OOC GUIDANCE FOR MECHANICAL "GRIP AND SEAL" PIPELINE CONNECTORS

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Disclaimer

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1 Summary of Guidance Document Objective

There have been multiple decades of use of mechanical pipeline connectors (grip and seal) with very limited issues. These connectors are designed to existing industry standards and involve design that exceeds the structural strength of the base pipeline pipe. The use of existing industry design standards should support use of these connectors for 20-years or more given proper design, fabrication, installation, use, inspection and maintenance. Emergency repair of pipeline systems using these connectors also generates a desire for them to remain in service for a period of time consistent with the pipeline systems they are deployed on.

A recent pipeline incident raised awareness and attention from BSEE, which permits the use of these connectors. This guidance document seeks to provide a consistent approach industry can take to facilitate efficient review and approval of permits for use of these connector types in most applications. The intent of this guidance document is not to apply to jumper hubs and connectors. The intent of this guidance document is not to hold up or create new requirements for emergency repairs.

2 Mechanical Pipeline Connector Design

Mechanical (grip and seal) pipelines connectors should be designed in accordance with published industry standards such as the following or equivalent as applicable.

A. DNV-ST-F101: Submarine Pipeline Systems (Latest Edition)
B. DNV-RP-F113: Pipeline Subsea Repair (Latest Edition)
C. ASME B16.5: Pipe Flanges and Flanged Fittings
D. ASME Section Boiler and Pressure Vessel Code, Section VIII: Rules for Construction of Pressure Vessels - Division 1 or 2
E. API 1111: Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)
F. API 5L: Pipe Specification
G. DNV RP-F103: Cathodic Protection of Submarine Pipelines
H. DNV RP-B401: Cathodic Protection Design

Offshore mechanical pipeline connectors must meet specific minimum design conditions as per BSEE regulations, API 1111, and ASME code to ensure safety and operational integrity. These conditions address material strength, pressure and temperature ratings, and environmental factors.

The following subsections breakdown the key design elements that each connector design should address in accordance with a published industry standard.

2.1 Material and Design Standards:

A. Pipeline connectors must adhere to recognized standards, including ANSI/ASME B16.5, ANSI/API Spec 6A, or their equivalent as applicable. These standards ensure connectors are suitable for their intended service.
B. Materials and equipment that are a permanent part of any piping system constructed under API RP 1111 should be suitable and safe for the conditions under which they are used.
C. Materials and equipment should be designed for the conditions of their use by compliance with specifications, standards, and special requirements of API RP 1111, ASME Section VIII, ASME B31.4 for liquid pipelines, or ASME B31.8 for gas pipelines.
D. Components not manufactured to a standard specification may be qualified for use as specified in ASME Section VIII, ASME B31.4 or ASME B31.8.

2.2 Pressure and Temperature Ratings:

A. Connectors must be able to withstand the Maximum Allowable Operation Pressure (MAOP) of the pipeline or Maximum Operation Pressure (MOP) plus any applicable surge and any future pressure testing, if required.
B. They must maintain their physical and chemical properties at the temperature range they might be subjected to during the service life.
C. Pipeline fittings should have pressure-temperature ratings based on stresses for pipe of the same or equivalent material.
D. The actual bursting strength of the fitting should be equal to or greater than the computed bursting strength of the pipe.

2.3 Internal Design Pressure:

A. The design pressure is the maximum difference, at each cross section, between internal pressure and external pressure during installation and operating conditions.
B. Limits on design pressure are set in section 4.3.1 of API RP 1111.
C. The internal design pressure of steel pipe is determined using a specific formula referencing ANSI B31.8 or through specific engineering for non-standard pipe and elbow geometries.

2.4 Environmental Factors:

A. Pipelines, including mechanical (grip and seal) connectors, must be designed and maintained to mitigate any reasonably anticipated detrimental effects of environmental factors (cyclic and constant) such as but not limited to, water currents, storm or ice scouring, soft bottoms, mud slides, earthquakes, and subfreezing temperatures.
B. In water depths where a pipeline is not buried out to approximately 200 feet, severe bottom currents and potential soil instability should be evaluated to determine if additional measures should be taken in the design of the pipeline and connectors, such as additional weight coating, and added wall thickness, etc.
C. Seabed anchoring, weight mattresses, pipeline standoffs shall all be applicable mitigation measures for environmental loading consideration.

2.5 Corrosion:

A. The design should consider the effect of corrosion and the means that may be necessary to mitigate corrosion and other deterioration of the material in service.
B. Pipelines systems (including use of connectors) should be provided with an external protective coating capable of minimizing underfilm corrosion and a cathodic protection system designed to mitigate corrosion for a minimum of 20 years or intended service life.

3 Independent Third Party (I3P) Review

Independent Third Party (I3P) review of mechanical (grip and seal) pipeline connectors can facilitate timely review and approval from BSEE. The scope of the I3P review includes review of manufacturer completed engineering design, and issuance of a statement of compliance that the engineering design was done to stated industry standard(s) and is suitable for stated limits. I3P review documentation should be available for mechanical (grip and seal) connectors through their supply chains so that they are readily available to the operator when permitting for use offshore. I3P reviews can be contracted by the manufacturers directly (BSEE GOAR confirmed for this specific scenario).

I3P review should also include review of manufacturer assumed requirements and associated engineering for mechanical (grip and seal) connector:

1. Design assumed external support (minimum soil strength or matting required)
2. Fluid and chemical limitations (seals and internal coating compatibility)
3. Temperature variation (considerations for maximum and minimum service temperatures)
4. Pressure cycling (number of cycles that support service life in application has been assessed)
5. Service life (considerations in design for a stated minimum service life)

4 Site-Specific Assessment (by Operator)

Each application of a mechanical (grip and seal) pipeline connector should also include an operator assessment of the site-specific use being applied for. Each of the following items should be addressed in the site-specific assessment. Site-specific technical justification should be provided for each item when submitting to BSEE.

1. Anticipated pressures are within rated values
2. Anticipated loading conditions are within rated values (including grip strength)
3. Connector seal is compatible with pipeline contents and temperatures
4. Anticipated pressure cycles are within desired service life pressure cycles designed for
5. Anticipated (geotechnical) support at the application site is within the required connector design support minimums
6. Desired service life is within engineered service life of the connector

As noted in Section 2.5 item A, in areas where environmental conditions such as mud-slide prone areas, additional site-specific engineering calculations may be required to support the application.

4.1 Common Loading Condition Considerations

To aid in the consistency of mechanical pipeline connector design and associated documentation, operators should provide manufacturers reference to standard desired loading conditions including pressure cycling and service life for different connector sizes.

4.2 Geotechnical Support Considerations

Mechanical (grip and seal) pipeline connector applications should be consistent with the pipeline system designs they are being applied to. These pipeline system designs should include geotechnical related information and condition assessments including some or all of the following:

1. Geological Surveys: A geological survey should be performed relevant to the design and siting of the pipeline and associated connectors. This survey should assess:
   - Seismic activity at the proposed site.
   - Fault zones, including the extent and geometry of faulting, and attenuation effects of geologic conditions near the site.
   - For pipelines located in producing areas, the possibility and effects of seafloor subsidence.
2. Soil and Foundation Conditions: Detailed analysis of soil properties is crucial to determine the suitability of the seabed for supporting pipelines and connectors. This includes evaluating:
   - Soil strength and composition to ensure that the pipeline can be supported and that the connectors are properly anchored.
   - Liquefaction, or the potential reduction of soil strength due to increased pore pressures.
   - The potential for degradation of subsea permafrost layers, if applicable.
   - Soil reactions on the pipeline foundations or anchoring systems.
   - Settlements and displacements that might occur over time.
   - Plastic deformation and formation collapse mechanisms.
3. Environmental Factors: The pipeline system (including connectors) must be designed to withstand the detrimental effects of various environmental factors:
   - Water currents.
   - Storm or ice scouring.
   - Known mud slide or seabed fluidization[1] areas.
   - Earthquakes.
   - Subfreezing temperatures.

Note 1: Seabed fluidization refers to the process where the seabed (the bottom layer of the ocean) becomes fluid-like due to the action of waves or currents. This phenomenon occurs when the forces exerted by waves or currents cause the sediment particles to lose contact with each other, resulting in a fluid-like behavior. It is often associated with excess pore water pressure and shear failure, which can lead to sediment resuspension and transport.

5 Minimum Installation Related Information

Each application to BSEE for use of a mechanical (grip and seal) pipeline connector should include the anticipated connector-specific installation procedures and associated measured installation forces to appropriately install the connector. Where ranges for such measured installation forces are provided by the manufacturer, the installation procedures submitted should include recording confirmation of actual installation forces being within recommended ranges. In general, submitted installation procedures should cover the following elements:

1. Anticipated site preparation (including required geotechnical support, if applicable)
2. Anticipated list of Installation tools
3. Anticipated torque and tensioning requirements for selected connector design
4. Anticipated installation documentation to be collected

In instances where matting or other support is required for geotechnical support of the connector, installation procedures submitted should also include installation of the required matting or other geotechnical support mitigation measures.

6 Inspection and Remediation (IR) Plan

Each application to BSEE for use of a mechanical (grip and seal) pipeline connector should include an appropriate Inspection and Remediation plan. This IR plan should include the frequency or trigger for inspection that supports the desired service life and may include consideration for different phases in the connector life cycle. For example, the IR plan may prescribe an inspection frequency that increases as the connector has been in place beyond a certain time frame.

6.1 Inspection Procedures

Mechanical (grip and seal) pipeline connector inspection procedures should cover what inspection will be completed and at what frequency during the service life of the connector. The inspection procedure should also include any repair or replacement criteria that is design-specific for the connector used.

6.2 Remediation Procedures

Mechanical (grip and seal) pipeline connector remediation procedures should include any connector-specific remediation that is required or reasonably possible during its service life or as recommended by the manufacturer on an anticipated or potential inspection-based condition.

7 Mechanical Pipeline Connector Data

Each mechanical (grip and seal) pipeline connector installed should have a minimum set of information captured for later reference. This is particularly important since many pipeline systems with these connectors can change ownership. By capturing this minimum set of information, key information will be available to the current owners of these systems. The minimum set of information that should be collected, retained and passed to future owners include:

A. Manufacturer
B. Size / Design / Model No. (inclusive of base materials - steel and elastomers)
C. Install date
D. As built install location (including Water Depth and orientation)
E. Operating conditions (pressure, temp, fluid)
F. Installed support or restraint
G. Maintained test data records (site acceptance test data)