in Argentina, in both unconventionals and mature field applications. The following chart shows the evolution of the wells that use Casing Drilling in the last 10 years in the country.

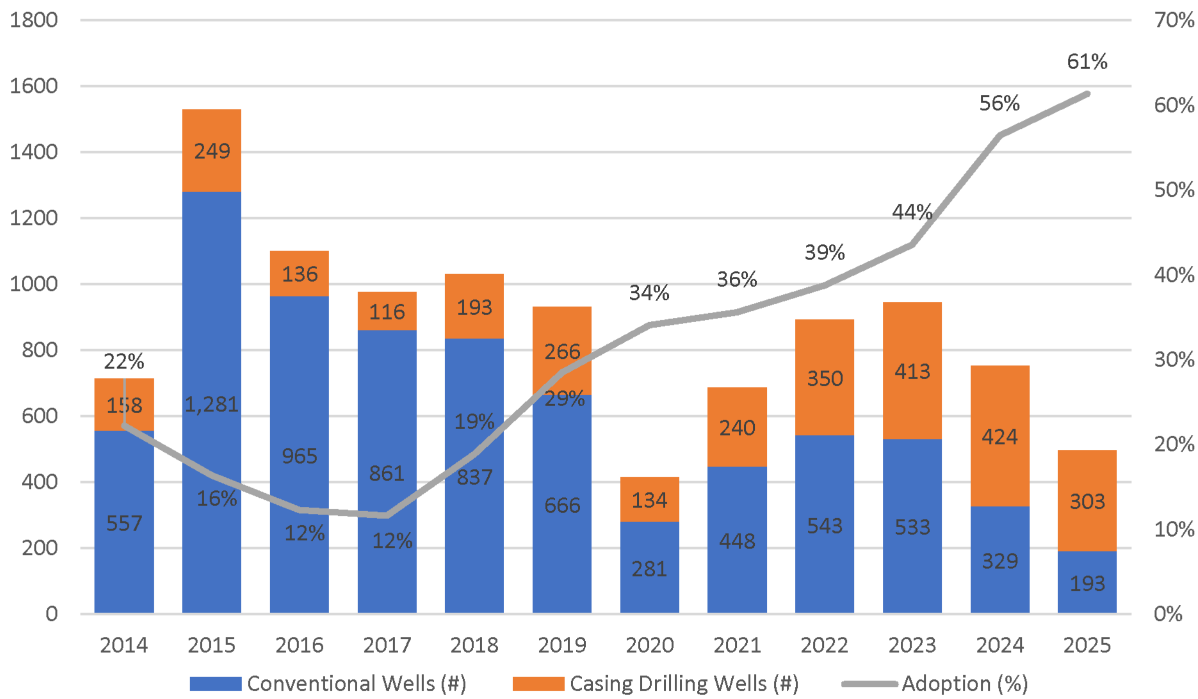


**Figure 1—Evolution and Adoption level – CWD Argentina.**

As you can see the trend has been growing steadily and currently over 80% of operators use this technology continuously. The value delivered by the technology will be addressed in the paper, however there have been key success factors:

- Increased availability of required tools: rigs with top drive, casing running tools, casing drilling bits and reliable casing connections.
- Measurable and deliverable value in terms of time and cost
- Best practices diffusion among industry actors

The challenges that Casing Drilling are different depending on the basins and operators. The first and most important driver was the use to reduce and eliminate wellbore stability issues, such as heavy mud losses, influx in waterflooding (Espinosa, et al. 2019) or wellbore stability in complicated areas. Then its improved reliability allowed the extension to applications with the focus of improving performance to reduce rig time.

## Unconventional Fields Experience – Vaca Muerta Neuquina Basin

Starting in 2016, the technique of Casing while Drilling (CwD) began to be applied in the surface section of shale wells, driven mainly by the need to deepen this section from the original 350 m to depths that currently range between 600 and 800 m, depending on the area and geological characteristics.

This increase in the depth of the surface section has the primary objectives of protecting shallow freshwater aquifers, providing structural support to the well, and isolating loss zones in order to safely drill the intermediate section. In this context, the application of the CwD technique proved to be particularly advantageous, as the savings in time and operational costs are proportional to the drilled depth.

As a result, the technique evolved progressively within the basin and is currently adopted by almost all operators. Adoption rates—defined as the ratio between the number of wells drilled using CwD and the total number of wells drilled—exceed an annual average of 80%. Figure 2 shows the evolution of CwD application in shale surface sections from 2016 to the present.

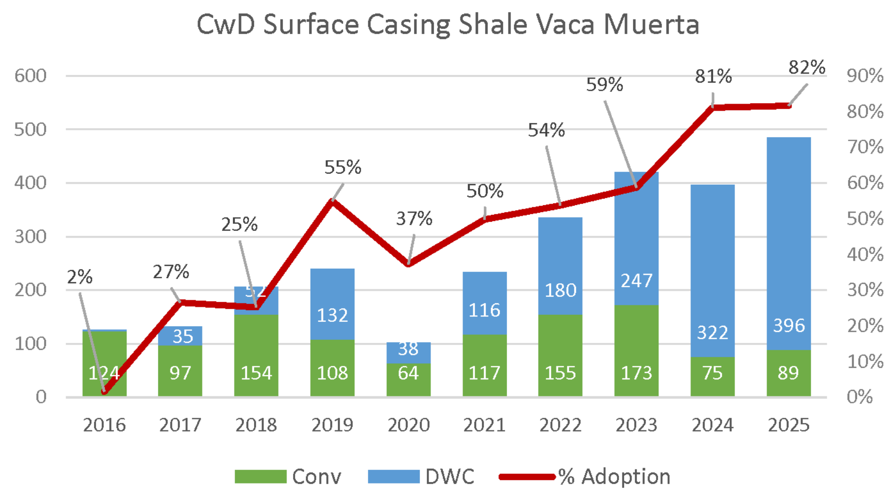


Figure 2—Evolution and Adoption level – CwD surface section in Vaca Muerta.

## Well Schematics

In the Unconventional operation of Argentina, mainly two different well string designs are used: a "robust" design to cover the uncertainties of exploratory, appraisal and extended reach wells, and a "slim" design as the most standard for the rest of oil and gas shale wells.

The difference between them is that, in the robust design the surface casing string is 13 3/8″ OD, while in the slim design the surface casing string is 9 5/8″ OD.

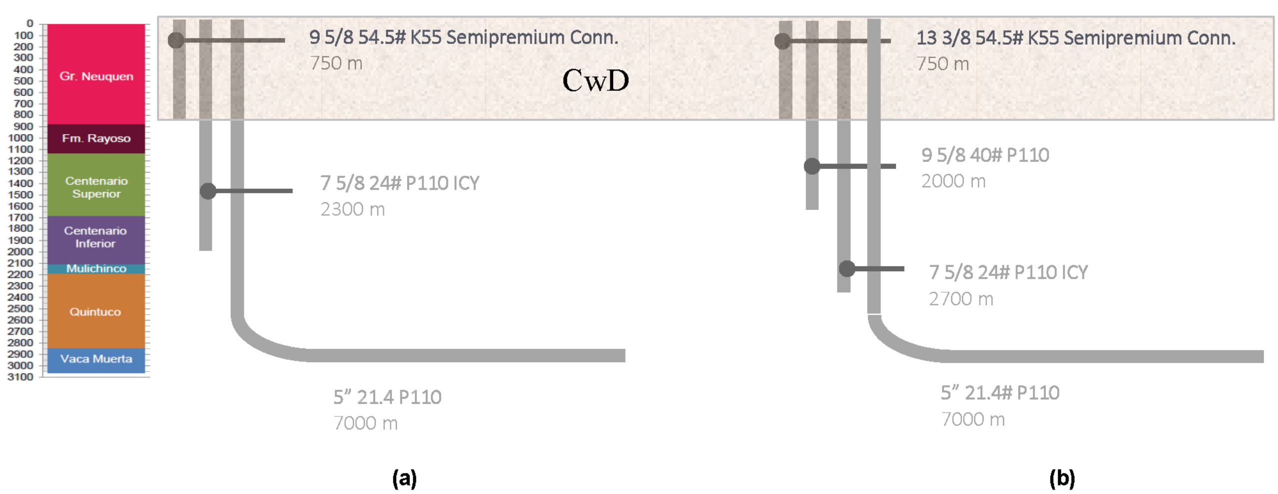


Figure 3—Unconventional Well Designs – (a) Slim, (b) Robust.

## CwD 9 5/8″ Surface Casing

With the exception of a few specific areas with more complex geological conditions, the surface section with 9 5/8″ in Vaca Muerta does not present significant drilling challenges. For this reason, the main objective of applying CwD in this section is the reduction of drilling time and operational costs. Table 1 presents a typical comparison of the time required for conventional drilling versus CwD operations.

**Table 1—Time Savings due to CwD application in surface sections of Shale wells.**

| | DWC | Conventional | Savings (%) |
|---|---|---|---|
| Total Time (days) | 1.16 | 2.91 | -60 |
| General ROP (m/h) | 36 | 24 | +33 |

Argentinian Operators has successfully implemented Casing While Drilling (CwD) technology to optimize the construction of surface sections in unconventional wells, achieving over 60% time savings compared to traditional drilling methods. But, as far as, Unconventional developments include several wells per PAD, the distances between them have been reduced from 12m to 6m in the last years. This change introduces the challenge of maintaining the trajectory of the well as vertical as possible.

In order to avoid collision between wells, it´s necessary to implement a gyro log operation after every drilled section, to measure the deviation and take the correct decision for the next well, whether to drill CwD or with a traditional Directional drilling BHA. In the lasta case, the cost and drilling time is increased.


**Figure 4—Tipical Unconventional 6 wells PAD and final trajectories of surface section (700m avg).**

Some innovative approaches are being studied:

1. The application of robust centralizers to build a "pendular casing BHA" gives the driller the possibility of improve verticality in real time, by changing drilling parameters.
2. Another approach was to take advantage of the already installed 25m deep conductors to apply intentional conductor deviations during location construction to pre-orient well trajectories. This method has shown promising results in reducing trajectory variability and the need for costly directional drilling. Future developments include refining conductor orientation techniques and implementing a complementary casing centralization to further improve trajectory control and operational performance [21].

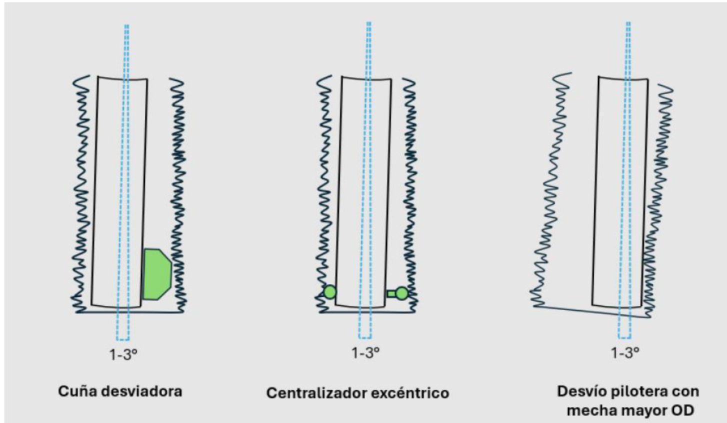


Figure 5—Intentional conductor deviation – different methods.

## CwD 13 3/8″ Surface Casing implementation

Due to the success of the CwD applications in 9 5/8″ Surface Casing strings, some Operators decided to apply the same concept to the robust well design, starting the well with a 13 3/8″ casing string. The static well design required a 13 3/8″ 54.5# K55 casing, to be installed up to 750m depth.

For the CwD operations, although it was known that fatigue loads would be present it was decided to use the same string configuration as the one used for 9 5/8″ string based on an extensive experience of drilling with 9 5/8″ in unconventional fields with a very simple string configuration composed by a standard shoe track (Drilling bit + casing + float collar) plus straight casing to the surface.

The first two wells were drilled with that configuration, applying conservative drilling parameters, resulting in satisfactory operations, reaching TD without any failure.

However, the project needed a faster operation, reaching higher ROPs to comply with the expected economic benefits of CwD. In that direction, pushing for more aggressive parameters (WOB and RPM), two consecutive failure events happened.

Once the string was pulled out of hole, the fishing point was inspected (Figures 6a, 6b and 6c) showing a transversal cut in the last engaged thread of the pin made up in the mill, at the first connection below the float collar.

(a) (b) (c)

Figure 6—13 3/8″ casing failure section, first well.

At first sight, the failure mechanism seemed to be fatigue due to the perfect transversal cut located in the thread. That was afterwards analyzed and confirmed at the lab.

Immediately after this event, the RIG made the skidding to the next neighbor well in the same PAD, Well-#2 to proceed drilling 13 3/8″ section with CwD technique.

Approximately 100 m before reaching TD, a similar behavior was registered, with a sudden loss of penetration and pressure drop.

The casing string was pulled out of hole, and the same kind of failure was observed, at the same position in the string, a transversal cut just below the float collar.

(a) (b) (c)

**Figure 7—13 3/8″ casing failure section, second well.**

The following scheme shows the position of the failures for both wells, and all the samples that were taken and sent to the laboratory for a detailed failure analysis.

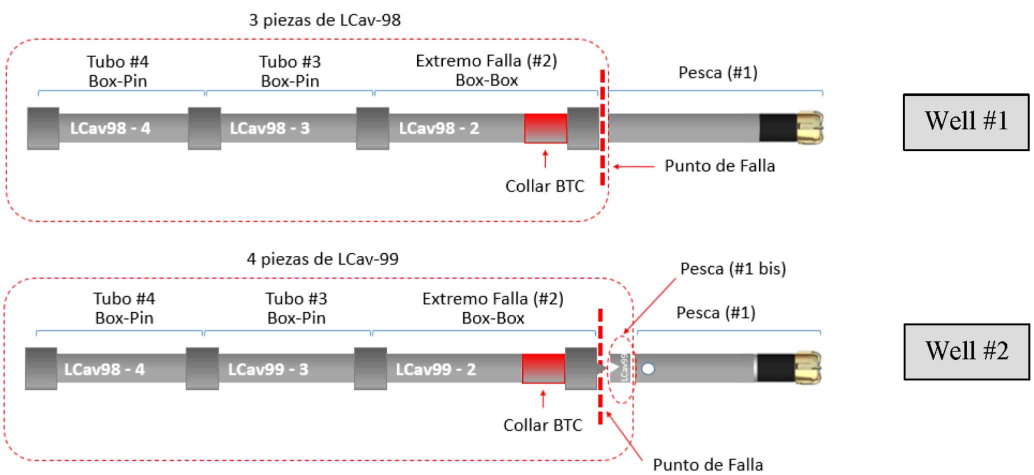


**Figure 8—13 3/8″ casing samples obtained for Failure Analysis.**

Figure 9 shows a longitudinal cut of the failure zone, including collar, coupling and the rest of the PIN engaged. It´s easy to appreciate geometrically how the configuration of collar + coupling is much stiffer than the PIN downwards, generating a stress concentration point.

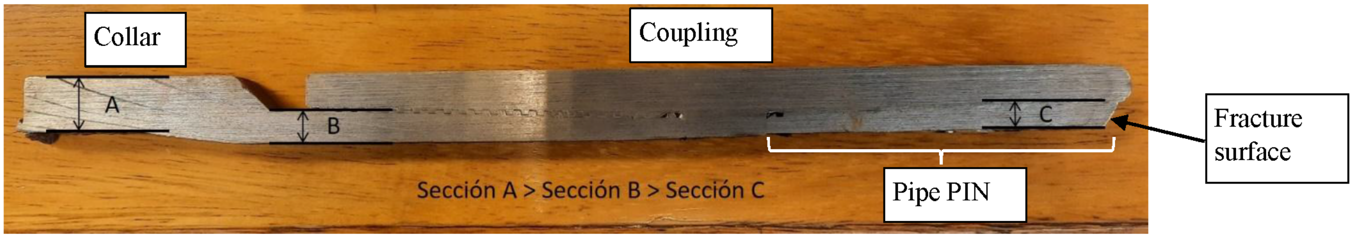


Figure 9—longitudinal cut of the failure zone.

***Lessons Learned.*** Due to the drilling conditions that led to failures, a reevaluation of the string design was needed. Different alternative designs were analyzed, such as the strengthening of the BHA with thicker pipes or hard-faced centralization to increase the stiffness of the string, in order to prevent casing buckling and fatigue.

In order to improve the stiffness of the lower section of the string, and also to reduce the fulcrum effect, two actions were taken:

1. Reduce the distance between drilling bit and float collar to minimize the pendulum effect of the collar and coupling and also avoid a bending stress magnification in that section were failures happened.

   To comply with this objective, the collar was mounted directly above the drilling bit, eliminating the shoe track for cementing. This practice was analyzed with cementing specialists and a special procedure for cement displacement was developed.
2. Increase the BHA stiffness, by adding higher weight casing in the lower 100 m of the string. This action aimed to reduce buckling and let the neutral point inside the thicker casing.

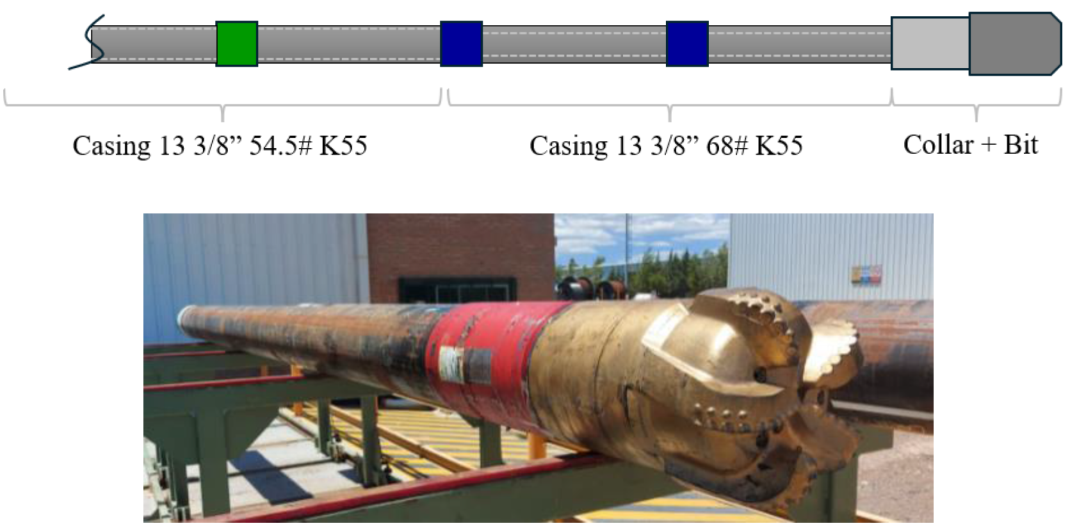


Figure 10—BHA configuration to improve stiffness and reduce bending stress magnification.

***Bit Selection and Casing Connection.*** The selection of a 16″ drill bit, instead of the 17 ½″ bit commonly used in the Neuquén Basin for drilling surface sections to be cased with 13 3/8″ casing, was based on maintaining a casing OD to wellbore ID ratio between 0.80 and 0.85. This ratio is considered optimal to enhance wellbore strengthening and to promote efficient cuttings transport and hole cleaning, particularly in challenging near-surface formations.

## Mature Fields Experience – Golfo San Jorge Basin

### Production Casing

The technique has been extensively applied by an operator in the Golfo San Jorge basin in the south of Argentina for production sections characterized by severe circulation losses, depleted formations, and increasing economic constraints. Since its large-scale implementation in 2015, approximately 600 wells have been drilled using CwD, providing a robust operational dataset for evaluating its performance, limitations, and long-term applicability.

Initial field applications confirmed the potential of CwD to mitigate losses and reduce non-productive time; however, they also revealed several technical and operational challenges. The most critical issues included fatigue and deformation of casing connections under compressive loads, restricted weight-on-bit (WOB) capacity, trajectory control limitations, and high variability in drilling performance. Addressing these challenges required a systematic learning process combining mechanical redesign, refinement of operating practices, and progressive integration of data-driven tools.

A major step change was achieved through the redesign of the Bottom Hole Assembly (BHA), incorporating a reinforced section of Casing Collars and the use of wear resistant centralizers that worked as stabilizers. This solution significantly increased axial stiffness, raised the helical buckling threshold, and improved the transfer of WOB to the bit while maintaining casing integrity. Following implementation and validation through pilot wells and fatigue testing, the new BHA configuration eliminated fatigue-related casing failures in more than 200 consecutive wells and enabled a consistent increase in drilling performance. The following pictures show both the casing collar design and the centralization scheme adopted.

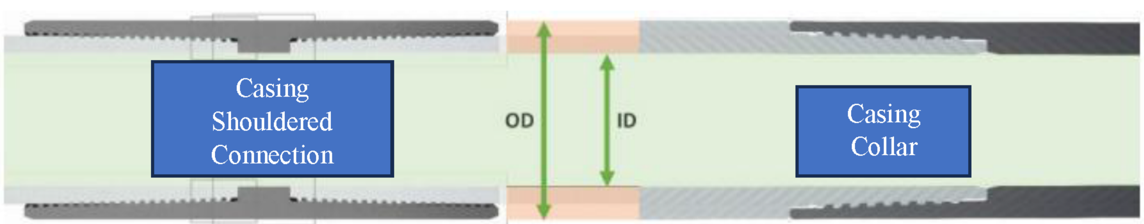


**Figure 11—BHA redesign – Casing collars.**

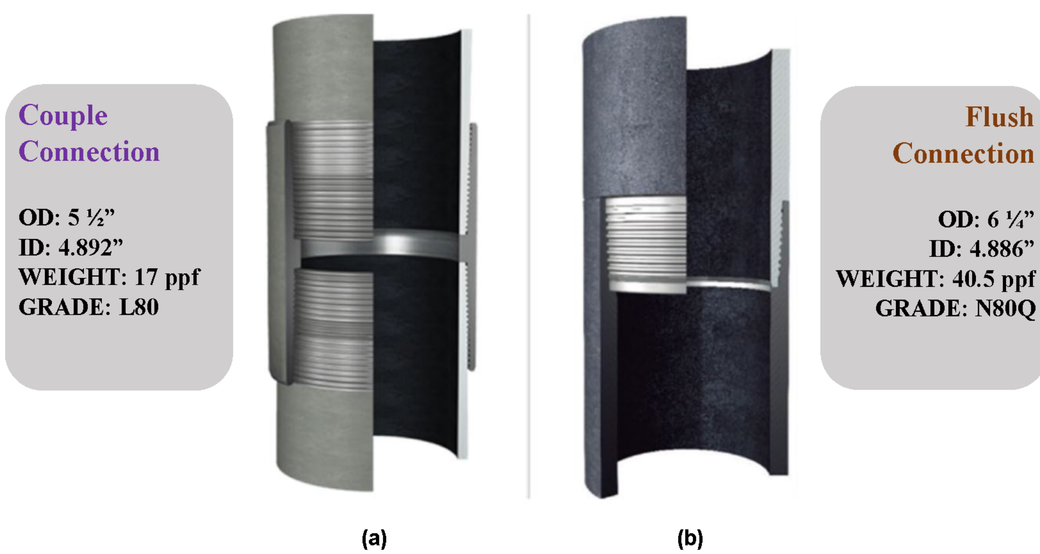


**Figure 12—Connections used for Casing string (a) and BHA (b).**

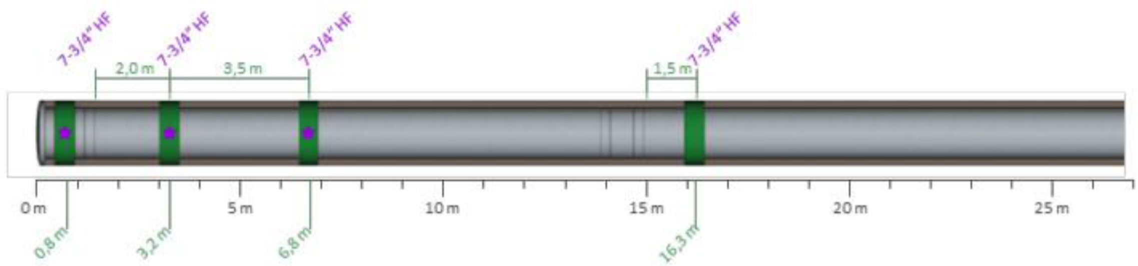


Figure 13—BHA redesign – Centralizers placement.

Directional control, initially a limiting factor due to the absence of conventional downhole measurements, was progressively improved through optimized centralizer placement, preventive parameter management, and the introduction of continuous inclination measurements prior to cementing. This approach allowed a transition from reactive to preventive trajectory control, maintaining verticality within acceptable limits in the majority of wells while sustaining higher rates of penetration (ROP).

CwD also demonstrated clear advantages in terms of cementing quality. The reduced open-hole exposure time, improved annular geometry, and immediate transition from drilling to cementing resulted in better hydraulic isolation compared with conventional drilling practices in similar geological settings. These improvements were particularly relevant in depleted zones with severe losses, where conventional cementing operations frequently exhibit poor returns and compromised isolation. The following chart compares the quality of cement between casing drilling and conventional sections, based on CBL logs for every well drilled during 2025, and the operator procedure to classify cement quality [20].

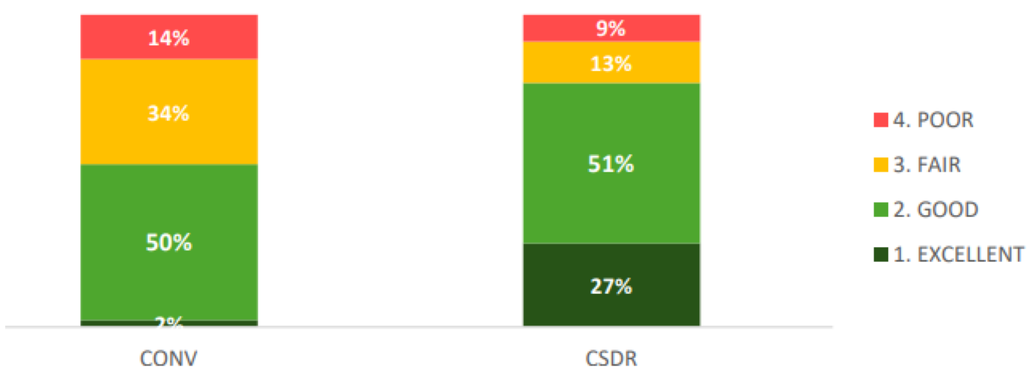


Figure 14—Cement Quality – CwD vs Conventional.

From 2021 onward, the CwD program incorporated high-frequency surface sensing and advanced data analytics, developed specifically for this application. Real-time measurements of torque, vibration, and dynamic response of the casing string, combined with machine-learning-based analysis, enabled a controlled expansion of operational windows for WOB, RPM, and torque. This digital integration reduced uncertainty in parameter selection and allowed more aggressive drilling strategies without compromising structural integrity.

The cumulative results of this evolution include reductions of approximately 25–30% in drilling time for the production casing phase of 2025 campaign (75 wells) vs 2015 average drilling time, sustained increases in ROP, and a significant reduction in operational variability, leading to improved predictability and planning efficiency. Beyond performance gains, CwD proved essential for maintaining the economic viability of mature-field developments by minimizing losses, reducing HSE exposure, and improving consistency in well construction. The following chart shows how drilling times have been reduced in the field, with casing drilling outperforming conventional drilling consistently conventional.

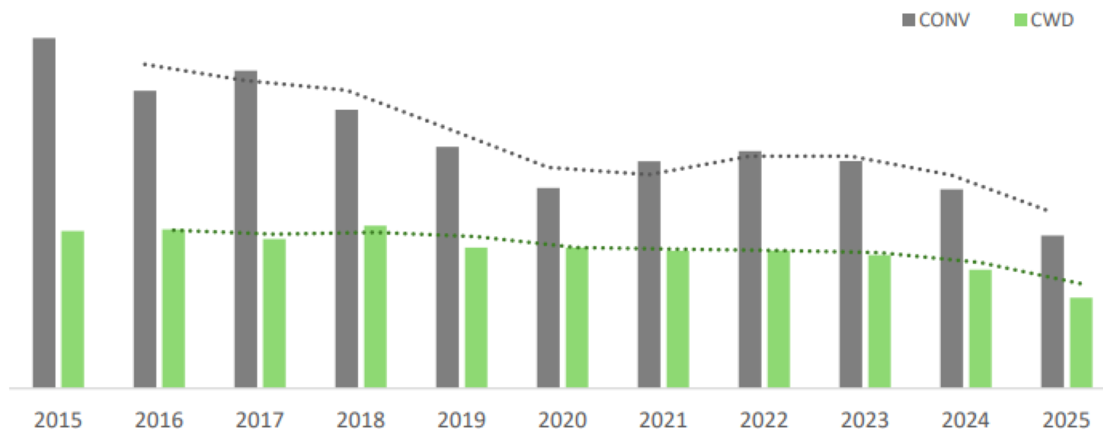

Figure 15—Drilling time evolution.

In fact, not only the average time for drilling has been reduced, the variability of results also decreased showing a great consistency of the technique as seen in the following chart:

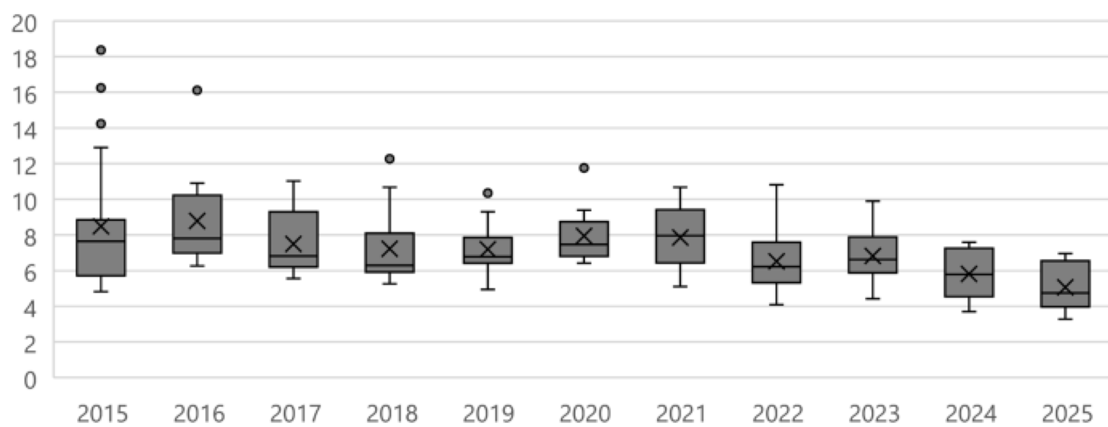

Figure 16—Consistency of CwD technique.

Current efforts are focused on extending its application to directional wells, further integrating digital workflows, and deploying predictive models to enhance real-time decision-making and long-term sustainability.

### Double Casing Drilling

In San Jorge Basing the success of casing drilling for production sections mentioned before draw the idea of using the technology for the two strings in the well. An operator drilled **65 wells entirely using Casing Drilling**, one of the largest documented field implementations for the technique [22].

The project involved the use of CwD in both the **surface section** (9 ⅝ in. casing with a 12 ¼ in. bit) and the **production section** (5 ½ in. casing with a 7 ⅞ in. bit). The primary objective was to eliminate conventional drilling and casing-running sequences, thereby reducing non-productive time associated with tripping, wellbore instability, and casing installation.

Results from the 65-well campaign show a **consistent reduction in drilling time**, with average savings of approximately **12 hours in the surface section** and **48 hours in the production section**, yielding a **total time reduction of about 60 hours per well**. These savings were achieved primarily by eliminating dedicated casing-running operations and reducing the exposure time of the open hole.

In addition to time reduction, the methodology contributed to **improved wellbore stability** and reduced risk of formation collapse, particularly relevant in depleted intervals typical of mature fields. The continuous presence of casing during drilling minimized wellbore enlargement and mitigated instability events commonly observed in conventional drilling.

The implementation required specific **design adaptations**, including the development of **CwD-optimized drill bits** for each section and the definition of operating parameters based on offset well analysis. Bit designs were tailored to ensure compatibility with casing geometry, durability during drilling, and effective drill-out performance.

## Connection Selection for CwD in Argentina

The connection selected for casing string in all these projects was a semi-premium, coupled connection with a torque shoulder, compatible with API Buttress (BTC). This type of connection was developed specifically for applications requiring torque transmission during casing rotation, such as Casing While Drilling (CwD) operations. The fatigue performance of this connection has been validated through Full Scale Tests (FST). In addition, the connection was designed to be fully compatible with API BTC, minimizing the need for crossovers in the string.

The integrated torque shoulder in the coupling provides the following benefits:

- Effective torque transmission during drilling operations
- Protection of the "J-area" of the coupling, reducing erosion
- 100% compression efficiency

Due to its robustness and excellent cost–benefit ratio, this connection is the most widely used for Casing while Drilling operations in Argentina and Bolivia. For surface (conductor/guide) sections, it is currently the only connection being applied, with consistently satisfactory results.

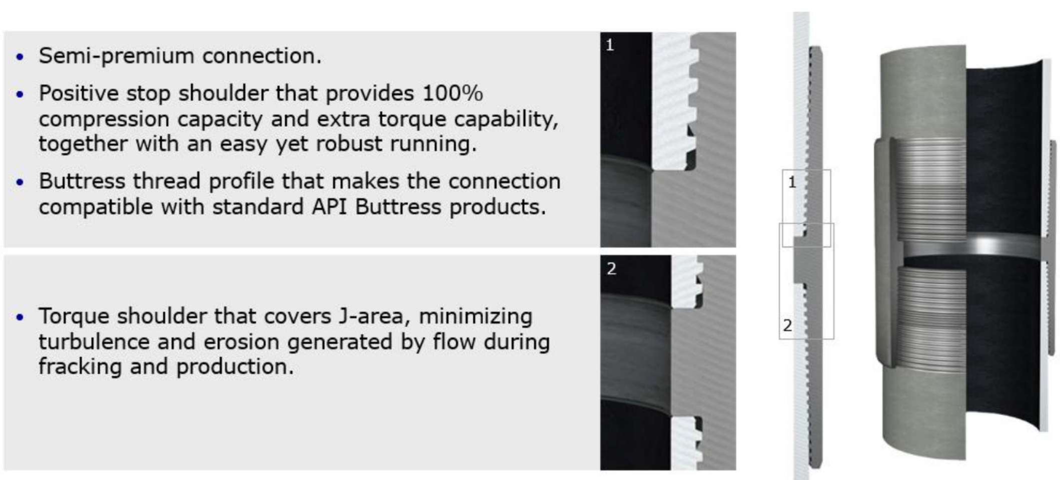


**Figure 17—Semi-premium BTC alike Connection – Coupled with Torque Shoulder**

## Real-time AI Monitoring System

### Vibrations during casing drilling

Fatigue related failures of casing connections during casing drilling operations in the past reduced the pace of the application of the technology. During the evaluation of the failure, the sources of loads could not be established for such failures.

A new system was developed to prevent fatigue failures, by measuring casing drilling torque and vibrations with high frequency sensors working at 120Hz and identifying several insights during the evaluation process. Torque variation occurs at higher frequencies and with greater amplitudes compared to the information registered with the Electronic Drilling Recorders (EDR).

The following picture (Figure 18) compares the torque measurements from the sensor (green line) and the data from the EDR (yellow line) for a period of 4 minutes of drilling. It is evident that the torque variation in amplitude and frequency is far larger and more detailed with the new system sensors. This highlights the importance of having high sensitivity sensors for proper measurement of loads.

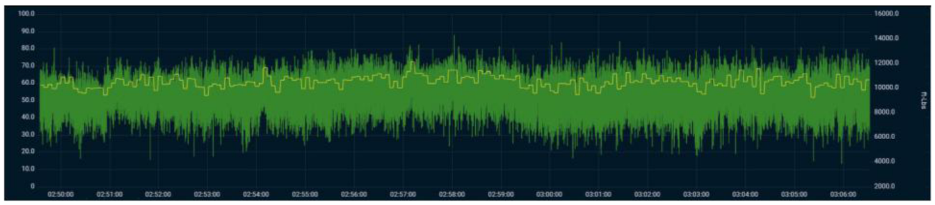

**Figure 18—Torque from sensor compared to torque registered in a EDR – Casing drilling**

The sensor also includes accelerometers en 3 axes. The following figure (Figure 19) shows the data collected from the sensor in the three axes. It is important to highlight that accelerations measurement during casing drilling were never measured before with this detail level. The accelerations variate significantly, reaching amplitudes over 8g within 1 second as seen in following picture.

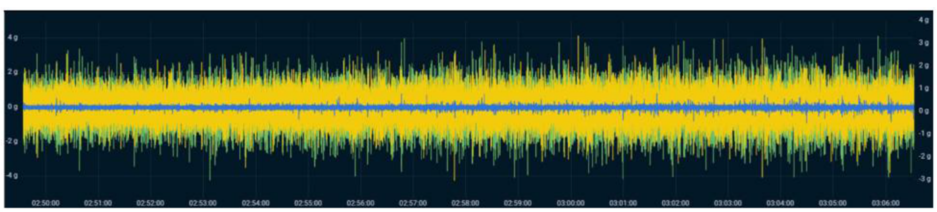

**Figure 19—Accelerations measurement by sensors**

## Model Development

As seen in the previous figure (Figure 19), it is impossible to identify trends or differences in the signals. This is more evident when the need is to identify in real time while drilling for several hours.

To address that, a machine learning model using Artificial Neural Networks (ANN) was trained to read signals in real time and classify its impact to fatigue damage to casing connections. (Figure 20). By combining torque and accelerations data, the ANN can classify the events with different thresholds based on torsional or lateral vibrations.

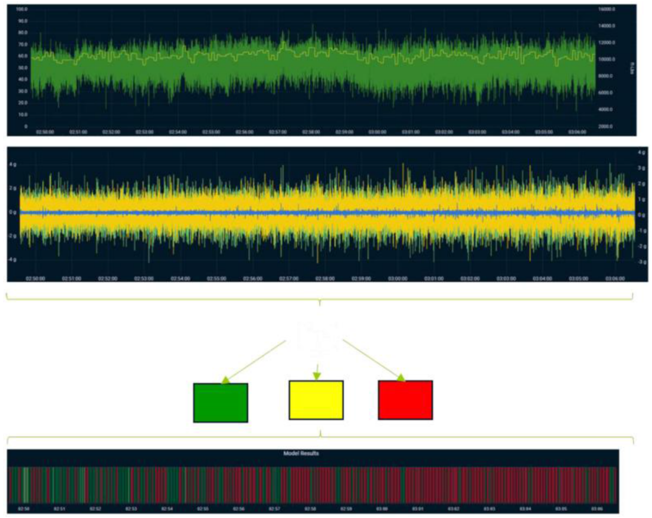

Figure 20—AI model concept converting signals.

The system is composed mainly by:

- A **high-frequency Torque and Tension Sub** (up to 120 Hz) installed below the top drive,
- A **real-time Artificial Intelligence (AI) model** running on an edge computer at the rig site, trained using historical well data,
- **Satellite data transmission** to a cloud-based platform for real-time remote monitoring and historical analysis.
- **Cloud database.** An internally developed cloud-based tool that stores and displays data for real time monitoring and historical analysis.
- **Real Time Monitoring.** An internally developed tool that allows the display of data transmitted in real time on-site and on any computer connected to the cloud app.

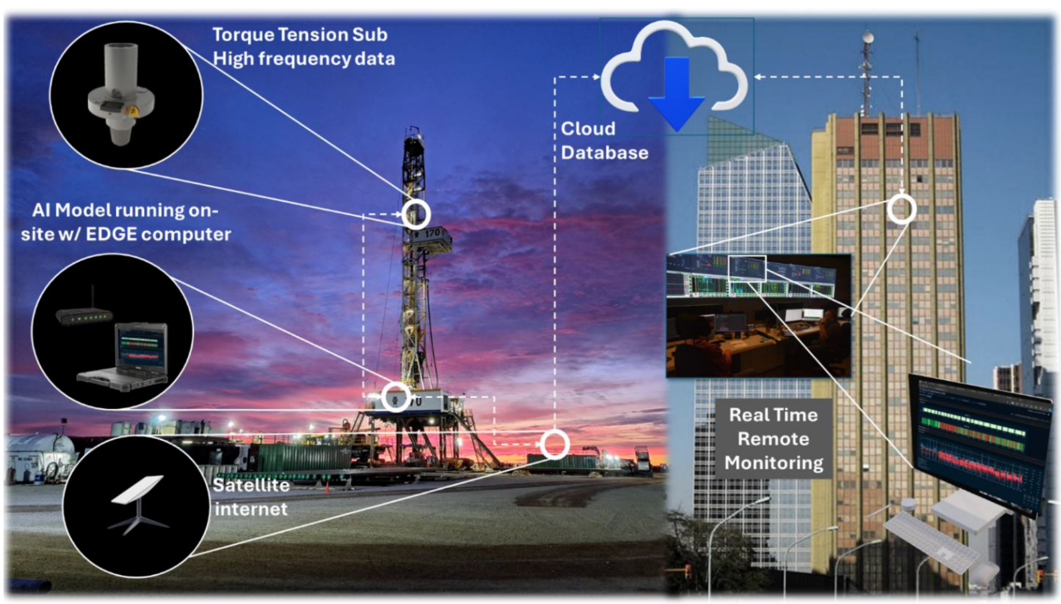


Figure 21—Vibration Model Schematic.

The AI model continuously classifies vibration conditions on a second-by-second basis and identifies potentially damaging events associated with casing fatigue. These events are displayed in real time, allowing drilling and engineering teams to promptly adjust operational parameters—primarily **RPM and Weight on Bit (WOB)**—to mitigate fatigue damage.

Between January 2024 and February 2025, the vibration monitoring system was implemented in **35 wells** drilled with casing in the Lajas project, Argentina. **All monitored wells were completed successfully without casing failures**, even under severe fluid loss conditions. In contrast, wells drilled without the monitoring system exhibited a **failure rate of approximately 18%**.

The analysis demonstrated that vibration behavior varies significantly between wells, even within the same pad, and that fatigue damage is not directly correlated with drilling time but rather with specific dynamic vibration modes. The real-time feedback provided by the AI-based system enabled operators to reduce high-risk vibration events and progressively optimize drilling practices.


**Figure 22—Effect of Modification of parameters to reduce vibration.**

Over time, the integration of vibration monitoring also allowed **higher RPM and lower WOB strategies** to be applied safely, resulting in a **measurable improvement in Rate of Penetration (ROP)** while maintaining casing integrity.

### Key Conclusions

- Fatigue failures in casing are primarily driven by unmeasured dynamic loads and vibrations rather than static drilling parameters.
- The implementation of **AI-supported real-time vibration monitoring** significantly reduces casing failures and non-productive time.
- Digital tools combining high-frequency sensors, AI models, and cloud-based visualization are key enablers for safer and more efficient drilling operations in complex environments.

## Conclusions

This paper presents the first integrated review of more than a decade of large-scale **Casing While Drilling (CWD)** deployment in Argentina, encompassing over **3.4 million meters drilled and 3,100 casing strings**

**installed** across unconventional and mature field environments. Based on this experience, the following conclusions can be drawn:

1. **Casing drilling has evolved from a niche solution into a mainstream drilling methodology** in Argentina. In both unconventional developments such as Vaca Muerta and mature fields like Golfo San Jorge, Casing Drilling has transitioned from an experimental technique focused on mitigating wellbore instability to a standardized, factory-drilling process delivering consistent reductions in drilling time, operational risk, and variability.
2. **In unconventional shale developments, CWD has proven particularly effective in surface sections**, where increased casing depths and stringent aquifer protection requirements amplify the economic benefits of drilling with casing. Adoption rates exceeding 80% demonstrate that, when geological complexity is moderate, CWD reliably outperforms conventional drilling by reducing rig time while maintaining well integrity.
3. **In mature and depleted fields, CWD enables access to reserves that would otherwise be economically marginal.** The ability to drill through severe loss zones, depleted formations, and unstable intervals while maintaining continuous wellbore support has resulted in significant reductions in non-productive time and improved cementing quality compared with conventional drilling practices.
4. **Early fatigue-related casing failures were not driven by static drilling parameters but by unmeasured dynamic loads and vibration modes.** Detailed failure analyses confirmed that stress concentration and bending amplification near stiff components such as collars and couplings were critical contributors, highlighting the limitations of conventional surface measurements and traditional design assumptions.
5. **Targeted mechanical redesign of the Bottom Hole Assembly was essential to achieving long-term reliability.** Increasing axial stiffness, relocating the float collar closer to the bit, strengthening the lower casing section, and optimizing bit-to-casing diameter ratios significantly reduced bending stresses and eliminated fatigue failures over extended drilling campaigns.
6. **Connection selection plays a critical role in CWD success.** Semi-premium, torque-shouldered connections demonstrated an effective balance between torque capacity, fatigue resistance, and operational simplicity, enabling widespread deployment without introducing additional complexity to casing logistics.
7. **The integration of high-frequency sensing and AI-based real-time monitoring represents a step change in casing drilling risk management.** By capturing torque and vibration data at frequencies far beyond conventional Electronic Drilling Recorders and translating them into actionable fatigue indicators, the system enabled proactive parameter adjustments that eliminated casing failures in monitored wells.
8. **Digitalization shifted CWD operations from reactive to preventive control.** Real-time classification of vibration severity allowed drilling teams to safely expand operational windows, apply higher RPM and optimized WOB strategies, and improve ROP without compromising casing integrity.
9. **Double casing drilling demonstrated the technical feasibility of drilling an entire well using CWD.** The successful execution of more than 60 wells using casing drilling in both surface and production sections confirms that, with appropriate design and digital support, conventional drilling and casing-running sequences can be fully eliminated in suitable field conditions.
10. **Overall, CWD has become a key enabler of safer, faster, and more predictable well construction.** The combination of mechanical design optimization, standardized operating practices, and AI-supported digital monitoring provides a robust framework for extending casing drilling applications to more complex wells and directional profiles.

The lessons learned from Argentina's decade-long experience demonstrate that **the future of casing drilling lies not only in hardware evolution, but in the integration of digital intelligence with sound mechanical design**. This approach offers a scalable roadmap for improving drilling efficiency and risk mitigation in both conventional and unconventional developments worldwide.

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