

# OILFIELD TECHNOLOGY

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# External pipe corrosion protection on FPSOs

**Figure 1.** Illustration of FPSO vessel – topsides with processing modules, helideck, flare, and lifeboats on a single hull for offshore production, storage, and offloading (source: Cogbill).



Hani Almufti, Cogbill Construction, discusses corrosion under pipe supports (CUPS) on FPSOs, focusing on the challenges, mechanisms, and a novel mitigation solution.

**C**orrosion under pipe supports (CUPS) on FPSOs is aggravated by warm, chloride-rich atmospheres with long time-of-wetness and hard-to-reach interfaces, accelerating crevice, under-deposit, galvanic, pitting, and microbially influenced corrosion (MIC) damage. This article presents the RedLineIPS SmartPad: a fully non-metallic fibre-reinforced polymer (FRP) saddle with

a bonded closed-cell gasket, secured by fibre-reinforced thermoplastic straps. It installs without the need for hot work (no welding, drilling, cutting, grinding, etc.) or the use of epoxy, and is intentionally removable for quick visual inspection. The sealed, non-wicking interface and dielectric load path eliminate electrolyte retention and metal-to-metal continuity – the prerequisites for crevice/galvanic attack – while avoiding coating damage. Unlike adhesive-bonded FRP wear pads, SmartPads are banded, enabling immediate open-and-reseal inspections with no adhesive cure windows. Operationally, per-support inspection time can drop from approximately 1 - 2 h to <10 min (access-dependent), reducing labour and work-at-height (WAH) exposure.

CUPS is a hidden threat on FPSOs: attack starts at the pipe/support contact – hard to see and reach – so wall loss can progress until alarms or intrusive inspections catch it late. Warm, chloride-rich atmospheres with long time-of-wetness accelerate the electrochemistry, while congestion and work-at-height (WAH) constraints make inspection costly.

Conventional fixes – welded pads, metallic clamps, or adhesive-bonded FRP – often damage coatings, create crevices, preserve electrical continuity, or add hot work/cure windows. The practical gap is how to both prevent CUPS and verify condition quickly in service.

This article summarises the key CUPS mechanisms on FPSOs (crevice/differential aeration, under-deposit, galvanic, pitting, MIC, and, where relevant stress corrosion cracking [SCC]); explains why warm climates intensify them; and introduces the RedLineIPS SmartPad – an all-non-metallic, sealed, dielectric, cold-work support that is intentionally removable for direct visual inspection. Scope is corrosion-focused; installation/inspection practicality is treated as an enabler for at scale deployment.

### FPSO fundamentals

An FPSO produces, processes, stores, and offloads hydrocarbons on a single hull. Fluids arrive via flexible risers to a weathervaning turret or spread moorings. Piping spans small-bore instruments to large crude/gas/water lines. Carbon steel dominates; external protection is typically multi-coat epoxy/urethane, with thermally sprayed aluminum (TSA) + sealer on high-exposure items. Supports –welded shoes/stools, split clamps, guides/stops, U-bolts with liners, wear pads – are densely packed in racks and under weather covers where ventilation is low and salt wetting is frequent.

Why do supports matter? They carry sustained/transient loads while accommodating thermal growth and hull motions. Micro-slip at the contact can fret coatings/oxides, exposing steel. The shaded interface traps salt and condensate, forming tight, damp crevices. A small coating holiday under a support becomes a tiny anode coupled through electrolyte to a much larger cathode (surrounding steel), accelerating loss via the area-ratio effect. Hidden geometry and elevation/insulation impede access, so CUPS can progress between inspection cycles.

### Corrosive environment for FPSO topsides

#### Macro environment

FPSO decks live in salty, humid air with strong sunlight and constant wet-dry cycling. Sea-salt deposits are hygroscopic – they pull moisture from the air – so surfaces can stay effectively



**Figure 2.** Rust halo at the pipe–saddle contact – an indicator of CUPS on offshore topsides; trapped salt moisture under the support initiates hidden wall loss (source: Cogbill).



**Figure 3.** SmartPad System – SmartBands (anti-backdrive buckles), bonded closed-cell gasket, and FRP SmartPad saddle – an all-non-metallic assembly that seals the pipe–pad interface for quick lift–look–re-band inspections (source: Cogbill).

'wet' even without rain. Heat speeds corrosion reactions and ultraviolet (UV) light ages coatings, making them more permeable to water and ions.

#### At the pipe/support contact

The narrow, shaded gap under a support location behaves like a crevice. It traps moisture, concentrates chlorides as it dries, and becomes oxygen-poor. That chemistry turns the hidden zone into the anodic site where steel dissolves, while nearby exposed steel acts as the cathode. Wicking, salt build-up, and local acidification keep the crevice active until it is opened and dried, leading to localised thinning under supports.

#### Warm vs cold seas

Tropical regions (e.g. West Africa, Brazil, Southeast Asia, the Arabian Gulf/Red Sea) are harsher: higher temperatures, more frequent salt deliquescence (longer 'time of wetness'), and more active microbiology. Net result: crevice, pitting, MIC, and galvanic processes start sooner and run longer than in temperate basins.

#### Operations that make it worse

Common FPSO conditions keep supports wet and salty: condensation on cold lines, seawater washdowns and spray, drainage toward supports, shaded/low-airflow racks, wick-prone insulation terminations, small leaks and residues, debris accumulation, and motions that rub away coatings. Weathervaning can load one side with more salt. Bottom line: longer wetness, higher chloride, and low oxygen – the perfect mix for CUPS.

#### CUPS mechanisms on FPSOs

- ▶ Crevice corrosion/differential aeration: moisture trapped in a tight gap becomes oxygen-starved, turning the hidden area into the active corrosion site until the crevice is opened and dried.
- ▶ Galvanic effects: if a small coating defect under a pad stays wet and is electrically connected to the larger surrounding steel, the small area corrodes faster (area-ratio effect) – even with 'similar' metals when oxygen levels differ.
- ▶ Under-deposit corrosion: rust, salts, paint chips, and grime hold brine and block oxygen, creating micro-crevices where chlorides concentrate and pH drops, accelerating local attack.
- ▶ Pitting corrosion: chloride-rich films locally break down protective oxides; warm temperatures make pits start and grow more readily, especially in shielded gaps.
- ▶ Microbiologically influenced corrosion (MIC): biofilms alter local chemistry; sulfate-reducers and other microbes can create conditions that favour localised corrosion in damp crevices.
- ▶ Stress corrosion cracking (SCC): tensile stresses plus aggressive local chemistry (chloride or sulfide environments) can nucleate and grow cracks from pits or weld features.
- ▶ Fretting-assisted corrosion: small motions from thermal growth and hull movement rub away



**Figure 4.** A water droplet on the HydroSeal gasket encapsulates its core promise: durable, leak-free sealing in demanding conditions.



**Figure 5.** SmartTool band-tensioning system for SmartPad installation (left → right): mechanical SmartTool with precision torque setting, pneumatic SmartTool for rapid, repeatable mass installation, and manual hand tool for low-access or spot work (source: Cogbill Construction/RedLineIPS).



**Figure 6.** SmartPad System installed on topside piping – FRP saddles with composite bands create a sealed, dielectric interface at supports, enabling quick cold-work lift-re-band inspections (source: Cogbill).

coatings/oxides and generate debris that retains brine, accelerating the mechanisms above.

## SmartPad system: non-metallic architecture tailored for FPSOs

### FRP saddle (wear pad)

A FRP saddle – continuous glass fibres in a corrosion-resistant, UV-stabilised resin – is profiled to the pipe outside diameter (OD). The laminate is electrically non-conductive and chemically resistant to marine atmospheres and common topsides contaminants, providing dielectric isolation at the pipe/support interface.

### Why it works on FPSOs

- ▶ Load distribution, coating care: the contoured, pipe-matched curvature spreads bearing load; smooth, radiused contact surfaces are low-abrasion to sound coatings.
- ▶ ‘Stay-put’ geometry: recessed band grooves and chamfered edges resist migration and ease alignment/removal during inspection.
- ▶ Weathering resistance: marine-grade resin systems with UV stabilisers limit embrittlement and colour change in hot, high-UV service.
- ▶ Dielectric interface: non-metallic contact breaks metal-to-metal paths at the support, a prerequisite for galvanic CUPS.

Options include coverage angle/length and laminate thickness to suit pipe size, load path, and inspection access.

### Closed-cell elastomeric gasket (HydroSeal concept)

A factory-bonded, closed-cell elastomer between the FRP saddle and pipe coating creates a continuous, conformal, non-wicking seal. Under band preload it fills coating texture without capillary paths.

- ▶ Watertight (National Electrical Manufacturers Association [NEMA] Type 4): the HydroSeal gasket itself is manufacturer-rated to NEMA Type 4. When compressed approximately 30% with the SmartTool (and aided by pipe deadweight), the pipe-pad interface provides an equivalent level of splash/spray exclusion.
- ▶ Holds preload: low compression set preserves contact pressure through thermal/vibration cycles and re-seals after cut-and-re-band inspections.
- ▶ Bonded to the saddle: maintains a continuous sealing surface and eliminates additional crevice edges.
- ▶ Materials: EPDM (hot water/brine), silicone (high-temp/UV), PTFE-faced (chemical resistance/low stick-slip); grade and hardness per project service.

### Fibre-reinforced thermoplastic straps and buckles

Its composition includes long-strand, fibre-reinforced thermoplastic straps (aligned fibres for higher strength vs chopped) with radiused, smooth inner faces and polymer buckles provide fully dielectric clamping without metal in the load path and avoid bruising sound coatings.

Key features include:

- ▶ Locking geometry: square-tooth, anti-backdrive buckles mechanically lock the band and resist loosening under vibration/thermal cycling; clamp load is maintained when installed to spec.
- ▶ Inspection and reuse: for visual checks, cut straps, lift pad, inspect/clean/dry, then reuse the same saddle and

buckles with new band stock and re-tension to spec. The cycle takes minutes, requires no hot work or cure windows, and keeps per-support inspection cost low.

## SmartTool and installation method

A compact SmartTool (manual or pneumatic) tensions the bands to a preset target and shears the tail flush, leaving no sharp edges near the coating. No hot work, drilling, or adhesives are required. On ‘live’ lines, installation is typically permissible under site permits because there is no heat source and no cure window; follow site isolation and work-at-height controls.

### Installation steps

Clean/dry the contact area; position the FRP saddle; route bands through the buckles; tension to the specified setting; verify uniform gasket compression and alignment in the band grooves.

### Inspection/removal

Cut the bands, lift the saddle, inspect/clean/dry, then thread fresh bands and re-tension. The expose/inspect/re-band cycle is completed in minutes, enabling direct visual checks in congested or elevated modules.

## FPSO-focused benefits (corrosion and operations)

### Corrosion control at the hotspot

- ▶ A sealed pipe-pad interface (NEMA-4 watertight seal when the gasket is compressed) keeps water out of the pipe/pad contact surface, even on windward/splash-exposed faces – cutting crevice, under-deposit (UDC), MIC, and chloride pitting.
- ▶ A fully dielectric load path (FRP saddle + closed-cell gasket + composite bands) breaks metal-to-metal continuity to support steel – reducing galvanic couples, including differential-aeration effects.
- ▶ The non-wicking, closed-cell gasket conforms to imperfect or previously coated surfaces and cushions micro-motion – limiting fretting and the debris/brine nests that feed UDC.

### Built for FPSO exposure

- ▶ Performs on windward racks, washdown/splash zones, and sweating cold services, keeping the gap dry where salt, fire-water testing, and condensation are routine.
- ▶ UV-stabilised composites and gasket options resist chalking/embrittlement on open decks; broad service window (approximately -60 °F to 400 °F/-51 °C to 204 °C) covers chilled, ambient, and hot duties.

### Mechanical integrity and coating care

Contoured FRP saddle eliminates point/line loading and protects coatings with smooth, radiused contact. Recessed strap grooves positively locate bands so vibration/hull motions cannot ‘walk’ them; clamp force stays on the saddle, off the paint – preventing seal loss and pad drop-off. Long-strand glass-fibre bands with square-tooth, anti-backdrive buckles hold preload through thermal/vibration cycles.

### Installation, inspection, and operations

- ▶ Epoxy-free, cold-work install on live lines: no welding/drilling, no cure windows, minimal clearance (approximately 1 - 2 in.), and no hot work permits.
- ▶ Preset SmartTool delivers repeatable preload.

- ▶ Rapid 'lift-look-re-band' visual inspections in minutes – practical in congested racks and at height – so issues are found early without heavy NDT such as UT, electromagnetic acoustic transducer (EMAT), and radiographic testing (RT).

#### Safety and EHS

Fewer hot work tasks/solvents, shorter jobs at height, and fewer confined-space NDT trips reduce exposure hours and permitting complexity.

#### Integration and assurance

- ▶ Retrofit-friendly (start with high-risk circuits, expand by RBI); newbuild-ready (specify in standards/isometrics).
- ▶ Compatible with site cathodic protection (CP)/earthing philosophies; verify isolation with a quick resistance check.
- ▶ Uses proven FRP/elastomers/composites; gasket chemistries (EPDM, silicone, PTFE-faced) match media and temperature.

#### Total cost of ownership (TCO)

- ▶ Minutes-per-support installs vs hours for welded/epoxied options; fewer permits and no specialist trades.
- ▶ Lower inspection burden (more visuals, less scaffolding/NDT), minimal coating touch-up, reusable hardware (replace only low-cost band stock), and faster, phased campaigns – delivering sustained OPEX and risk reduction over vessel life.

#### Installation and inspection on FPSOs

Cold-work install on live lines; typical install/reinstall take approximately 2 - 5 min per support (access-dependent). For

inspection, cut bands, lift saddle, clean/dry, refit saddle/buckles, and re-band to spec. This expose/inspect/re-seal cycle requires no hot work or cure window.

#### Conclusions

On FPSOs, CUPS stems from retained electrolyte, oxygen restriction, galvanic continuity, and debris-held crevices in warm, chloride-rich atmospheres. A non-metallic, sealed pipe/support interface interrupts these drivers. The SmartPad System – FRP saddle, closed-cell gasket, and fibre-reinforced thermoplastic straps – breaks metal-to-metal paths, blocks persistent crevice films, and can be opened and re-sealed in minutes for direct visual inspection. This is especially valuable in warm-water regions where heat and humidity accelerate corrosion and salt deliquescence. Retrofit-friendly and requiring no hot work or cure windows, it reduces inspection time and cost. In sum, sealed, dielectric, removable supports provide a targeted barrier to FPSO CUPS and merit specification, subject to checks on coating condition, materials compatibility, and support duties. ■

#### About the author

Hani Almufti is Engineer and Manager of Strategic Development at Cogbill Construction (RedLineIPS). With 15+ years in pipe supports – ten focused on offshore – he specialises in CUPS and the performance of FRP/composite and metallic supports. He leads product strategy and materials selection, aiming to cut risk, vibration, and lifecycle cost.

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