

WHITE PAPER

Improving Electrical Feedthrough Reliability in HPHT Downhole Environments

Introduction

Modern upstream drilling operations rely heavily on real-time data to optimize well placement, improve efficiency, and reduce operational risk. To achieve this, downhole sensors must transmit electrical signals from deep within the wellbore to internal electronics and surface systems without interruption.



At the heart of this transmission chain lies the electrical feedthrough. These components serve as the link between the internal electronics of the tool and the external wellbore environment. Because they sit at this interface, feedthroughs represent a vital reliability point within the tool's data acquisition system. If a feedthrough fails, the result is often signal loss, forced tool removal, and significantly increased non-productive time (NPT). As the industry pushes into deeper, more volatile formations, the reliability of these components has never been more essential.

The Problem: The Downhole Environment

The primary challenge in maintaining signal integrity is the extreme nature of the environment in which these components must operate. Feedthroughs must maintain the highest performance while exposed to stressors that can degrade standard materials in hours.

Key environmental challenges include:

- **Extreme Pressures:** Operations frequently encounter pressures of 20,000 psi and above.
- **High Temperatures:** Applications ranging from 300°F to 600°F (approximately 150°C to 315°C).
- **Mechanical Stress:** Tools are subject to continuous shock, vibration, and mechanical loading during drilling.
- **Chemical Aggression:** Constant exposure to drilling fluids, hydrocarbons, sour gas, and seawater creates a highly corrosive environment.

When feedthrough materials are not properly matched to these operating conditions, performance risks increase significantly. The consequences of inadequate material selection include signal loss from critical sensors, changes in electrical resistance, and seal degradation. Ultimately, this leads to tool failure and costly downtime.

Greene Tweed understand that electrical feedthroughs play a critical role in enabling reliable data transmission in modern upstream drilling tools.

The Solution: A Material-First Approach

To combat these challenges, engineering teams must prioritize the right material selection. In High-Pressure, High-Temperature (HPHT) drilling applications, feedthrough performance is strongly influenced by the specific materials selected for the connector body, the electrical contacts, and the sealing systems.

1 Connector Body Materials

The structural integrity of the feedthrough relies on high-performance thermoplastics. Materials such as PEEK (polyether ether ketone) and PEK (poly ether ketone) are widely adopted for these structures due to their unique combination of electrical insulation capability, mechanical strength under load, and chemical resistance.

Engineers select different grades of PEEK and PEK based on the specific downhole conditions:

- **Unfilled PEEK/PEK (Arlon® 1000/Arlon® 2000):** Ideal for pressures up to 20,000 psi and temperatures up to approximately 350°F.
- **Glass-reinforced PEEK/PEK (Arlon® 1160/Arlon® 2400):** Utilized when higher structural strength is required to prevent deformation.
- **Cross-linked PEEK (Arlon® 3000XT):** Formulated for extreme thermal stability, capable of withstanding temperatures up to 500°F.

2 Electrical Contact Optimization

The performance of the feedthrough contacts affects signal quality and power delivery. While stainless steel is often used for structural durability, it is not always the optimal choice for conductivity.

- **Beryllium Copper:** Frequently recommended in high-performance applications where signal integrity is critical. It offers strong conductivity and low electrical resistance.
- **Nickel Alloys:** Selected for their superior corrosion resistance in chemically aggressive environments.

3 Advanced Sealing Strategies

Even the strongest connector body will fail if the seal is compromised. Downhole environments expose feedthroughs to fluids and gases that can degrade conventional elastomers, leading to fluid ingress into electronics and pressure leakage.

For HPHT environments, the industry standard is moving toward **FFKM (perfluoroelastomer) or Chemraz®**. Unlike FKM or HNBR, FFKM maintains sealing performance at elevated temperatures while resisting chemical degradation from sour gas and aggressive drilling fluids.

4 Structural Reinforcement for Extreme Pressure

In applications exceeding 10,000 psi, relying solely on material properties may be insufficient. Advanced designs incorporate additional mechanical reinforcement to improve reliability. These features—such as metallic support washers, reinforced thermoplastic connector bodies, and specialized load-distribution geometries—help maintain compression strength and prevent cracking under sustained high pressure.

Seal-Connect® Electrical Connectors



Conclusion:

Partnering with Greene Tweed Seal-Connect® for HPHT Reliability

As drilling operations continue to push into deeper and more demanding formations, there is no margin for error in tool design. Reliable connector solutions must balance thermal stability up to 600°F, pressure resistance up to 35,000 psi, and compatibility with degradative chemicals.

This is where Greene Tweed excels.

We understand that electrical feedthroughs play a critical role in enabling reliable data transmission in modern upstream drilling tools. By leveraging our expertise in engineered thermoplastics—such as reinforced PEEK connector designs—and advanced sealing solutions like chemically resistant FFKM, we help operators significantly improve durability and reduce risk in their electrical feedthroughs.

Early collaboration between tool designers and connector experts is the key to success. Greene Tweed offers specialized material selection strategies and design considerations tailored to specific downhole challenges. By partnering with us, engineers can ensure their feedthroughs are not the weak link, but rather the reliable bridge that keeps data flowing and operations running.

Contact Greene Tweed today to explore how our high-performance material solutions can enhance the reliability of your HPHT drilling tools.

Greene Tweed

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