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1.0 Contents

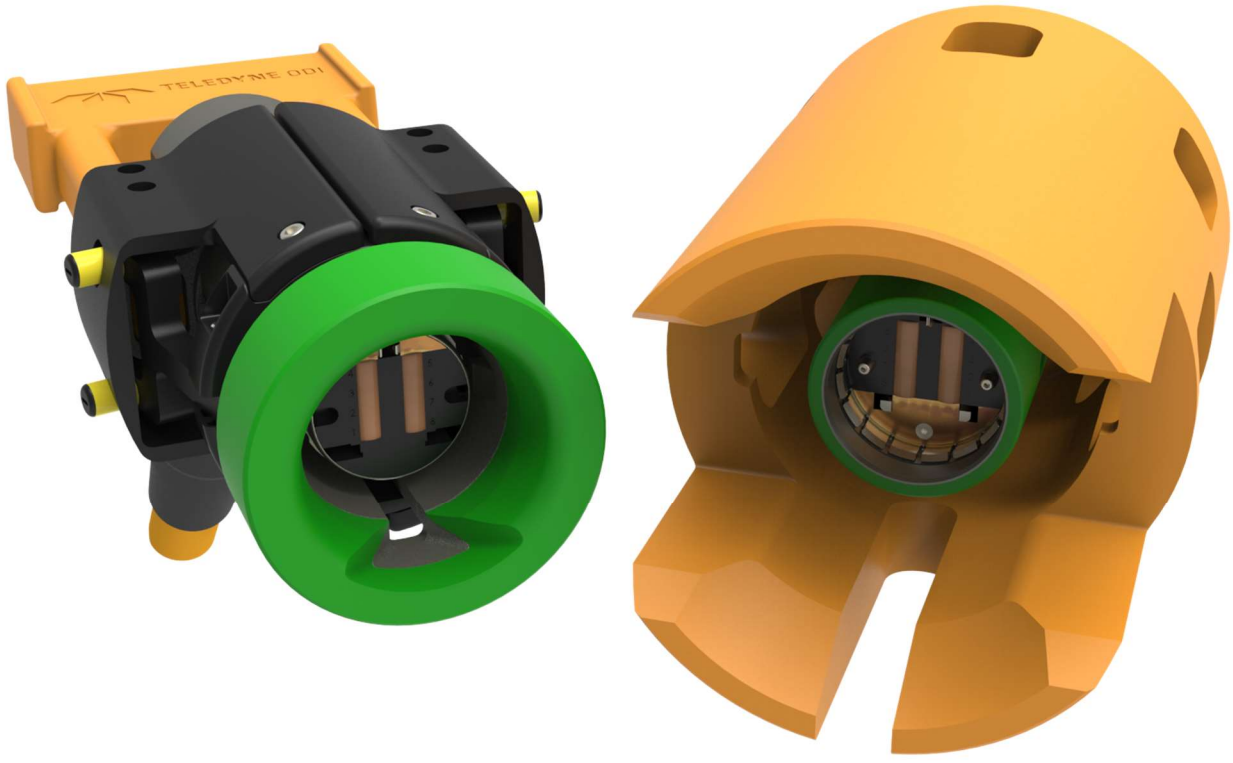


Figure 1: Example of a Wet-Mate Hybrid Connector

2.0 Introduction

NOTE: Hybrid connectors may include both electrical and fiber optic connections.

This Installation and Operation Manual covers Teledyne Oil & Gas, Inc. wet-mate hybrid bulkhead plug and flying lead receptacle connectors, specifically the 4-way and 8-way **Rolling Seal** product line, and the **Nautilus Rolling Seal Hybrid** product line. If required, the connector's outline and interface details will be provided from drawings referenced on the cover sheet.

3.0 General Notes of Caution

The Teledyne Oil & Gas wet-mate hybrid connectors are unlike any other connectors with which you may be familiar and they require special handling to function properly. Failure to follow correct procedures, as outlined below, will most likely cause **severe** damage.

NOTE: Mk I connectors are **not** interchangeable with Mk II, Mk III, or Mk IV connectors.

- **Never** exceed the connector specifications.
- **Never** mate Mk I connectors to Mk II, Mk III, or MK IV connectors. MK I connectors are not compatible with MK II, III or IV hardware. They must be treated as unique and if reorder hardware is required, it should be made clear that the MK I connectors are being used. If in any doubt, contact Teledyne Oil & Gas for clarification of connector type.
- **Never** "bounce" the connector with the ROV during installation in an attempt to mate.
- After 100 mates, please contact Teledyne for refurbishment. See the refurbishment section of this manal for an overview of the process.
- Live Connection and Disconnection - These connectors are not designed to be connected or disconnected while power is applied to the electrical circuits. **Severe** damage (including connector failure) can occur if this is done. In the event that live connection may occur or has occurred, please contact Teledyne Oil & Gas, Inc. for further guidance.
- Do not permit exposure of these connectors to petroleum-based fluids or lubricants, or other aggressive fluids that adversely affect natural rubbers.
- Do not permit prolonged exposure to sunlight. **Always fit a temporary or permanent protective cap when any connectors are left unmated.**
- Simple tests, such as continuity, for example, can only be done on fully mated connectors with conductor pigtails or other exposed cable ends. There are no optical or electrical contacts accessible for probing or visual inspection on either connector half.
- **Never** attempt to actuate the connector's seals using anything but a mating connector.

- **Never** attempt to insert anything into any of the ports of the connector shells.
- Avoid any damage to the exposed rubber parts on the connector's mating faces.
- Be extremely careful not to sharply bend the optical fibers, which are particularly vulnerable at the point where they exit the connector. Fiber breakage resulting in the permanent loss of the affected circuit would result.
- The relatively high mating and de-mating forces can make hand mating difficult. This is particularly true for ROV mateable versions. Care should be taken to verify that excessive force is not used to mate or de-mate the connector and that the maximum mating/de-mating speed is not exceeded. The mating/de-mating motion should be smooth and steady. If access to the connectors makes controlled mating and de-mating difficult, then Teledyne Oil & Gas, Inc. should be contacted to provide either on site assistance or for consultation on a mating and de-mating fixture tailored to the specific application and the access limitations.
- Like all of Teledyne Oil & Gas's standard ROV connectors, ROV versions of the connector should be handled and mated and de-mated using the attached handle only. The mate is a simple push to connect and the de-mate is a simple pull to disconnect, both via the handle. Any attempt to disconnect by pulling on other parts of the connector (including the hose or cable termination) will likely result in permanent damage to the connector.
- Do not allow the ROV jaw to handle the hose such that the minimum bend radius of 5 inches is violated.
- Do not allow the ROV jaw to contact the connector shell, as this will prevent mate operation and possibly cause damage to the connector. See Figure 2 for reference:

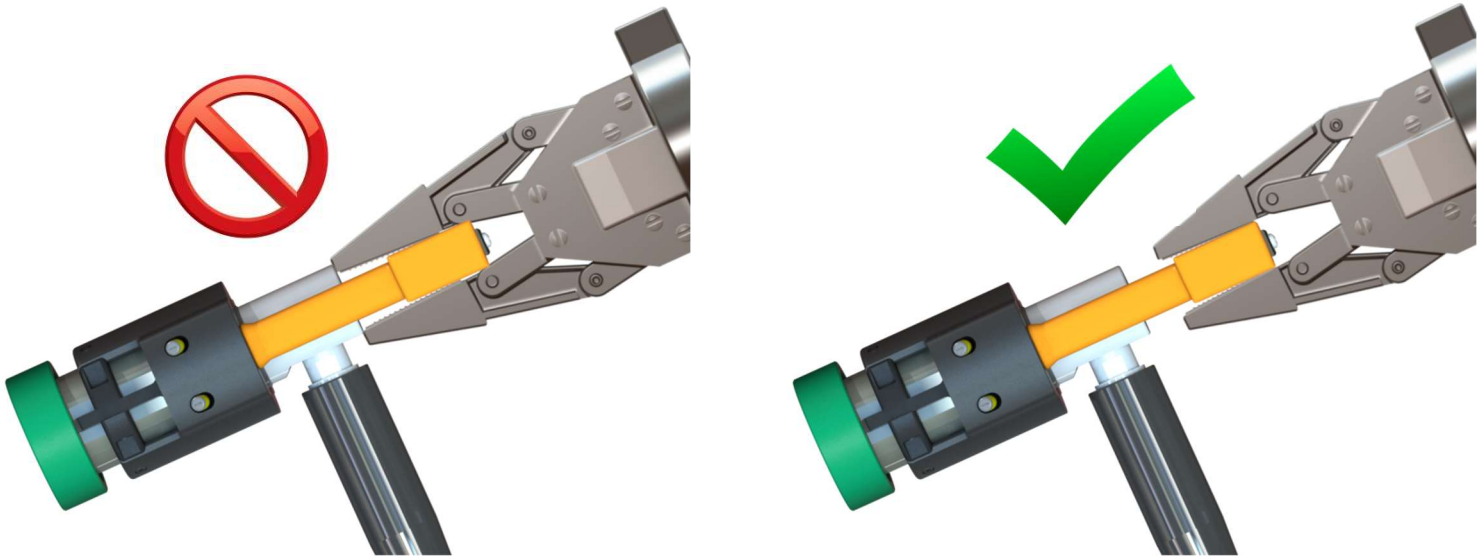


Figure 2: Incorrect (left) and Correct (right) Positioning of the ROV Jaw in Relation to the Connector Handle

- Unlike Mk I connectors, which require full mate and de-mate, Mk II, Mk III, and Mk IV connectors may be backed out once the connector halves begin to go together without damage occurring.
- Do not coil the hose more than 1/2 turn within 3 feet of connector/penetrator termination shell. Excessive coiling of the hose in close proximity to the termination shell could lead to fiber and wire management issues inside of the termination shell.
- **Never** store subsea without a long term protective cap.
- When mating Mk II to Mk III or Mk IV connectors, contact TOG for optional GAF and ELI hardware to further increase chances of a successful mate.

4.0 Unpacking

Wet-mate hybrid connectors are frequently supplied with loose fiber optic pigtails. Great care must be taken while unpacking the connectors to prevent damage to these pigtails. Damage to these pigtails will most likely require the connectors be returned to Teledyne Oil & Gas, Inc. for repair. If in doubt, leave the boxes closed and consult Teledyne Oil & Gas, Inc. for further information. If the boxes have to be opened to verify their contents, then it is strongly recommended that the connectors themselves are not removed from the box.

4.1 Check list for Unpacking Connectors

NOTE: A small amount of residual silicone oil may be present from filling the connectors just prior to shipment. This is normal.

NOTE: Contact Teledyne Oil & Gas if issues are noted.

☐ Upon opening the shipping container, check to see if the contents appear to have been disturbed.

☐ Inspect the packing material that the connectors are lying on for the presence of excess silicone oil.

☐ Take care not to damage any fiber optic pigtails that may be present, remove the connector assemblies from the packing crate.

☐ Verify there is no damage to the Enhanced Latch Indicator Kit (E.L.I.) or fiber optic pigtails.

☐ Inspect the connector assembly for any signs of damage.

☐ Remove the protective cover over the front of the connector and inspect the face against Figure 11 (Plug) or Figure 12 (Receptacle) of Appendix A.

☐ The rolling seals should be closed (no openings in the seals visible) with a smooth undamaged surface. The paddles should appear uniformly separated.

☐ If the connector is an ROV mated flying end receptacle without an E.L.I. kit installed, then inspect the latch fingers. The fingers should be lying flush with the body of the shell when mated to a plug. (Appendix A – Figure 13)

5.0 Installation

The wet-mate hybrid connectors are simple and straightforward to install if the special handling instructions given here are followed. The installation can usually be carried out without the need for special tools. The following sections must be read to prevent damage to the connectors.

NOTE: Where cable termination work and mounting are carried out by those other than Teledyne Oil & Gas, Inc. the responsibility for that work lies with the customer or his subcontractor. The following information is provided for guidance only**.**

5.1 Mounting

Teledyne Oil & Gas manufactures its connectors from various materials. Most notably, the ROV connectors are manufactured from titanium. Teledyne Oil & Gas can provide isolation adapters for all of its connectors should the mounting structure be made from a dissimilar material. Please contact Teledyne Oil & Gas for connector materials and isolation adapters to prevent galvanic corrosion.

5.2 Terminations

For most applications, we recommend that these connectors be terminated to their cabling at Teledyne Oil & Gas, Inc. In the event that the connectors must be terminated in the field, then they will be supplied with optical and/or electrical pigtails, as required.

5.2.1 Electrical Terminations

The connectors are supplied with one of the following electrical terminations:

- Both plug and receptacle are provided with 16 AWG pigtails for cable connection. Conventional crimping or soldering techniques should be employed to verify good joints.
- Both plug and receptacle are provided with gold plated solder buckets for cable connection. 4-way and 8-way Rolling Seal solder buckets can accommodate wire sizes from 20 AWG to 14 AWG. NRH solder cups can accommodate wire sizes up to 12 AWG (4.0 mm2) and up to 10 AWG (6 mm2) using solder cup adaptors. Termination should be performed per an industry recognized soldering standard such as IPC/J-STD-001 or IPC-WHMA-A-620.

5.2.2 Optical Terminations

Both plug and receptacle are provided with fiber optic pigtails. It is recommended that these be fusion-spliced to the cable fibers. The connectors are frequently supplied with the pigtails terminated with FC, ST, SC, LC, or E-2000 type test connectors to allow optical measurements to be made on the finished connector.

5.3 Boot Seals

5.3.1 Electrical Terminations

If rubber "mechanical" boot seals are employed, then both wire jacket and boot seal nipple should be cleaned with a suitable solvent (verify compatibility with wire jacket), dried, and then lightly lubricated with silicone lubricant (e.g., Dow Corning, DC-4). Take care to verify the wire is cut cleanly and that no sharp edges or stray wires are sticking out that may damage the boot seals during installation. If the connectors are supplied with pigtails, then boot seals will be in place. These should not be removed.

5.3.2 Optical Terminations

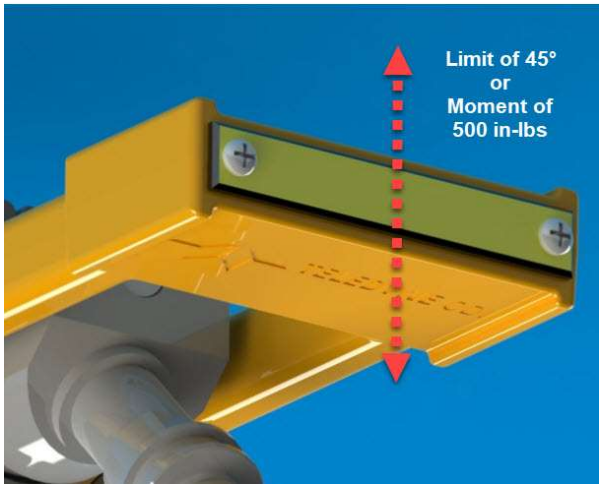
Rubber "mechanical" boot seals are employed on the fiber optic pigtails and are in place when the connector is delivered. These boot seals should not be removed.

5.4 O-rings

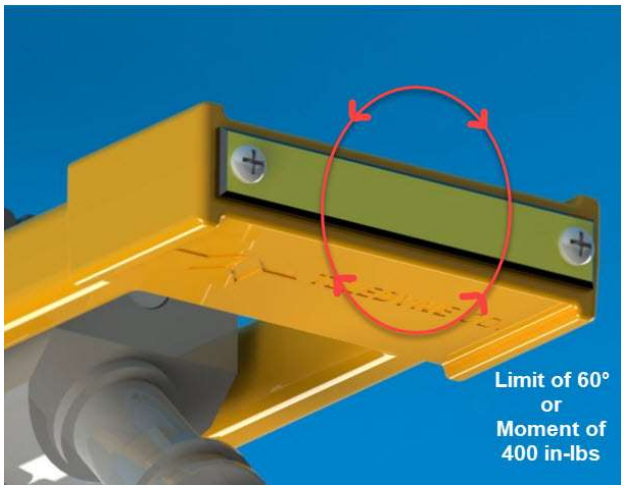
Both the plug and receptacle are supplied with O-rings required for sealing the connector onto its mounting. Normally, these are Nitrile O-rings and their compatibility with the contained fluid (if any) should be confirmed. The O-rings are supplied in a separate bag. Prior to installation, verify that the O-ring groove in the connector is clean. Lightly lubricate the O-ring with silicone lubricant and install in groove.

5.5 ROV Handle Limitations

5.5.1 It is recommended to avoid pitching the handle more than 45 degrees, the moment should not exceed 500 in-lbs



5.5.2 It is recommended to avoid rolling the handle more than 60 degrees, the moment should not exceed 400 in-lbs



5.6 ROV Mating Guidelines – ROV Stabilization

5.6.1 There are two fundamental ways to control the ROV prior to mating the Teledyne Oil & Gas, Inc. connectors. The ROV can either grab on to the subsea structure with one of the manipulator arms while mating, or not grab on at all and 'free-fly' mate the connectors together.

5.6.2 Although Teledyne Oil & Gas, Inc. does not promote one method above another, great care must be taken if the ROV is supported by grabbing onto the structure with one manipulator arm. This fixed point can act as a pivot point, causing excessive off-axis loading on the connectors leading to severe connector damage.

5.7 ROV Mating Guidelines – Horizontal Connection

NOTE: Operator must refer to Appendix B – Mating Checklist before starting operation.

NOTE: Positioning the camera off axis to the ROV connector increases the potential for damaging due to misalignment.

NOTE: If the ROV connector is not aligned with the bulkhead connector, attempt again to re-align the connectors before mating. If the stab is made with very slight misalignment (± 5° tilt), the connector handle is compliant enough to allow the connectors to mate without damage. However, excessive angular misalignment (greater than ± 5°) can cause severe damage to the connectors.

5.7.1 Use the ROV manipulator jaw to grasp the flying lead handle squarely. Adjust the arm so that the connector is held as close to horizontal as possible. The alignment keyway in the ROV connector should be aligned with the key on the bulkhead.

5.7.2 Position the manipulator jaw and the connector such that the camera is in line with the centerline of the axis of the connector.

CAUTION: Do not "bounce" the connector with the ROV during installation in an attempt to mate.

5.7.3 Once the conical lead-in on the ROV flying connector has engaged the outer bushing on the bulkhead connector and proper alignment is confirmed, mate the connectors by applying linear motion and along the axis of the connectors.

5.7.4 Positive thrust should be maintained until the yellow latching indicator buttons pop out of the connector body. If the enhanced latch indicator is not installed, as on a Mk I or Mk II connector, maintain positive thrust until the locking arms (latch fingers) on the ROV connector are witnessed as flush with respect to the side of the ROV connector shell.

5.7.5 Inspect latch fingers per the "ROV Connectors" section. Verify that latch fingers are flush with respect to ROV connector shell.

5.7.5.1 In the event of a partial mate where latching is not achieved, the ROV operator should inspect the OFL connector face to ensure the paddles have returned to the full closed position.

5.8 ROV Mating Guidelines – Vertical Connection

NOTE: Operator must refer to Appendix B – Mating Checklist before starting operation.

NOTE: Positioning the camera off axis to the ROV connector increases the potential for damaging due to misalignment.

NOTE: If the ROV connector is not aligned with the bulkhead connector, attempt again to realign the connectors before mating. If the stab is made with very slight misalignment (± 5° tilt), the connector handle is compliant enough to allow the connectors to mate without damage. However, excessive angular misalignment (greater than ± 5 °) can cause severe damage to the connectors.

5.8.1 Use ROV manipulator jaw to grasp the plastic handle on the ROV flying connector.

5.8.2 Position the manipulator jaw and connector such that the camera is in line with the centerline axis of the connector.

5.8.3 Use the ROV manipulator jaw to gently set the ROV flying connector onto the bulkhead connector so that the acceptance cone in the ROV flying connector guides down onto the bulkhead connector bushing.

CAUTION: Do not "bounce" the connector with the ROV during installation in an attempt to mate.

5.8.4 Release the manipulator jaw from the connector handle.

5.8.5 Turn the manipulator jaw on its side and gently press down on the top of the handle until the yellow latching indicator buttons pop out of the connector body. If the enhanced latch indicator is not installed, as on a Mk I or Mk II connector, maintain positive thrust until the locking arms (latch fingers) on the ROV connector are witnessed as flush with respect to the side of the ROV connector shell.

5.8.6 Inspect latch fingers per the "ROV Connectors" section. Verify that latch fingers are flush with respect to ROV connector shell.

5.9 ROV De-mating Guidelines – Horizontal Disconnection

NOTE: Operator must refer to Appendix B – De-mating Checklist before starting operation.

NOTE: Positioning the camera off axis to the ROV connector increases the potential for damaging due to misalignment.

5.9.1 Position the manipulator jaw and connector such that the camera is in line with the centerline axis of the connector.

5.9.2 Stabilize the ROV sub then close the manipulator jaw on the flying connector plastic handle.

5.9.3 Apply linear and steady motion to disconnect the flying lead.

5.9.4 Inspect the connector faces per Appendix A.

5.10 ROV De-mating Guidelines – Vertical Disconnection

NOTE: Operator must refer to Appendix B – De-mating Checklist before starting operation.

NOTE: Positioning the camera off axis to the ROV connector increases the potential for damaging due to misalignment.

5.10.1 Position the manipulator jaw and connector such that the camera is in line with the centerline axis of the connector.

5.10.2 Stabilize the ROV sub.

5.10.3 Extend and open the ROV manipulator jaw.

5.10.4 Position the open manipulator jaw squarely under the connector handle.

5.10.5 Raise the manipulator arm vertically to raise the connector slightly off the bulkhead receptacle.

5.10.6 Close the manipulator jaw on the handle to avoid dropping the connector.

5.10.7 Inspect the connector faces per Appendix A.

6.0 Diver Mateable Connector Mating Guidelines

Figure 3: An Example of a Diver Mate Connector Pair

6.1 Diver Mate Connector Preparation

6.1.1 Verify both plug and receptacle connectors for damage or build-up of debris.

6.1.2 If there is any noticeable quantity of particulate or larger debris, refer to the maintenance section of this document for guidelines.

6.2 Mating Diver Mate Connectors

NOTE: A "C" Spanner may be used to rotate the locking sleeve. The maximum torque applied to the locking sleeve must not exceed 6.7 Nm (60 in-lbs.).

NOTE: The speed for Manual mate operation is the function of the operator/technician and can vary as long as the wet-mate connector specifications are not exceeded. (Section 8.1).

6.2.1 Once visual inspection is complete, position the connectors that are to be mated so that they are both held as close to horizontal as possible. The alignment keyway should be aligned with the mating connector alignment key prior to mating connectors.

6.2.2 Verify the alignment key has entered the keyway and proper alignment is confirmed; mate the connectors by applying linear motion along the axis of the connectors until the locking sleeve meets the male thread.

6.2.3 Rotate the locking sleeve in a clockwise direction as slow and steady as possible until the connector shells meet and the locking sleeve cannot be rotated any further, i.e. it is "hand tight."

6.3 De-Mating Diver Mate Connectors

NOTE: A "C" Spanner may be used to rotate the locking sleeve during the de-mating sequence, if required.

6.3.1 Verify the power to the connector has been shut down and a sufficient time has passed for the residual charge to bleed off.

6.3.2 Position the mated connectors so that they are both held as close to horizontal as possible.

6.3.3 Rotate the locking sleeve counter-clockwise until the sleeve is free of the threads.

6.3.4 De-mate the connectors.

6.3.5 Inspect the connector faces for damage.

6.3.6 Install protective covers, if available to prevent damage and fouling.

Figure 4: An Example of a "C" Spanner Tool that can be used for Mating & De-mating Diver Mate Connectors.

NOTE: Use of the pedestal is highly recommended. However, if the pedestal is not used, the mating and demating guidelines shall apply to all hand mating operations.

The hand mate pedestal, Figure 5, is supplied for use with test connectors to verify flying lead operation before deployment. It is highly recommended that this pedestal be used when performing hand mates, as mating the connectors without the plug secured to a hard mount can induce connector damage.

6.4 Pedestal Assembly and Connector Installation

6.4.1 Assemble the hand mate pedestal according to the exploded diagram in Appendix C.

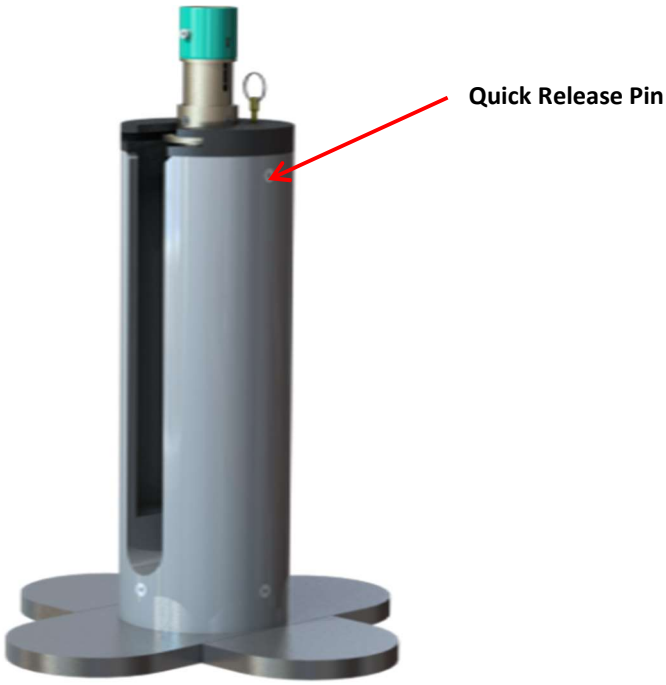


Figure 5: The Hand-Mate Pedestal, Shown with Connector Installed

6.4.2 To secure a test connector into the hand-mate pedestal PN 1018563, carefully slide the plug connector flange into the pedestal mount, as in Figure 6. Ensure no optics or wiring will be pinched upon installation, and that the connector is oriented such that the key and termination shell will clear the entrance into the fixture.

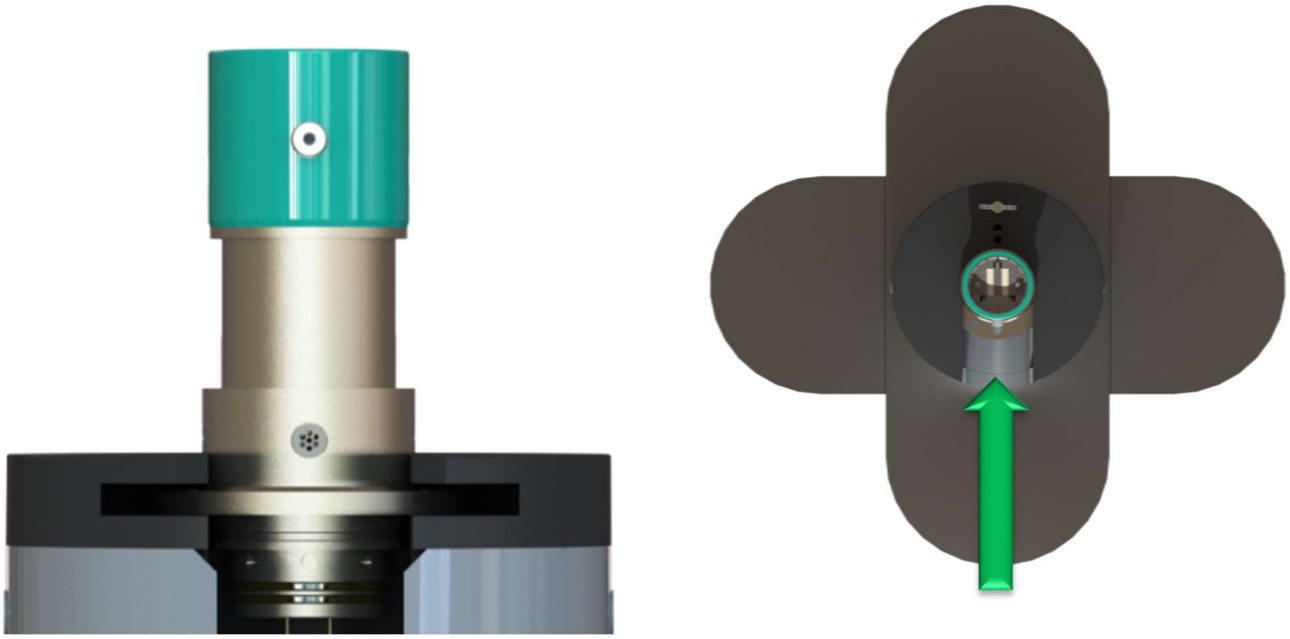


Figure 6: Connector Installation into the Hand-Mate Pedestal PN 1018563

6.4.3 Using the provided quick release pin, lock the connector in place by inserting it into the proper alignment hole in the hand mate stand and through the proper hole in the connector flange. Verify that no protrusions will prevent the two connector halves from mating.

6.5 Hand Mate and Demate

NOTE: A visual inspection of all rolling seals should take place before and after the mate/demate process. Failure to perform this inspection could result in damage. Contact Teledyne if issues are witnessed.

6.5.1 Perform a visual inspection of the connectors per Appendix B, contacting Teledyne if issues are witnessed.

6.5.2 Once the plug connector is firmly held in place in the hand-mate pedestal, it is ready to be mated to a flying lead. Hand-mating of the flying lead is a simple push-to-latch / pull-to-unlatch procedure.

6.5.3 Holding just the orange handle of the flying lead and without touching any other portion of the connector, align the keyway of the flying lead with the key on the plug connector mounted in the pedestal.

6.5.4 Firmly press the flying lead straight down into the connector shell until the system latches.

6.5.5 To demate, stand on the hand mate pedestal mounting plate and pull firmly on the orange handle of the flying lead to release. Pull in a single, smooth motion. Rocking the connector back and forth may induce damage.

6.5.6 After demate, perform a visual inspection of the connectors per Appendix B, contacting Teledyne if issues are witnessed.

7.0 Operation

Wet-mate hybrid connectors require special instructions regarding their operation. See section 8.1 on operational limitations. The following lists the capabilities of the wet-mate hybrid connector. These should not be exceeded.

NOTE: These connectors are intended for general subsea use. They are wet-mateable at any ocean depth.

NOTE: Section 8.1 refers to the wet-mate hybrid connectors' qualified capabilities and not to the factory acceptance tests actually carried out on the delivered connectors. Refer to test procedure for details of the delivered connectors tested parameters.

NOTE: A mating log record of the connector use should be kept, particularly for test connectors, as exceeding the lifetime may result in damage to the connector and to any other connector to which it is mated.

NOTE: Mk I connectors are **not** interchangeable with Mk II, Mk III, or Mk IV connectors.

Example of MKI Style

Example of MKII Style

Example of MKIII Style

Example of MKIV Style

Figure 7: Evolution of the Wet Mate Hybrid Connector Mk I, Mk II, Mk III & MK IV

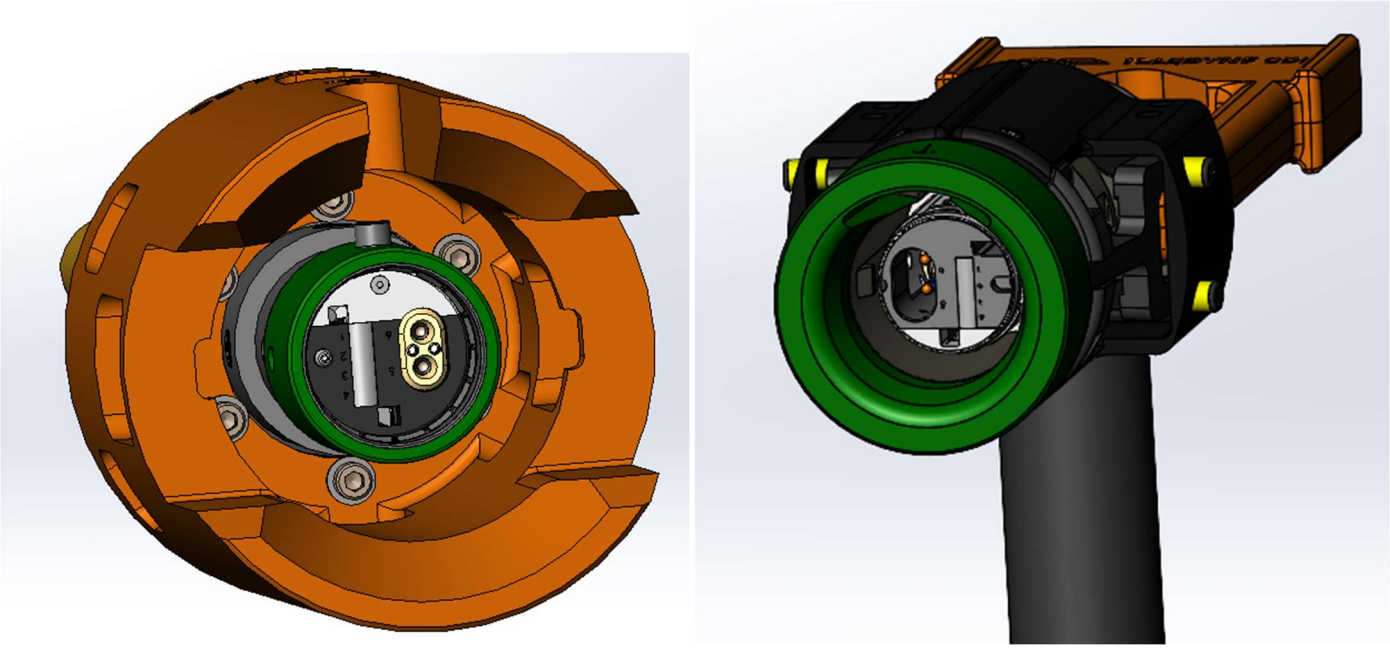


Figure 8: Wet Mate Nautilus Rolling Seal Hybrid Connector (NRH)

- Bulkhead connector has electrical female sockert, cable end connector has electrical male pins

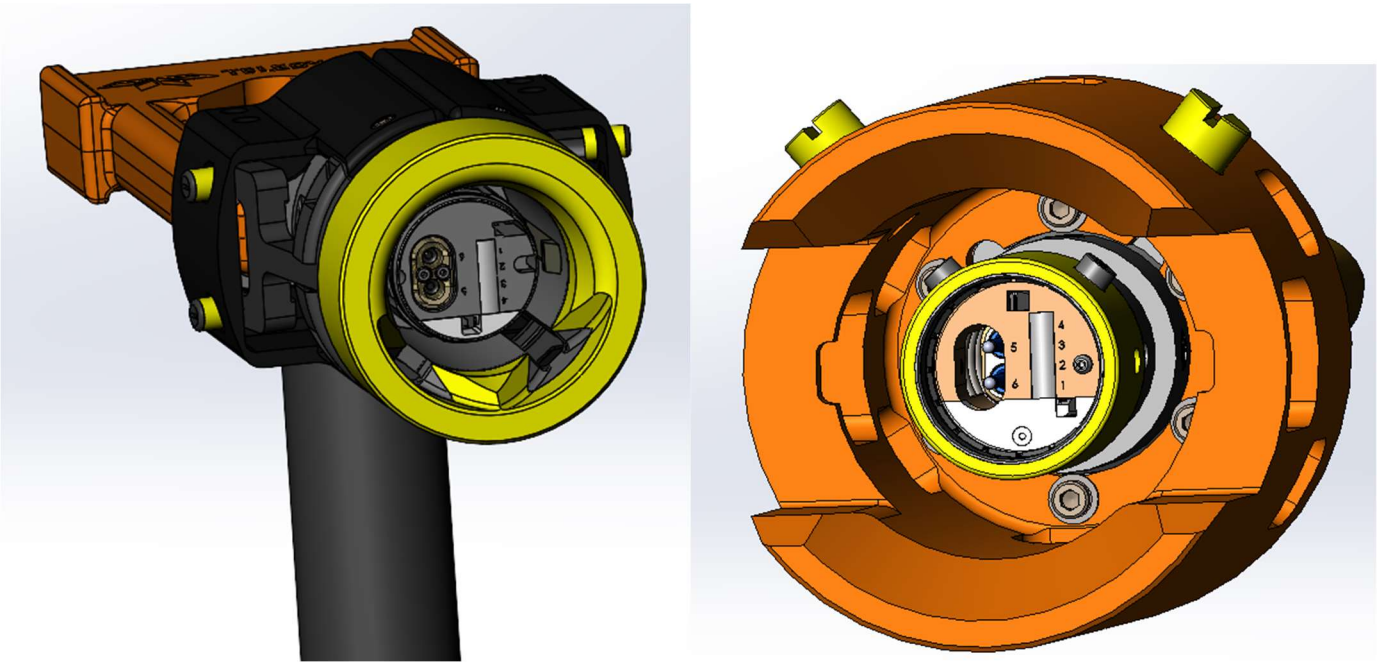


Figure 9: Wet Mate Nautilus Rolling Seal Reverse Gender Hybrid Connector (NRH RG)

- Bulkhead connector has electrical male pins, cable end connector has electrical female sockets.

7.1 Rolling Seal Hybrid Specifications

Parameter		Rating
Operational Temperature		-5°C to +40°C (seawater) -18°C to +50°C (air)
Storage Temperature		-30°C to +60°C
Maximum Operational Pressure		10,000 psi ambient 5,000 psi differential (bulkhead)
Mate/De-mate Cycles		100 without refurbishment
Mating / De-mating Force		≤ 120 lbs / 100 lbs
Configurations		ROV, Stab & Manual-Mate
Material		Titanium is preferred shell material
Design Life		30 years
Number of Circuits		RS4: 4 max, optical (or legacy electrical) RS8: 8 max, optical (or legacy electrical)
Insertion Loss		≤ 0.5 dB @ 1310/1550/1625 nm (single-mode) ≤ 1.0 dB @ 850/1300 nm (multi-mode)
Return Loss		≥ 30 dB @ 1310/1550/1625 nm (UPC) ≥ 45 dB @ 1310/1550/1625 nm (APC)
Maximum Optical Power		300 mW continuous
Fully Compatible Fluids		Fresh Water, Sea Water, DC 200 Silicone Fluid
Intermittently Compatible Fluids		MEG, 50% Citric Acid, 50% Acetic Acid, Oceanic HW 443
Maximum Mating/Demating Speed		Mate: 0.5 m/s Demate: 1.0 m/s
Allowable Rotational Misalignment		+/- 10˚ (Figure 17)
Allowable Angular Misalignment		+/- 30˚ (5˚ without GAF) (Figure 18)
Allowable Linear Misalignment		+/- 0.175 in (Figure 19)
Allowable Axial Force	**During Mating**	450 lbs
	On Mated Connector	1124 lbs

7.2 Nautilus Rolling Seal Hybrid Specifications

Parameter		Rating
Operational Temperature		-5°C to +40°C (seawater) -18°C to +50°C (air)
Storage Temperature		-30°C to +60°C
Maximum Operational Pressure (Pressure Balanced)		10,000 psi ambient
Maximum Operational Pressure (Differential Pressure)*		N/A*
Mate/De-mate Cycles		100 without refurbishment
Mating / De-mating Force		≤ 120 lbs / 100 lbs
Configurations		ROV & Manual-Mate
Material		Titanium is preferred shell material
Design Life		30 years
Number of Circuits		2 electrical, 4 max optical
Insertion Loss		≤ 0.5 dB @ 1310/1550/1625 nm (single-mode) ≤ 1.0 dB @ 850/1300 nm (multi-mode)
Return Loss		≥ 30 dB @ 1310/1550/1625 nm
Maximum Optical Power		300 mW continuous
Maximum Operational Current		30 amps per circuit
In-Rush Current		100 amps for 0.5 seconds
Maximum Operational Voltage *(Mated Connectors and Unmated Sockets Only)*		1.0 kVAC Phase to Ground 1.73 kVAC Phase to Phase 3.3 kVDC
Insulation Resistance		≥ 10 GΩ @ 1kVDC
Contact Resistance		≤ 10 mΩ per contact
Mated Connector Continuity Resistance		≤ 0.2 Ω per contact
Fully Compatible Fluids		Fresh Water, Sea Water, DC 200 Silicone Fluid
Intermittently Compatible Fluids		MEG, 50% Citric Acid, 50% Acetic Acid, Oceanic HW 443
Maximum Mating/Demating Speed		2 in/sec
Allowable Rotational Misalignment		+/- 10˚ (Figure 17)
Allowable Angular Misalignment		+/- 30˚ (5˚ without GAF) (Figure 18)
Allowable Linear Misalignment		+/- 0.175 in (Figure 18)
Allowable Axial Force	**During Mating**	450 lbs
	On Mated Connector	1124 lbs

***NRH bulkhead plugs are not to be used in differential pressure configuration.**

7.3 Visual Inspection

Before each mate and prior to subsea installation, the mating faces of each connector should be visually inspected. This is to verify that no damage has occurred to the seals and seal actuators. Looking at the face of a plug connector (Figure 20), the center actuator should visually appear to be symmetric and approximately centered in its guide slot. The absolute position of the center actuator is not critical; rather ensuring that the actuator is not really deformed is the goal.

The rolling seals should be closed (no openings visible in the seal). Looking at the face of a receptacle connector (Figure 21), the rolling seals should be closed and the paddles on the ends of the rolling seals should again be rotated to the same position on both seals.

7.4 Corrective Action

Should any difficulty be found with mating or de-mating a connector, or should a visual inspection show a reason for concern, it is critical that no further mates be carried out with that connector. Teledyne Oil & Gas, Inc. should be contacted immediately for instructions on how to proceed or what corrective action needs to be taken.

7.5 Maintenance

Wet-mate hybrid connectors require no periodic maintenance and are maintenance-free for their intended life. If their mating cycle lifetime (100 mates) is exceeded, the connectors should be returned to Teledyne Oil & Gas, Inc. for refurbishment. If damage occurs to the connector, then the entire connector must be returned to Teledyne Oil & Gas, Inc. for repair or replacement.

NOTE: Never insert anything into the connector since this may introduce contamination into the connector or cause internal damage.

NOTE: Never inject connectors with any type of fluid or attempt to clean connectors with any fluid not stated below. For specific questions, contact Teledyne Oil & Gas.

CAUTION: A low-pressure water jet (< 1000 psi) is acceptable, but the jet MUST not be directed onto the connector face as this will result in water being forced through the primary seals which could render the connector inoperable and/or unable to mate.

7.5.1 Basic Cleaning

Rolling Seal connectors can be cleaned by rinsing with clean water. Do not clean with alcohol to avoid degradation of natural rubber seals. An Alconox solution cleaner may be used instead.

7.5.2 Removal of Marine Growth and Calcareous Deposits

To remove calcite growth from the Rolling Seal connectors, a solution of 50% by volume of citric acid and water is recommended. All seawater exposed elastomeric materials in the connectors have been fully tested against citric acid and are compatible for duration of 1 hour. After soaking, rinse with fresh water to remove traces of the citric acid solution.

7.5.3 Subsea Cleaning

A low-pressure water jet (< 1000 psi) may be used to clean the connector while subsea, however, the connector must be in the mated condition during this operation. Do not direct the water jet onto the face of an unmated connector as this will result in water being forced through the primary seals which could render the connector inoperable and/or unable to mate. Ensuring the connector is mated to another connector or protective cap will prevent marine growth from forming on the connector face.

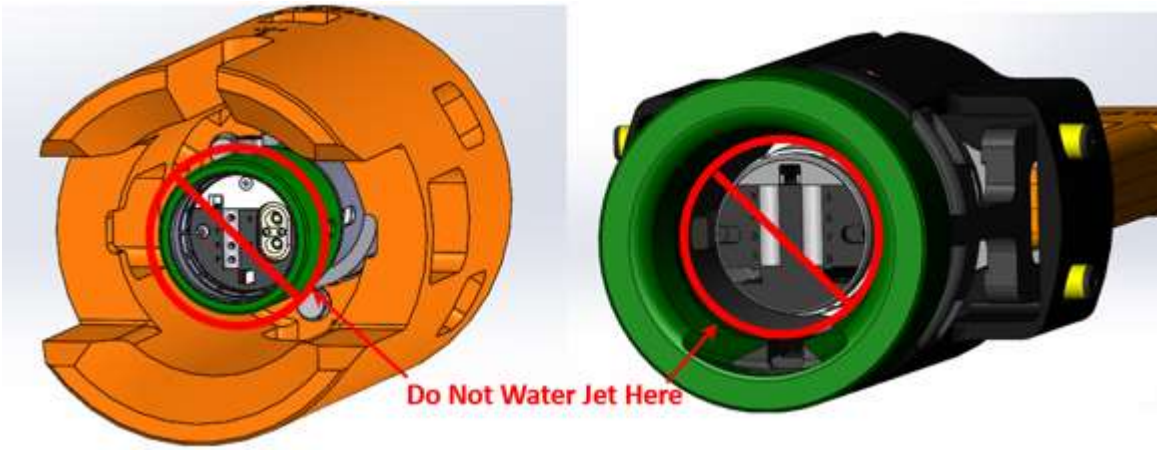


Figure 10: Optic/Hybrid Connector Locations to Avoid with Water Jet

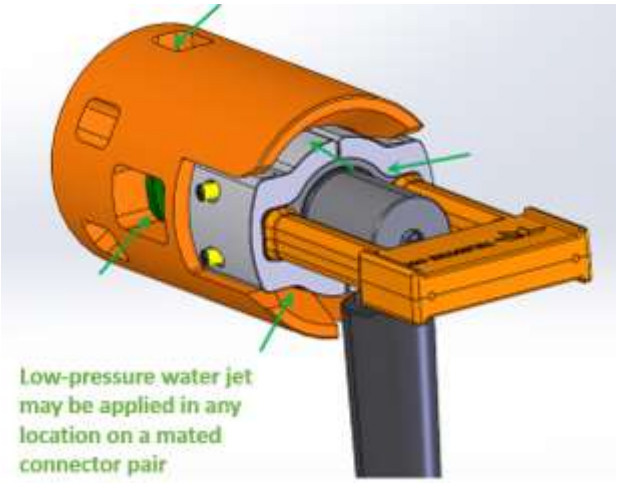


Figure 11: Optic/Hybrid Mated Connector Pair, Use of Low-Pressure Water Jet Acceptable

NOTE: If marine growth is present on the front face connector due to lack of protection subsea, the connector will have to be retrieved topside for cleaning according to chapter 7.5.2.

7.5.4 Mate Logging

All test connectors are available with a plastic card, which should be punched to indicate that a mate has occurred. For connectors without a plastic punch card, it is recommended to maintain a log of mates, so that once 100 mates have been performed, the connector may be immediately returned to or serviced by Teledyne Oil & Gas personnel. See the "Teledyne Oil & Gas refurbishment Procedure" section of this document for information about the refurbishment process.

8.0 Storage

8.1 Topside Short-term Storage (up to 1 year)

The connectors should be stored in clean, dry conditions and protected from exposure to sources of UV or ozone. Preferably, they should remain in their original shipping containers with shipping/protective caps in place.

8.2 Topside Long-term Storage (greater than 1 year)

The same storage conditions should be observed as specified above. Additionally, if the connectors remain unused after 2 years of storage, it is strongly recommended that they be returned to Teledyne Oil & Gas, Inc. for evaluation. If in doubt, contact Teledyne Oil & Gas, Inc.

8.3 Subsea Storage

Rolling Seal or NRH bulkhead plug connectors, with or without exposed electrical pins must be protected when stored for any length of time subsea. A bulkhead plug connector left unmated subsea runs the risk of particulate building up behind the manifold and preventing actuation.

Connectors exposed to subsea environments with high marine growth rates are susceptible to a more rapid build-up of particulates. As such, maintenance after 1 year is required under these conditions. Refer to Section 7.5.2 for instructions on the removal of marine growth and calcareous deposits.

CAUTION: Storing a bulkhead plug connector subsea without the use of a protective cap can result in decreased connector performance, damage to connector, and possible damage to customer equipment. Teledyne Oil & Gas is not responsible for issues caused by improper subsea storage of products.

8.3.1 Non-Actuating Long Term Protective Caps (Bulkhead Storage)

The non-actuating long term protective cap (LTC) is the standard for use with front-mount bulkhead Rolling Seal optical connectors. However, the non-actuating LTC cannot be used with rear-mounted bulkhead connectors.

Note that the non-actuating LTC cannot be used with NRH bulkhead connectors with electrical pins (i.e. Reverse Gender), as the exposed electrical pins require a protective cap with a socket assembly for long-term storage; the actuating LTC must be used instead.

CAUTION: NRH bulkhead connectors with exposed electrical pins (i.e. Reverse Gender) are also at risk for corrosion and marine growth if left unmated subsea for a cumulative period of greater than 2 weeks. However, due to the risk of sediment accumulation behind the manifold, *all* optical/hybrid bulkhead connectors must be covered by a long term protective cap for any length of time subsea.

8.3.2 Actuating Long Term Protective Caps (Bulkhead Storage)

The actuating long term protective cap (LTC) is the only qualified solution for rear-mount bulkhead optical connectors. It is also field-proven for front-mount bulkheads, but is more complex than the non-actuating LTC. The actuating long term protective cap (LTC) is the only qualified solution for NRH bulkhead connectors with exposed electrical pins (i.e. Reverse Gender).

CAUTION: NRH bulkhead connectors with exposed electrical pins (i.e. Reverse Gender) are also at risk for corrosion and marine growth if left unmated subsea for a cumulative period of greater than 2 weeks. However, due to the risk of sediment accumulation behind the manifold, *all* optical/hybrid bulkhead connectors must be covered by a long term protective cap for any length of time subsea.

8.3.3 Flying Lead Receptacle Storage

4-way and 8-way Rolling Seal flying lead receptacle connectors may be stored subsea mated to non-actuating parking positions, which amount to empty connector shells, though parking position use is not mandatory. Titanium and Delrin versions of the optical parking position are fully qualified, and either may be used.

NRH flying lead receptacles with exposed electrical pins (i.e. Standard Gender) should be mated to an NRH-specific parking position with a Nautilus socket assembly, which provides mandatory corrosion protection for the exposed pins.

NRH flying lead receptacles with exposed electrical pins should not be left unmated subsea for a cumulative period of greater than 2 weeks due to corrosion and marine growth.

Connectors exposed to subsea environments with high marine growth rates are susceptible to a more rapid build-up of particulates. As such, maintenance after 1 year is required under these conditions. Refer to Section 7.5.2 for instructions on the removal of marine growth and calcareous deposits.

Electrical pins left unmated for more than 2 weeks should be cleaned and inspected. Upon re-deployment the pins may remain for another 2-week period. NRH flying lead receptacles with exposed pins should never be left unmated with power applied to exposed pins.

9.0 Use of Gross Alignment Funnel with Enhanced Latching Indicator

Teledyne Oil & Gas has developed a gross alignment funnel and enhanced latching indicator system for use with rolling-seal hybrid connectors. Use of this equipment is a mandatory part of the Mk III and Mk IV (current) connector design, as the risk of damage to connectors during ROV intervention is greatly reduced.

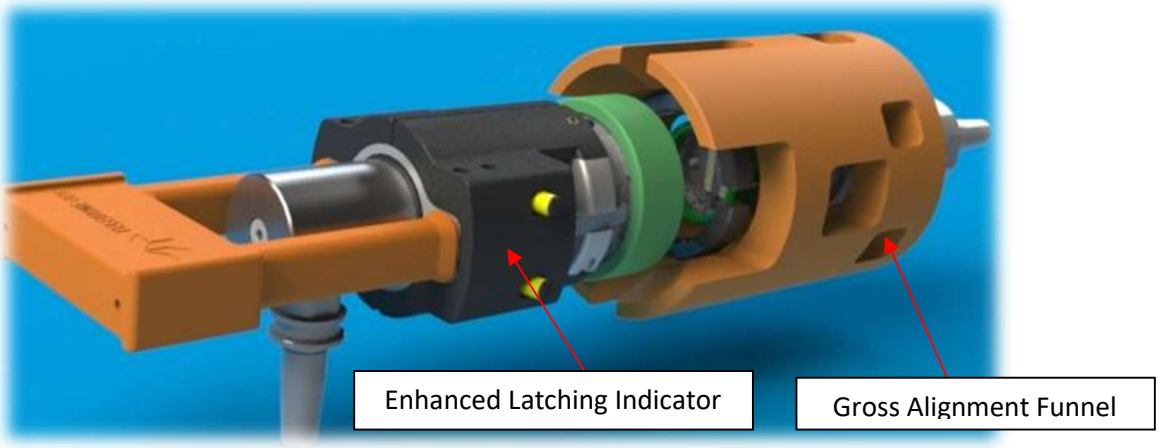


Figure 12: Gross Alignment Funnel and Enhanced Latching Indicator

The use of these components allows a much greater incidence angle during mating approach. The gross alignment funnel has a 60 degree included conical funnel at its mouth, which allows a steeper approach. The piloting dimensions of the latch and funnel together allow a maximum angle of 4 degrees between connectors during engagement.

The enhanced latching indicator can be retrofitted in the field, per Teledyne Oil & Gas assembly procedure **DN 10655**. The gross alignment funnel can be field assembled using Teledyne Oil & Gas assembly procedure **DN 244051**.

The gross alignment funnel must be attached to the bulkhead plug connector during assembly onto the mounting structure. An assembly drawing shall be provided for each unique configuration of the GAF. Torque of mounting bolts is to be 40 ± 4 in-lbs. (4.52 ± 0.45 N-m).

10.0 Appendix A: Figures

Rolling Seals

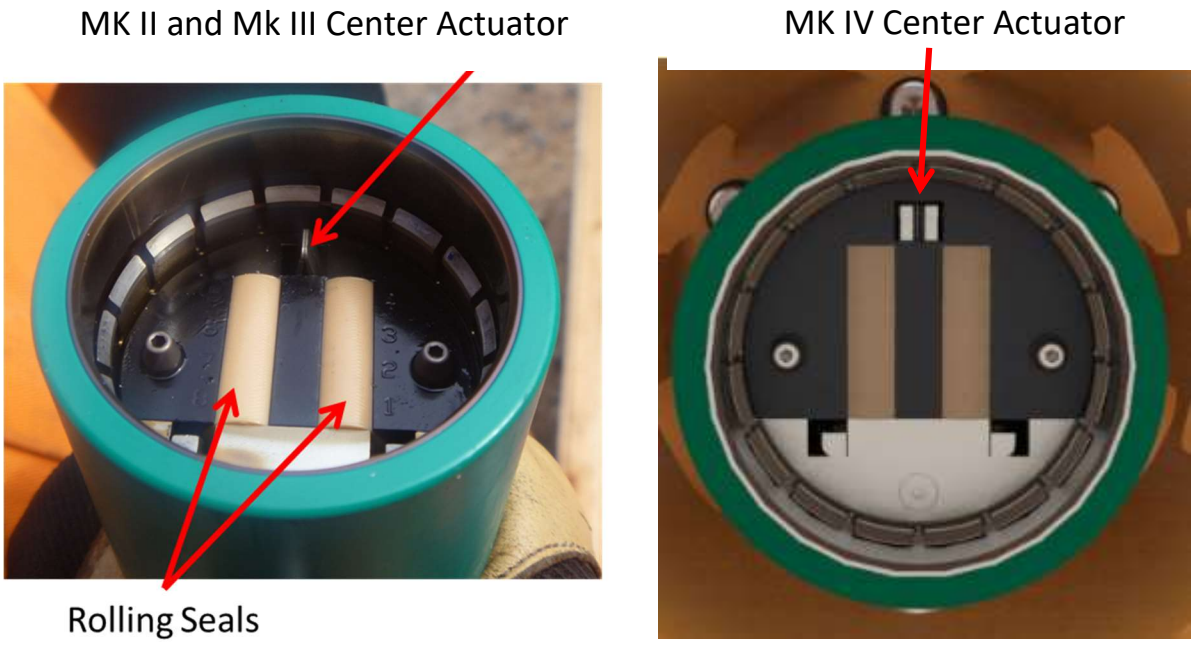


Figure 13: Plug Connector Mating Face

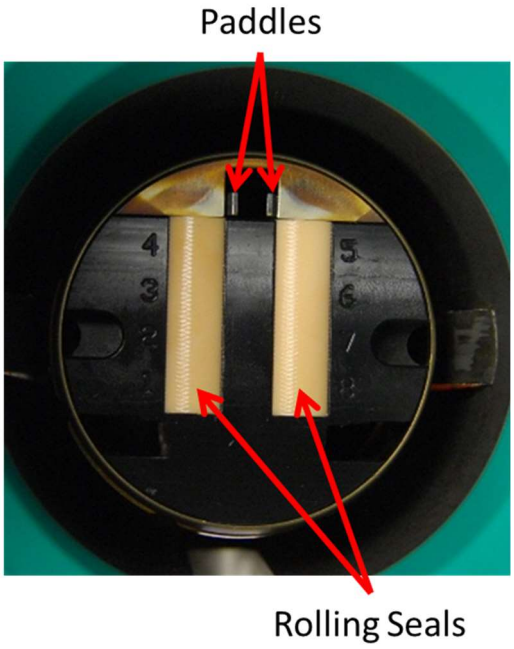


Figure 14: Receptacle Connector Mating Face

ROV Connectors

Figure 15: ROV Latch Fingers in the Closed Position (Mk II)

Figure 16: ROV Latch Fingers in the Open Position (Mk II)

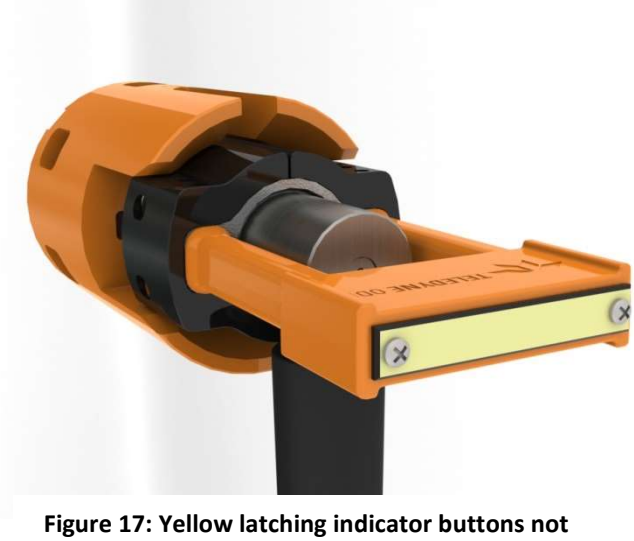


Figure 17: Yellow latching indicator buttons not popped out (not mated) on a Mk III or Mk IV connector

Figure 18: Yellow latching indicator buttons popped out (fully mated) on a Mk III or Mk IV connector

NOTE: Latching indicator buttons are present only on the Mk III and Mk IV versions of the flying lead optical connector.

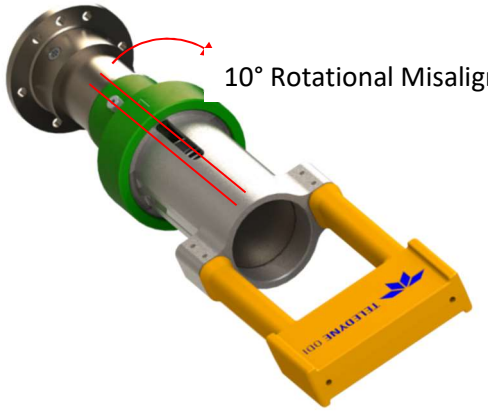


Figure 19: Depiction of Ten Degree Rotational Misalignment of ROV Connector with Respect to Bulkhead Connector

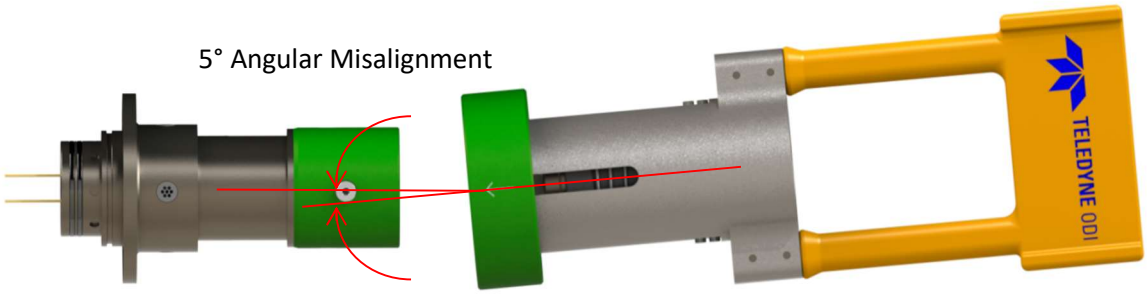


Figure 20: Depiction of Five Degree Angular Misalignment (Tilt) of ROV Connector with Respect to Bulkhead Connector

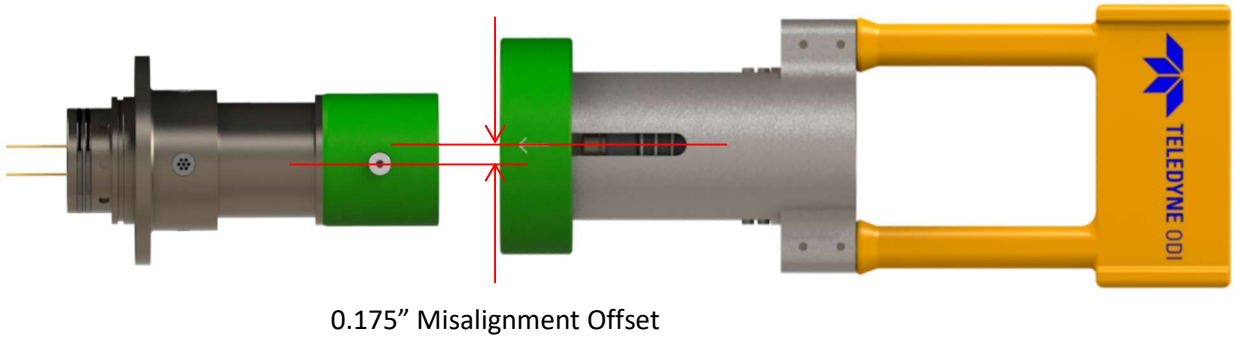
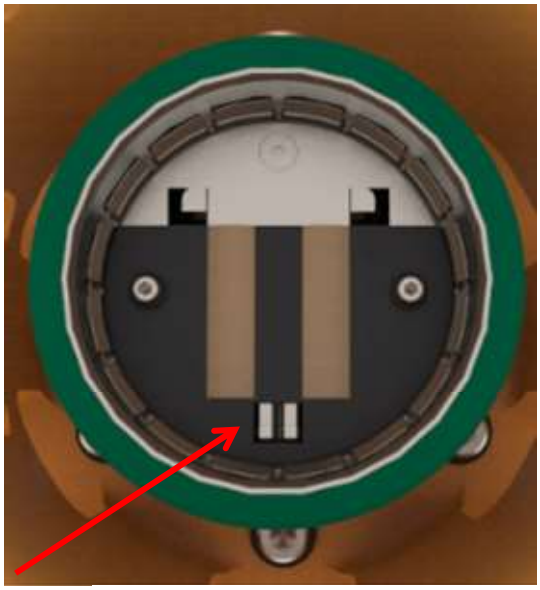


Figure 21: Depiction of a Linear Misalignment Offset of 0.175” of ROV Connector with Respect to Bulkhead Connector

11.0 Appendix B: ROV Operator Checklist

Checklist for Inspection of Bulkhead (Plug) Connector

- ☐ Center actuator arms touching in center (Except Mk IV Center Actuators).
- ☐ Rolling seals fully closed - no openings visible. No tears or damage.
- ☐ Qty 2 side actuators are approximately flush with the manifold face.
- ☐ Bushing attached to connector.
- ☐ No debris/scale on manifold or collet which may prevent proper mating.



Mk IV Center Actuator

Mk II and Mk III Center Actuator

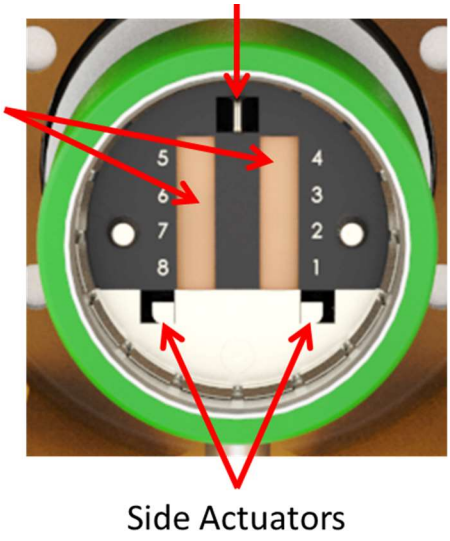


Figure 22: Bulkhead Connectors

Checklist for Inspection of OFL (Receptacle) Connector

- ☐ Rolling seals fully closed – no openings visible. No tears or damage.
- ☐ Paddles are in upright position, relative height equivalent to top of manifold.
- ☐ No debris/scale on manifold which may prevent proper mating.

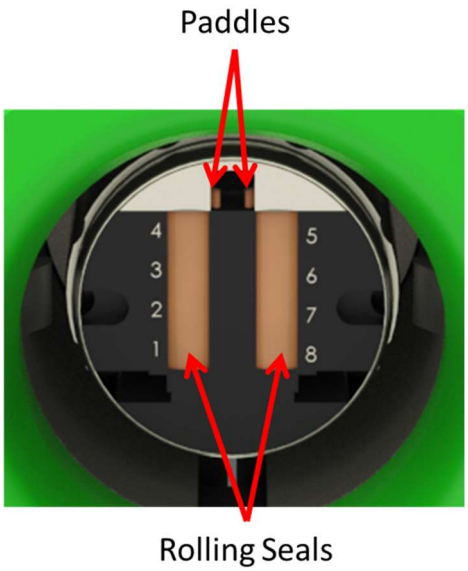


Figure 23: OFL Connector

Checklist for Mating Guidelines - Horizontal Connection

- ☐ Use the ROV manipulator jaw to grasp the flying lead handle squarely.
- ☐ Position the manipulator jaw so that connector is in line with camera.
- ☐ Adjust the arm so that the connector is held perfectly horizontal.
- ☐ The alignment keyway in the ROV connector should be aligned with the key on the bulkhead.
- ☐ Once the conical lead-in on the ROV flying connector has engaged the outer bushing on the bulkhead connector and proper alignment is confirmed, mate the connectors by applying linear motion and along the axis of the connectors.
- ☐ Positive thrust should be maintained until the yellow latching indicator buttons pop out of the connector body. If the enhanced latch indicator is not installed, maintain positive thrust until the locking arms (latch fingers) on the ROV connector are witnessed as flush with respect to the side of the ROV connector shell.
- ☐ Verify that yellow latching indicator buttons have popped out of the connector body. If the enhanced latch indicator is not installed, verify that latch fingers are flush with respect to ROV connector shell (closed).

Checklist for Mating Guidelines - Vertical Connection

- ☐ Use the ROV manipulator jaw to grasp the flying lead handle squarely.
- ☐ Position the manipulator jaw so that connector is in line with camera.
- ☐ Use the ROV manipulator jaw to set the ROV flying connector onto the bulkhead connector. The acceptance cone in the ROV flying connector guides down onto the bulkhead connector bushing.
- ☐ Release the manipulator jaw from the connector handle.
- ☐ Turn the manipulator jaw on its side and press down on the top of the handle until the yellow latching indicator buttons pop out of the connector body. If the enhanced latch indicator is not installed, press down on the top of the handle until the locking arms (latch fingers) on the ROV connector are witnessed as flush with respect to the side of the ROV connector shell.
- ☐ Verify that yellow latching indicator buttons have popped out of the connector body. If the enhanced latch indicator is not installed, verify that latch fingers are flush with respect to ROV connector shell (closed).

Checklist for De-Mating Guidelines - Horizontal Connection

- ☐ Position the manipulator jaw and connector such that the camera is in line with the centerline axis of the connector.
- ☐ Stabilize the ROV sub then close the manipulator jaw on the flying connector plastic handle.
- ☐ Apply linear and steady motion to disconnect the flying lead.
- ☐ Inspect plug and receptacle connector faces for damage per checklists "**CHECKLIST, INSPECTION OF BULKHEAD (PLUG) CONNECTOR**" and "**CHECKLIST, INSPECTION OF EOFL (RECEPTACLE) CONNECTOR**".

Checklist for De-Mating Guidelines - Vertical Connection

- ☐ Position the manipulator jaw and connector such that the camera is in line with the centerline axis of the connector.
- ☐ Stabilize the ROV sub.
- ☐ Extend and open the ROV manipulator jaw.
- ☐ Position the open manipulator jaw squarely under the connector handle.
- ☐ Raise the manipulator arm vertically to raise the connector slightly off the bulkhead receptacle.
- ☐ Close the manipulator jaw on the handle to avoid dropping the connector.
- ☐ Inspect plug and receptacle connector faces for damage per checklists "**CHECKLIST, INSPECTION OF BULKHEAD (PLUG) CONNECTOR**" and "**CHECKLIST, INSPECTION OF EOFL (RECEPTACLE) CONNECTOR**".

12.0 Appendix C: Assembly of Hand Mate Pedestal

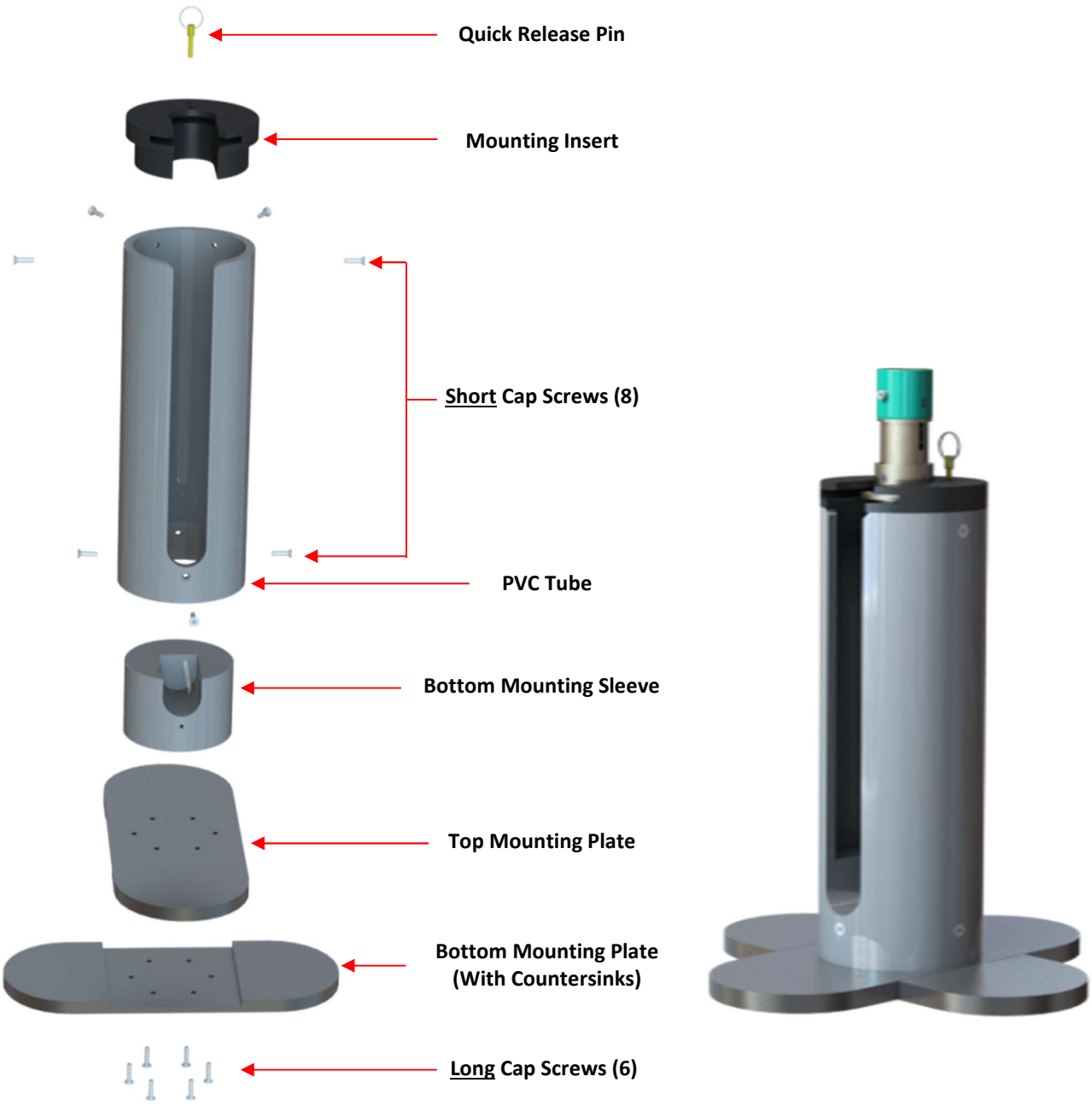


Figure 24: Exploded Assembly View of the Hand Mate Pedestal PN 1018563

13.0 Teledyne Oil & Gas Refurbishment

Teledyne Oil & Gas rates all optical and hybrid wet-mate connectors for 100 mate/demate cycles. When this number of mates is reached, it is recommended that connectors be sent back to the manufacturer for refurbishment. Refurbished connectors undergo a thorough inspection, complete cleaning, and have all wear components replaced. Certification of refurbished connectors is done via the standard battery of factory acceptance testing performed on new connectors.

Refurbishment may include the following steps, depending on the condition of the returned units and customer requirements. It is provided in this manual for information only.

13.1 Unpacking and Incoming Inspection

Upon receiving the returned product or products, the shipping container and associated packaging material is carefully inspected for any damage that might have occurred during shipping. The products undergo an exterior visual inspection for cosmetic/mechanical damage, excessive leakage of fluids, and any other abnormalities. The RMA documentation is also reviewed, so that the appropriate technical personnel are aware of any other product issues.

13.2 Exterior Cleaning and Operational Check

In order to prevent contamination or damage to customer products and Teledyne test equipment, the exterior surfaces of the products are cleaned of dirt, debris, biological growth, and other contaminants. Product exteriors are once again examined for damage. An appropriate operational check is performed for each returned product. This is used to verify performance before refurbishment takes place and gage overall connector health.

13.3 Disassembly and Detailed Inspection

A complete connector disassembly is performed in order for a more detailed inspection of components to be performed. All components are inspected for damage and excessive or abnormal wear. Components that are expected to wear will be replaced in the subsequent refurbishment steps.

13.4 Cleaning

Once disassembly has taken place, components undergo a thorough cleaning. Components are wiped and pre cleaned with lint-free products such as Kim Wipes, Cletop sticks, and foam tipped swabs, in preparation for ultrasonic cleaning. Ultrasonic cleaning is a two step process. Components are first cleaned in an Alconox solution and then ultrasonically cleaned in distilled water.

13.5 Wear Component Replacement

During the lifetime of a product, certain components experience wear and require replacement. In every refurbishment, all elastomers are replaced, including rolling seals, O-rings, gland seals, bladders, and other components. All optical stems and all paddles are also replaced. Contact surfaces such as latch collets, bushings, guide keys, and latch fingers are carefully examined and replaced at the discretion of engineering. All components are potentially replaceable should the inspection professional deem it necessary.

NOTE: In all refurbishment cases, a legacy Grade 23 center actuator installed on a bulkhead plug connector will be replaced a with standard Grade 19 center actuator.

13.6 Rebuild

When all components have been cleaned, inspected, and replaced to the satisfaction of the technical professional, the product is rebuilt per the standard build procedure. The build also offers an additional visual inspection step for the assembler.

13.7 Post Refurbishment Factory Acceptance Test

In order for the refurbished product to be certified in “like new” condition, the product undergoes the standard factory acceptance test (FAT). This is the same battery of tests used to certify new connectors as deployment ready before they leave the manufacturing facility. The satisfactory FAT results are Teledyne Oil & Gas’ certification that products have been successfully refurbished and are ready for another cycle of use.

13.8 Final Quality Assurance and Return Shipment

Upon completion of refurbishment, products undergo a final quality assurance checkout. Products are then returned to the customer.

14.0 Revision History

Revision	CO #	Revised By	Summary of Changes	Release Date
Y	63602	Z. Lys	Added rolling and pitching limit to rov handles in section 5 to more accurately layout rov connector's limits	9/21/2022
W	62067	T. Sidenstricker	Added Figures 8 and 9, updated remaining figure numbers	04/21/2022
V	60992	T. Dubay	Added conditions for retrieval of connector for cleaning in section 7.5.3	02/14/2022