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R. Jazowski

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S. Barlow

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M. Bartell

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TITLE: Installation & Operation Manual for Wet-Mate Hybrid Connectors

Teledyne ODI, Inc.

1026 North Williamson Blvd.

Daytona Beach, FL 32114 USA

386-236-0780 (phone)

386-236-0906 (fax)

Marketing@odi.com (e-mail)

Emergency Contact Number

386-236-0780 (Message Service Option 7)

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1.0 **Introduction:**

This installation and operation manual covers Teledyne ODI, Inc. wet-mate hybrid plug and receptacle connectors. If required, the connector's outline and interface details will be provided from drawings referenced on the cover sheet.

2.0 **Unpacking:**

Wet-mate hybrid connectors are frequently supplied with loose fiber 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 ODI, Inc. for repair. If in doubt, leave the boxes closed and consult Teledyne ODI, 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.

2.1 Check list

- A. Upon opening the shipping container, check to see if the contents appear to have been disturbed.
- B. Inspect the packing material that the connectors are lying on for the presence of excess silicone oil.

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

- C. Taking care not to damage any optical fiber pigtails that may be present, remove the connector assemblies from the packing crate.
- || D. Verify there is no damage to the fiber pigtails. ||
- E. Inspect the connector assembly for any signs of damage.
- F. Remove the protective cover over the front of the connector and inspect the face against the Figures 1 and 2.
- G. The rolling seals should be closed (no openings in the seals visible) with a smooth undamaged surface. The paddles should appear uniformly separated.
- H. If the connector is an ROV mated flying end receptacle, then inspect the latch fingers. The fingers should be lying flush with the body of the shell when mated to a plug (see Figure 3).

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3.0 **Installation:**

Although unlike any other connector with which you may be familiar, 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. However, the following sections should be read to prevent damage to the connectors.

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

3.1 Terminations

For most applications, we recommend that these connectors be terminated to their cabling at Teledyne ODI, 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.

3.1.1 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 ensure good joints.
- Both plug and receptacle are provided with gold plated solder buckets for cable connection. The solder buckets can accommodate wire sizes from 20 AWG to 14 AWG. Conventional soldering techniques should be employed to ensure good joints.

3.1.2 Optical Terminations

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

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3.2 Boot Seals

3.2.1 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 ensure 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.

3.2.2 Optical Terminations

Rubber “mechanical” boot seals are employed on the optical pigtails and are in place when the connector is delivered. These boot seals should not be removed.

3.3 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, ensure that the o-ring groove in the connector is clean. Lightly lubricate the o-ring with silicone lubricant and install in groove.

3.4 ROV Mating Guidelines – ROV Stabilization

3.4.1 There are two fundamental ways to control the ROV prior to mating the Teledyne ODI, 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.

3.4.2 Although Teledyne ODI, 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.

3.5 ROV Mating Guidelines – Horizontal Connection

3.5.1 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.

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

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

- 3.5.3 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.

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.

- 3.5.4 Positive thrust should be maintained until the locking arms (latch fingers) on the ROV flying connector are witnessed as flush with respect to the side of the ROV connector shell.

- 3.5.5 Inspect latch fingers per Figure 3. Ensure that latch fingers are flush with respect to ROV connector shell.

3.6 ROV Mating Guidelines – Vertical Connection

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

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

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

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- 3.6.3 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.

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.

- 3.6.4 Release the manipulator jaw from the connector handle.

- 3.6.5 Turn the manipulator jaw on its side and gently 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.

- 3.6.6 Inspect latch fingers per Figure 3. Ensure that latch fingers are flush with respect to ROV connector shell.

3.7 ROV De-mating Guidelines – Horizontal Disconnection

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

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

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

- 3.7.3 Apply linear and steady motion to disconnect the flying lead.

- 3.7.4 Inspect the connector faces per Section 5.3.

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3.8 ROV De-mating Guidelines – Vertical Disconnection

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

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

- 3.8.2 Stabilize the ROV sub.

- 3.8.3 Extend and open the ROV manipulator jaw.

- 3.8.4 Position the open manipulator jaw squarely under the connector handle.

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

- 3.8.6 Close the manipulator jaw on the handle to avoid dropping the connector.

- 3.8.7 Inspect the connector faces per Section 5.3.

4.0 **General Notes Of Caution:**

The Teledyne ODI 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.

- 4.1 **Never** exceed the connector specifications of section 5.1.

- 4.2 The MKII connectors are not interchangeable with the MKI connectors. If in any doubt, contact Teledyne ODI for clarification of connector type.

- 4.3 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 ODI, Inc. for further guidance.

- 4.4 Do not permit exposure of these connectors to petroleum-based fluids or lubricants, or other aggressive fluids that adversely affect natural rubbers.

- 4.5 Do not permit prolonged exposure to sunlight. Always fit a temporary or permanent protective cap when any connectors are left unmated.

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- 4.6 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.
- 4.7 **Never** attempt to actuate the connector's seals using anything but a mating connector.
- 4.8 **Never** attempt to insert anything into any of the ports of the connector shells.
- 4.9 Avoid any damage to the exposed rubber parts on the connector's mating faces.
- 4.10 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.
- 4.11 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 ensure that excessive force is not used to mate or de-mate the connector and that the maximum mating/de-mating speed is not exceeded (see section 4.1). The mating/de-mating motion should be smooth and steady. If access to the connectors makes controlled mating and de-mating difficult, then Teledyne ODI, 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.
- 4.12 Like all of ODI's standard ROV connectors, ROV versions of the MKII connector should be 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.
- 4.13 Unlike MKI connectors, which require full mate and de-mate, MKII connectors may be backed out once the connector halves begin to go together without damage occurring.
- 4.14 Do not coil the hose 1 full turn within 3 feet of connector/penetrator termination shell. Coiling the hose in close proximity to the termination shell could lead to fiber and wire management issues inside of the termination shell.

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5.0 **Operation:**

Wet-mate hybrid connectors require special instructions regarding their operation. See section 3.4 for operational limitations. The following lists the capabilities of the wet-mate hybrid connector. These should not be exceeded.

5.1 Wet-mate Hybrid Specification

Characteristics:	These connectors are intended for general subsea use. They are wet-mateable at any ocean depth.
Pressure Rating:	10,000 psi ambient pressure
Maximum Working Current:	8 amps/circuit
Maximum Working Voltage:	1000 VDC mated, 500 VDC unmated
Electrical Insulation:	When mated, 10 gigaohm between circuits and to seawater @100 VDC
Resistance:	0
Contact Resistance:	$\leq 0.2 \Omega$ /physical contact but can be less than 0.01Ω /physical contact. Consult ODI for actual rating of connector.
Optical Fiber:	125/900 or 125/250 micron single or multi-mode
Typical Optical Loss:	≤ 0.5 dB (connector) + ≤ 0.1 dB per splice.
Max Mating/De-mating Speed:	2 inches/second
ROV Mating Indication:	Visual latch finger engagement (see Figures 3 & 4)
Maximum rotational offset:	+/- 10° (see Figure 5)
Maximum angular offset:	+/- 5° (see Figure 6)
Maximum linear offset:	+/- 0.175" (see Figure 7)

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Connector Mating Force: Approximately 100 lbs., depending upon connector configuration

Connector De-mating Force: Approximately 40 lbs., depending upon connector configuration

Maximum Allowable Axial Force during Mating: Approximately 450 lbs., depending upon connector configuration

Maximum Allowable Axial Force On Mated Connector (Applied to termination Shell): Qualified to 1124 lbs. without connector damage.

ROV Connector Mated Breakaway Force: ≥ 300 lbs. (272 kgf) applied via hose or termination shell

Temperature Rating: -5 to + 50° C - working
-30 to + 60° C - storage

Mating Cycle Lifetime: 100 mate cycles maximum before connector refurbishment.

Note: The above refer 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: The mating cycle lifetime is limited to 100 mate cycles. A mating log record of the connector use should be kept, particularly for test connectors, as exceeding this lifetime may result in damage to the connector and to any other connector to which it is mated.

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5.2 Protection of mating surfaces

Wet-mate hybrid connectors may be used in the mated condition for their intended life. However, like most subsea connectors, these connectors should be fitted with an appropriate protective cap when left in the unmated condition. The protective caps will prevent the build-up of debris and marine growth on the connector, which could adversely affect its operation. These caps are simple in design and do not actuate the rolling seals. This is not necessary as the hybrid connectors are pressure balanced and sealed from the subsea environment.

5.3 Visual Inspection

Before each mate and prior to subsea installation, the mating faces of each connector should be visually inspected. This is to ensure that no damage has occurred to the seals and seal actuators. Looking at the face of a plug connector (Figure 1), the center actuator should be uniform and centrally located in its guide slot. The rolling seals should be closed (no openings visible in the seal). Looking at the face of a receptacle connector (Figure 2), 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 (Figure 2).

5.4 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 ODI, Inc. should be contacted immediately for instructions on how to proceed or what corrective action needs to be taken.

5.5 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 ODI, Inc. for refurbishment. If damage occurs to the connector, then the entire connector must be returned to Teledyne ODI, Inc. for repair or replacement.

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6.0 **Storage:**

6.1 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.

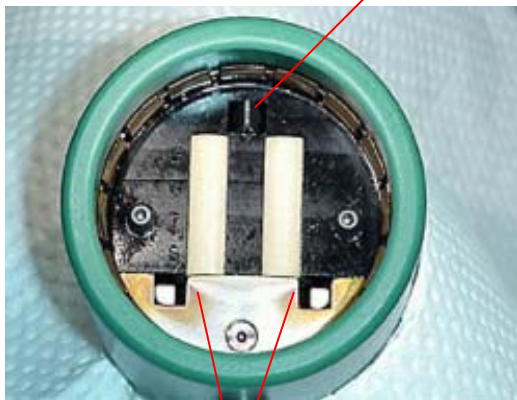
6.2 Long-term Storage (greater than 1 year)

The same storage conditions should be observed as specified in 5.1 above. Additionally, if the connectors remain unused after 2 years of storage, it is strongly recommended that they be returned to Teledyne ODI, Inc. for evaluation. If in doubt, contact Teledyne ODI, Inc. for further information and guidance.

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APPENDIX A: FIGURES

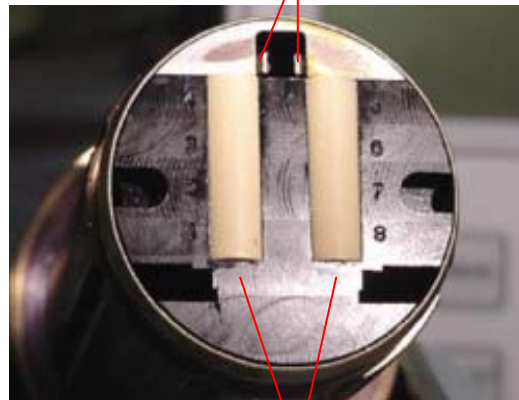
Center Actuator



Rolling Seals

Figure 1: Plug Connector Mating Face

Paddles



Rolling Seals

Figure 2: Receptacle Connector Mating Face



Figure 3: ROV Connectors Showing ROV Latch Fingers in the Closed Position



Figure 4: ROV Connectors Showing ROV Latch Fingers in the Open Position

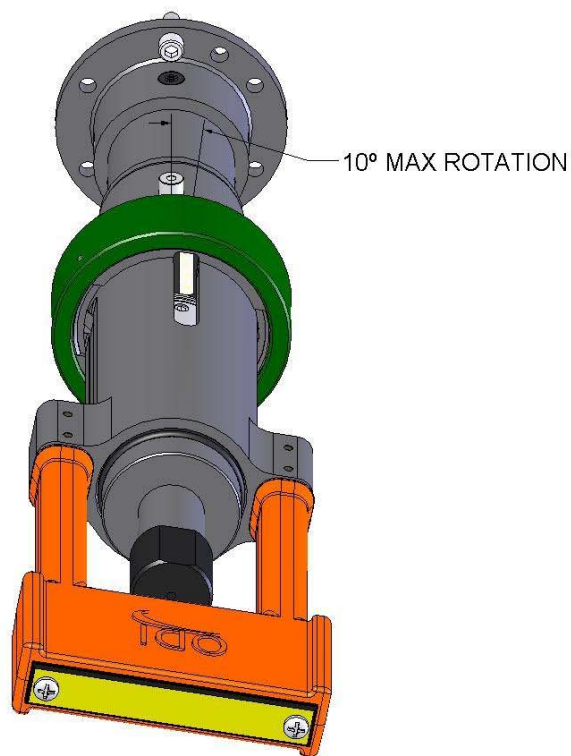


Figure 5: Depiction of Ten Degree Rotational Misalignment of ROV Connector with Respect to Bulkhead Connector

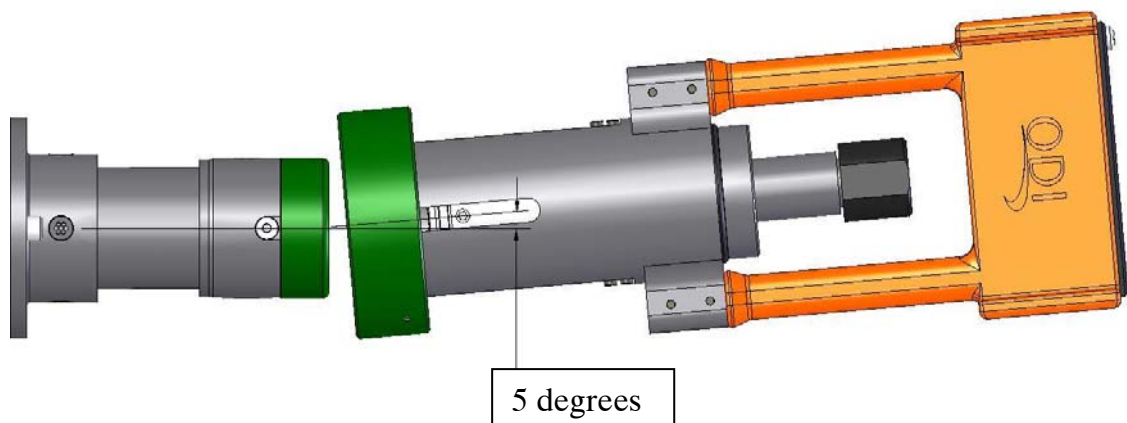


Figure 6: Depiction of Five Degree Angular Misalignment (Tilt) of ROV Connector with Respect to Bulkhead Connector.

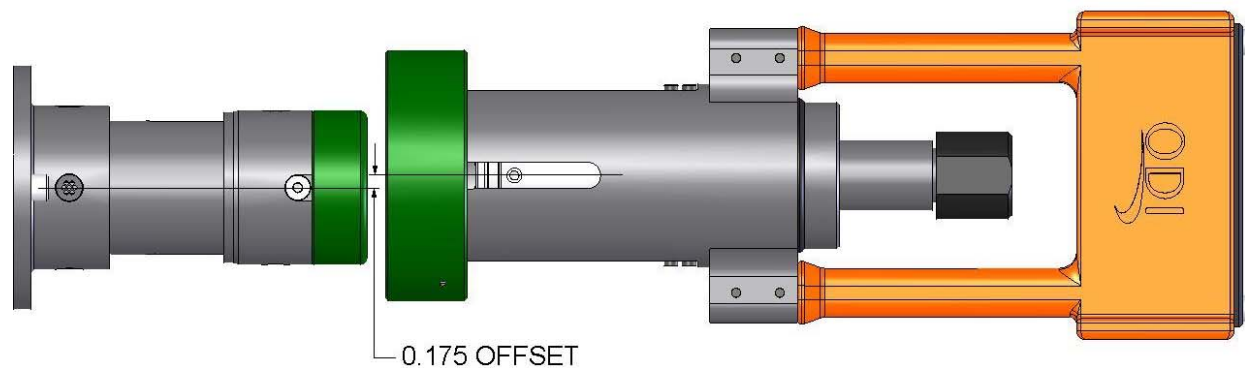


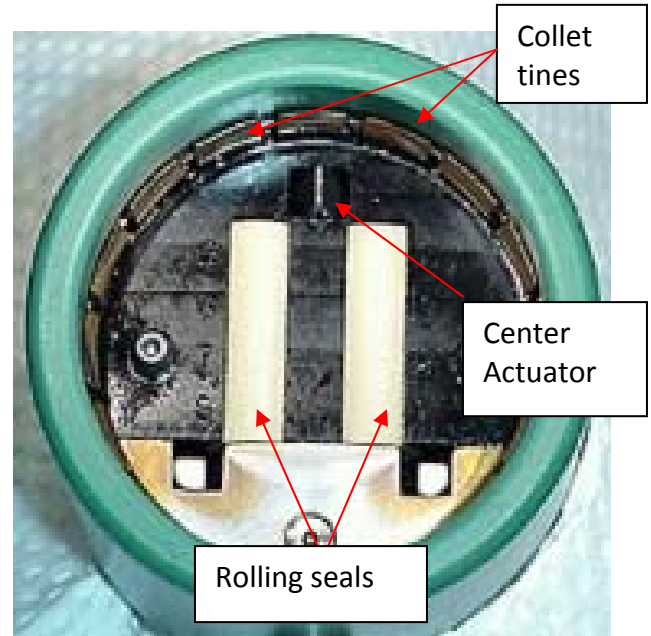
Figure 7: Depiction of a Linear Misalignment Offset Of 0.175" of ROV Connector with Respect to Bulkhead Connector.

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APPENDIX B: ROV OPERATOR CHECKLIST

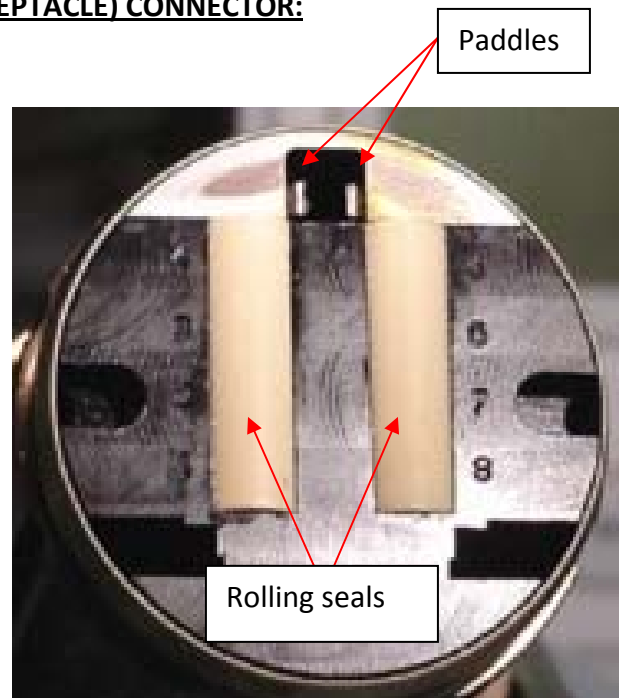
CHECKLIST, INSPECTION OF BULKHEAD (PLUG) CONNECTOR:

- ☐ Center actuator arms touching in center, not bent to one side
- ☐ Rolling seals fully closed, no openings visible. No tears or damage.
- ☐ Collet not recessed in shell, inside of shell not visible above collet tines (only green bushing shows).
- ☐ Green bushing attached to connector.
- ☐ No debris/scale on manifold or collet which may prevent proper mating.



CHECKLIST, INSPECTION OF EOFL (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.

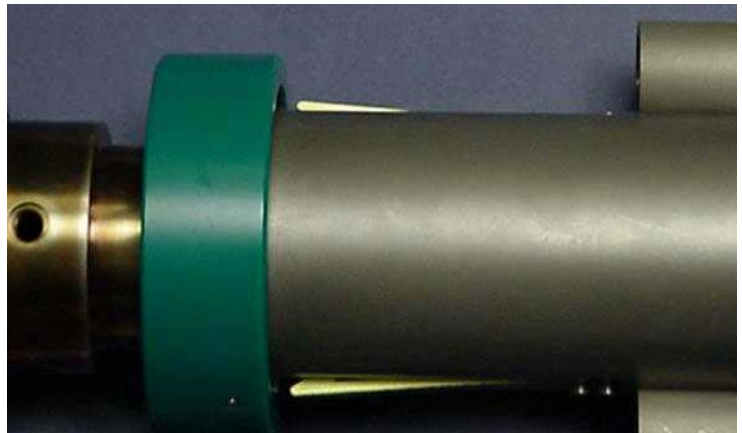


CHECKLIST, MATING GUIDELINES, HORIZONTAL CONNECTION

- ☐ 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 locking arms (latch fingers) on the ROV flying connector are witnessed as flush with respect to the side of the ROV connector shell.
- ☐ Inspect latch fingers. Ensure that latch fingers are flush with respect to ROV connector shell (closed).



Latch Fingers Closed



Latch Fingers Still Open

CHECKLIST, 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 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.
- ☐ Release the manipulator jaw from the connector handle.
- ☐ Turn the manipulator jaw on its side and gently 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.
- ☐ Inspect latch fingers. Ensure that latch fingers are flush with respect to ROV connector shell (closed).



Latch Fingers Closed



Latch Fingers Still Open

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CHECKLIST, 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, 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**".