



# SUPPLY OF AN UNDERWATER ENCLOSURE (‘MANIFOLD’) AND CONNECTIONS CNRS/2024/015 (17/10/2024)

ATRIUM-927471

## Summary

This document defines the technical requirements for an underwater enclosure connected to the KM3NeT MEOC2 telecoms cable, acting as a manifold for connection to the future nodes N3, N4, N5.

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LABEL  
PLATEFORME  
AIX-MARSEILLE



# SUPPLY OF AN UNDERWATER ENCLOSURE ('MANIFOLD') AND CONNECTIONS

ATRIUM-927471

## STATUS DU DOCUMENT

VERSION	DATE	WRITTEN BY	VERIFIED BY	APPROVED BY
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## MODIFICATION TABLE

The following table indicates the evolution history of the document and the origin of the modifications.

VERSION	DATE	MODIFICATIONS
0.1	05/01/2024	Creation of the document.
1.0	12/01/2024	First distributed version.
1.1	29/01/2024	Second distributed version after corrections.
1.2	29/02/2024	Third version for wide distribution, English version.
1.3	05/03/2024	Added details on test interlinks.
1.4	17/10/2024	Added 'parking position' and 8/12 optical fibers. Final French version.
1.4_EN	20/10/2024	Final version 1.4 translated into English (N. Lumb)
1.5	12/11/2024	Optional tranches removal
1.6	14/11/2024	Corrections
1.7	28/11/2024	Possibility of additionnal units (3.3.4 and 3.4.4)
1.7_EN	01/12/2024	Add 3.3.4 and 3.4.4 into English

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## GLOSSARY

TERME	DEFINITION
AC	Alternating current
CCTP	Cahier des Clauses Techniques Particulières
CPPM	Centre de Physique des Particules de Marseille
CNRS	Centre National de la Recherche Scientifique
Dry-mate	System for connection/disconnection in air
OF	Optical fiber
Interlink	Optical or electrical line between the Manifold connection panel and nodes 3, 4 or 5.
Jumper	Optical or electrical line between the distribution enclosure and the Manifold connection panel.
MEOC	Main Electro-Optical Cable
MEUST	Mediterranean Eurocentre for Underwater Sciences and Technologies
PBOF	Pressure Balanced Oil Filled
PSJB	Pre-Scientific Junction Box
LSPM	Laboratoire Sous-marin Provence Méditerranée
Wet-mateable	System for connection/disconnection in water
RMS	Root Mean Square

## REFERENCE DOCUMENTS

ID	TITRE	REFERENCE

## 1 BACKGROUND

The Laboratoire Sous-marin Provence Méditerranée ([LSPM](#)) is an IN2P3 national research platform of CNRS. The Centre de Physique des Particules de Marseille ([CPPM](#)) is the host laboratory.

The platform consists of a cabled infrastructure deployed at 2500m depth in the Mediterranean Sea, 40km from Toulon (France). The platform acts as a base for a unique instrumented underwater network, positioned as a world-class scientific and technological center for the study of neutrinos and the marine environment (Figure 1).

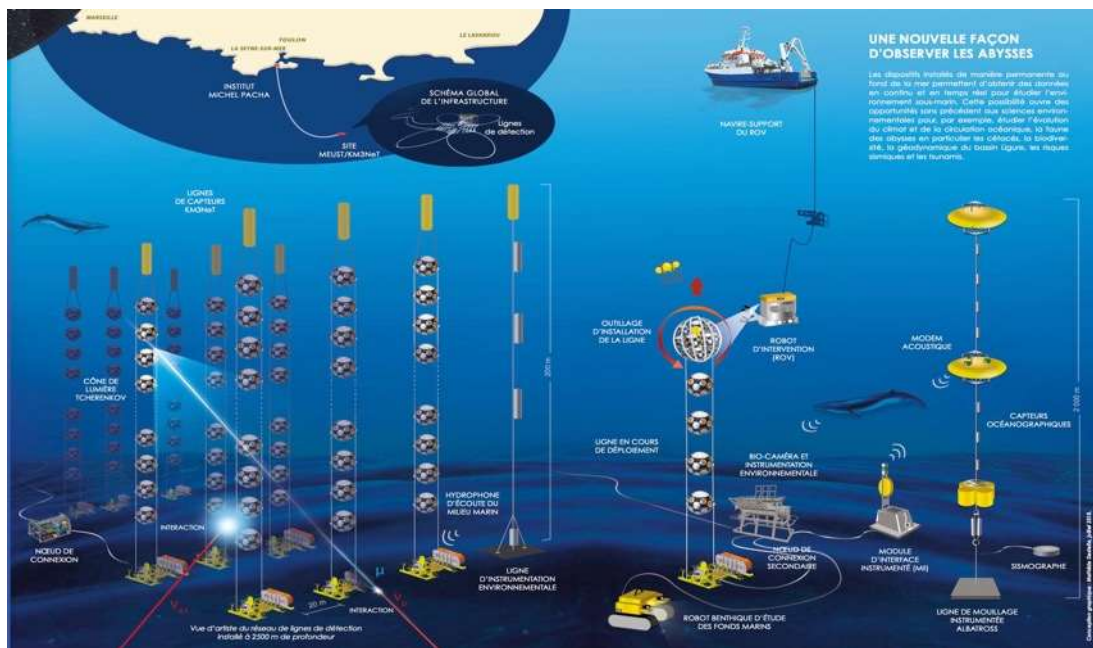


Figure 1 : artist's impression of the underwater infrastructure

The platform currently consists of an on-shore power hut, an electro-optical cable (MEOC1) and 3 nodes (Node 1, Node 2 and PSJB). It hosts the KM3NeT ORCA neutrino detector, internationally recognised as a leading project in the field, and environmental sensors deployed for the European Multidisciplinary Seafloor and water column Observatory ([EMSO](#) Ligure Ovest). Additional connection ports are available for possible future users.

The NEUMED extension constitutes the 3rd phase of construction of the platform. It aims to complete the technical and logistical basis for the deployment of the entire KM3NeT-ORCA telescope, by the addition of a second underwater MEOC branch. Following the experience gained from the development and exploitation of the first branch, it was decided that for the NEUMED extension a star configuration will be adopted, with the nodes linked by wet-mateable connectors to a passive manifold at the end of the MEOC2 cable (Figure 2).

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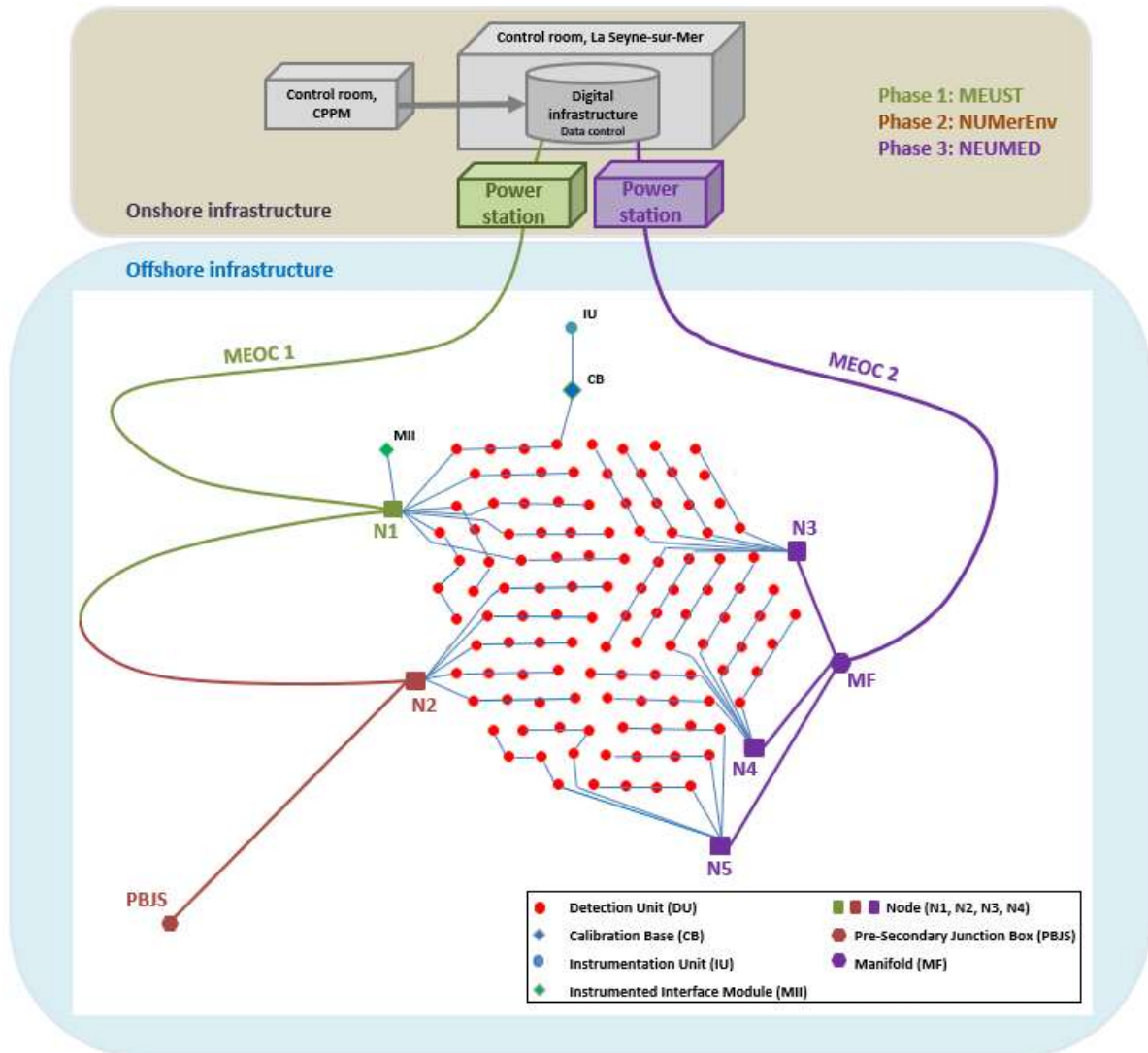


Figure 2 : topology of the LSPM platform

This document constitutes the technical specification ('CCTP') for the supply of the Manifold and its associated connections, in the framework of the NEUMED funding phase.

## 2 GENERAL DESCRIPTION

### 2.1 Theoretical positions of Manifold, Node 3, Node 4, Node 5

The theoretical positions of the Manifold and nodes 3, 4 and 5 are indicated in Table 1.

	Latitude	Longitude
<b>Node 3</b>	N42 48.33711	E6 01.78341
<b>Node 4</b>	N42 48.27190	E6 01.76736
<b>Node 5</b>	N42 48.23950	E6 01.74075
<b>Manifold</b>	N42 48.28204	E6 01.79190

*Table 1 : theoretical positions of Manifold and Nodes 3-5*

From the above table, the theoretical distances between the structures can be calculated :

- Theoretical distance between Node 3 and Manifold: 102 m
- Theoretical distance between Node 4 and Manifold: 38 m
- Theoretical distance between Node 5 and Manifold: 105 m

The lengths of the associated interlinks are given in Chapter 3.3 and 3.4.

### 2.2 Technical constraints

- Depth: 2500 m.
- Service pressure: 250 bars.
- Storage temperature: -10 °C / +50 °C.
- Seawater temperature: 13°C at 2500 m depth.
- Water salinity: 37 PSU (37 g/l).
- Corrosion resistance.
- Required lifetime immersed in sea water: **20 years minimum**.  
The system must have a pre-operational lifetime of at least 5 years.  
(The pre-operational lifetime is defined as the time between delivery of the system and its deployment on the sea bed).
- Maintenance: attention should be paid to the ability of the system to be quickly repaired (easy access to the MEOC penetrator and jumper).



## 3 TECHNICAL SPECIFICATIONS

The tender is divided into 4 distinct lots (Figure 3) :

- Lot 1 : MEOC 2 penetrator.
- Lot 2 : distribution container.
- Lot 3 : electrical connections for Manifold and nodes.
- Lot 4 : optical connections for Manifold and nodes.

Candidates are free to submit proposals for one or several lots, depending on their field of expertise.

CPPM reserves the right, depending on the submitted proposals and the technical and economic constraints, to take charge of lot no.2.

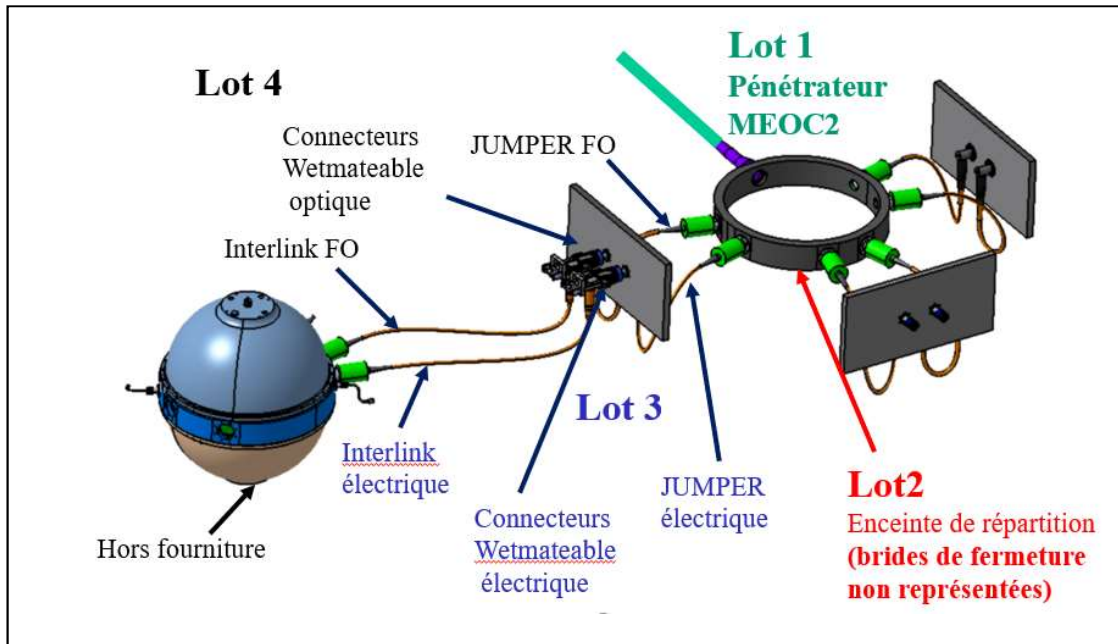


Figure 3 : visual description of Lots 1, 2, 3, 4

### 3.1 Lot 1 : MEOC 2 penetrator

Lot 1 consists of the supply of a cable termination (penetrator), to be mounted at the end of the MEOC 2 cable, feeding through to the Manifold container, as described in Chapter 3.2.

The MEOC 2 is a standard telecommunications cable supplied by Alcatel Submarine Networks (mix of URC3 and OALC7). It provides the electrical link (coaxial copper conductor) and a data link (monomode optical fibers) between the power hut on shore and the Manifold. The length of the cable is 39 kilometers.

A 60m length of OALC7 LWS cable will be supplied in order to terminate the MEOC. The connection of this cable to the sub-sea MEOC is the exclusive responsibility of CPPM.

The main characteristics of the OALC7 LWS cable are summarized in Table 2.

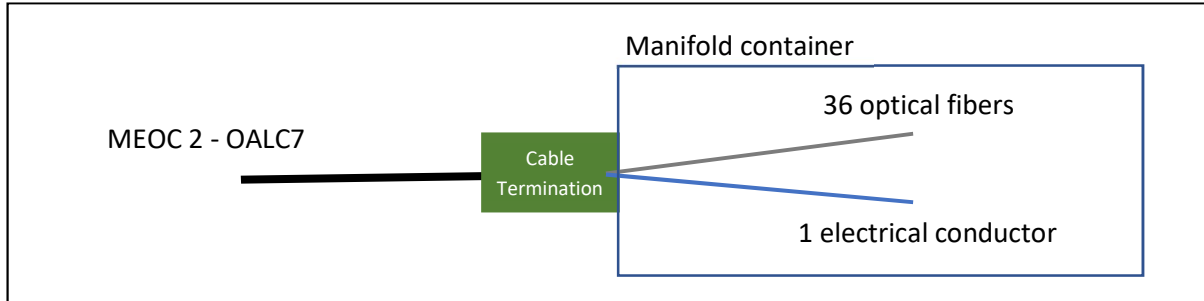


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<b>Performance</b>	CBL (Cable Breaking Load) [kN]	100
	NPTS (Nominal Permanent Tensile Strength) [kN]	25
	NOTS (Nominal Operating Tensile Strength) [kN]	50
	NTTS (Nominal Transient Tensile Strength) [kN]	80
	Pressure resistance [Mpa]	100
	Hydrodynamic constant (lay) [°/knots]	43
	Hydrodynamic constant (recovery) [°/knots]	51
	Crush resistance [kN]	30
	Impact resistance [J]	> 20
	Minimum Bend Radius, coiling in tank [m]	1
	Minimum Bend Radius, no load (drum storage) [m]	0.5
	Minimum Bend Radius, load up to NTTS [m]	1.5
<b>Characteristics</b>	First layer wire number (left hand)	8
	First layer wire diameter [mm]	1.9
	Second layer wire number (left hand)	16
	Second layer wire diameter [mm]	1.3 & 1.8
	Outer diameter of insulation sheath [mm]	20
	Cable outer diameter [mm]	27.5
	Weight in air [kg/m]	1.09
	Weight in water [kg/m]	0.48
<b>Optical</b>	Number of fiber	36
	Type	G655 NZDSF LEAF-EP
<b>Electrical</b>	Nominal voltage [V DC]	12.5
	Resistance [ $\Omega$ /km @ 10 °C]	0.7
	Insulation between composite conductor and water [M $\Omega$ .km @ 500V DC]	> 10 <sup>5</sup>
	Capacitance [ $\mu$ F/km]	0,133
	Inductance [ $\mu$ H/km @ 50 Hz]	1849
	Dielectric strength between composite conductor and water	>45kV DC for 5min

Table 2: characteristics of the OALC7 LWS cable



*Figure 4 : functional cross-section of MEOC 2 penetrator*

Optical characteristics of the termination:

- Length of optical fibers exiting termination : 3m
- Connector type at end of fibers: SC APC

Electrical characteristics of the termination :

- AC network
- Type of conductor : tin-plated copper
- Cross-sectional area of conductor: consistent with the current and resistance values specified below (area should be minimized; current density ideally 2A/mm<sup>2</sup>).
- Flexibility of cable and conductor at termination exit: flexible, class 5.
- Operating voltage (normal conditions) : 5 kV RMS
- Operating current (normal conditions) : 36 A RMS
- Linear resistance : < 0,001  $\Omega$ /m
- Insulation resistance : > 10 G $\Omega$
- Dielectric strength : > 45 kV DC 5 min, > 36 kV RMS AC 1 min
- Extra length of electrical conductors exiting termination : 3 m
- Electrical conductor at exit of termination with dismounting option.

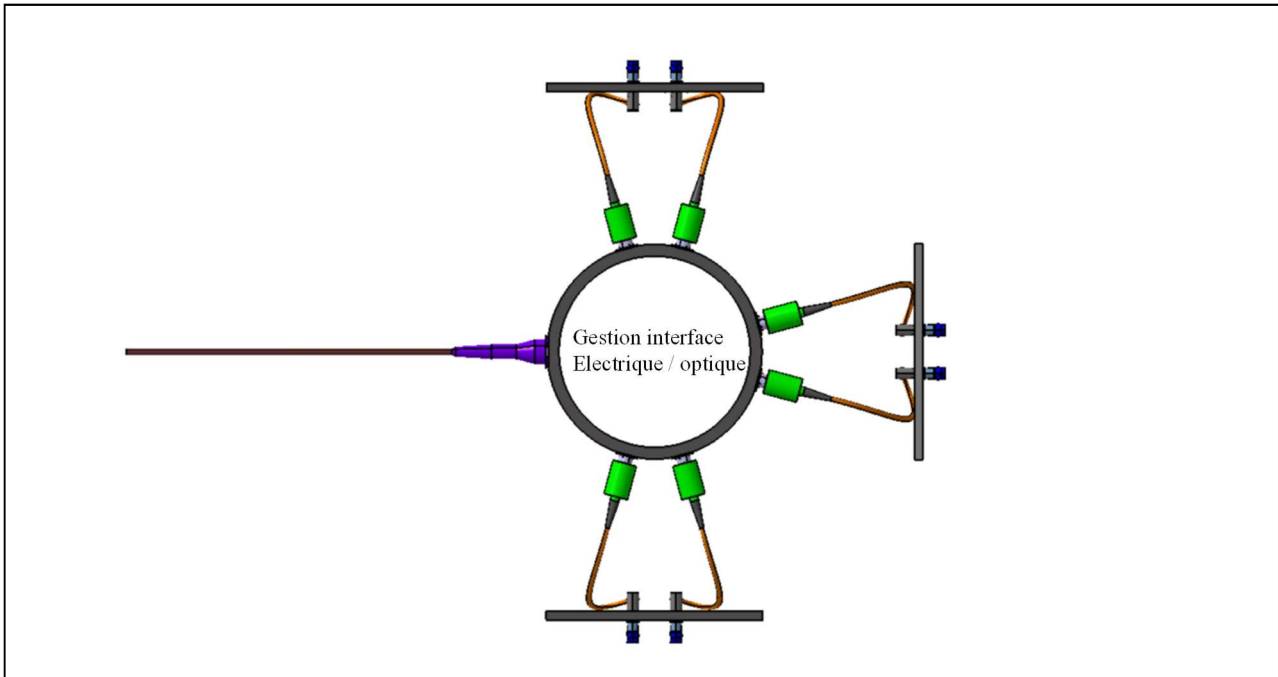
## 3.2 Lot 2 : distribution container

Lot 2 consists of the supply of the distribution container.

The distribution container is a passive system linking the MEOC 2 penetrator described in Chapter 3.1 to the 3 optical jumpers and to the 3 electrical jumpers described in Chapters 3.3 and 3.4 . The container can be designed:

- with atmospheric pressure technology
- or a hybrid system (atmospheric pressure and pressure balancing), in the framework of a “variant at the initiative of the candidate”.

## 3.2.1 Container at atmospheric pressure



*Figure 5 : plan view of the container at atmospheric pressure*

This container, whose dimensions depend on the dimensional constraints of the MEOC 2 penetrator, along with the penetrators for the 3 optical and 3 electrical jumpers, must resist the qualification phases (300 bar minimum pressure, giving a safety factor of 1.2).

In order to facilitate the electrical and optical cabling in the interior of the container, the parts must be dismountable, with redundancy incorporated in the sealing.

## 3.2.2 Hybrid container with pressure balancing / atmospheric pressure

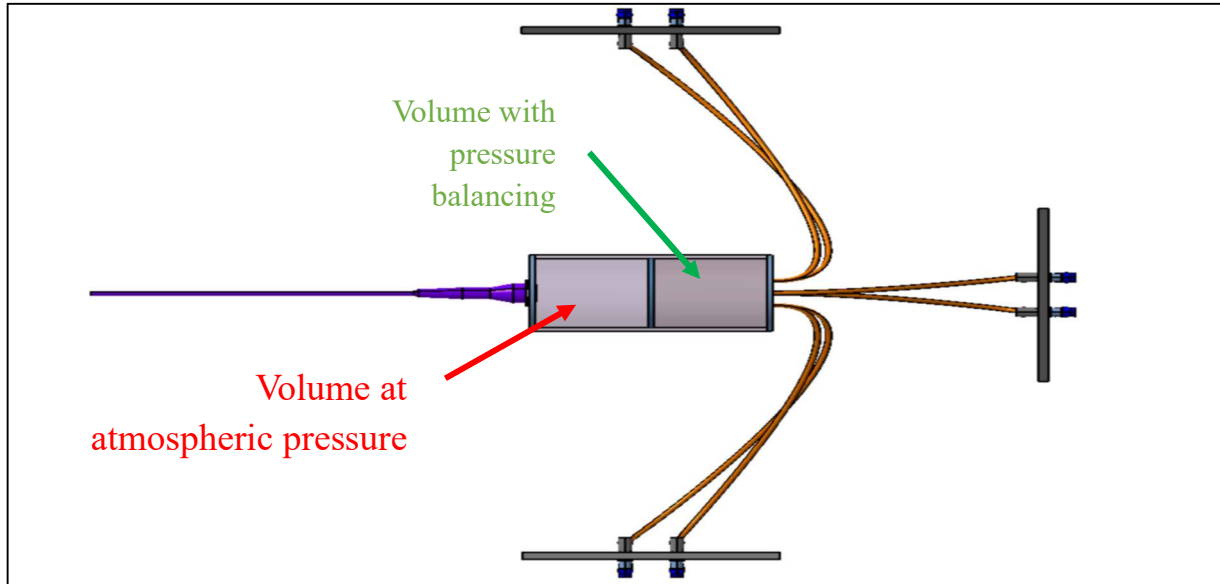


Figure 6 : plan view of hybrid container

This container, whose dimensions depend on the dimensional constraints of the MEOC 2 penetrators, along with the penetrators for the 3 optical and 3 electrical jumpers, must resist the qualification phases (300 bar minimum pressure, giving a safety factor of 1.2). If the solution with a pressure-balanced compartment is envisaged, a conceptual description will be requested for evaluation.

## 3.3 Lot 3 : electrical connections Manifold, Node 3, Node 4, Node 5

Lot 3 comprises of the supply of :

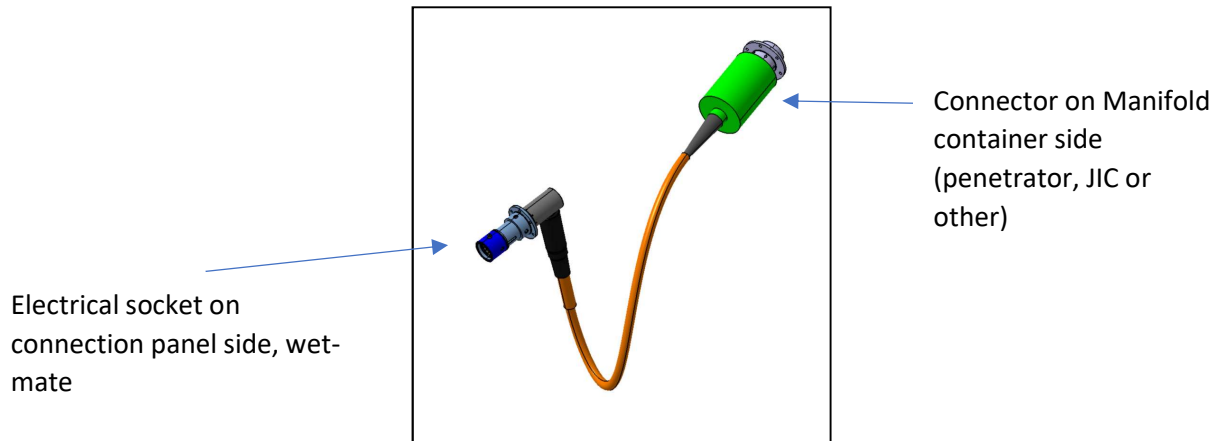
- 3 electrical jumpers
- 2 electrical interlinks
- 3 long-term protection caps for electrical sockets
- 3 short-term protection caps for electrical sockets
- 4 short-term protection caps for electrical interlinks
- 1 electrical test interlink on the manifold connection panel side with a short-term protection cap
- 1 electrical test interlink on the node side with a short-term protection cap
- In the case of a solution with a dry-mate connector on the interlink: 1 electrical test interlink which connects to the dry-mate connector on the node.
- 2 ROV handles
- 2 long-life electrical sockets ('parking position') to be integrated into node 3 and node 4.

### 3.3.1 Electrical jumpers

The electrical jumpers constitute the link between the distribution container of the Manifold and the connection panel of the Manifold.

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*Figure 7 : electrical jumper*

## Jumper electrical characteristics:

- AC network
- Number and type of conductor : 1 conductor in tin-plated copper
- Cross-sectional area of conductor: consistent with the current and resistance values specified below (area should be minimized; current density ideally  $2\text{A/mm}^2$ ).
- Flexibility of cable and conductor at termination exit: flexible, class 5.
- Permanent voltage (normal conditions) : 5 kV RMS
- Permanent current (normal conditions) : 12 A RMS
- Linear resistance :  $<0.004 \Omega/\text{m}$
- Insulation resistance :  $> 10 \text{ G } \Omega$
- Dielectric strength :  $> 45 \text{ kV DC 5 min, } > 36 \text{ kV RMS AC 1 min}$
- Extra length of electrical conductor at penetrator exit : 3 m
- Electrical conductor at exit of connector on manifold container side with dismounting option.

## Jumper mechanical characteristics :

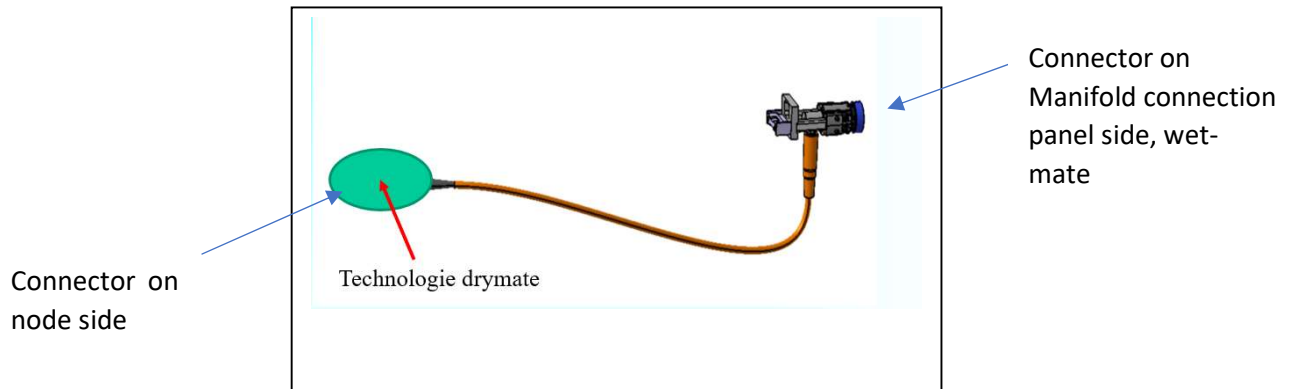
- Length of jumper : 3m
- The candidate will indicate the dimensional details together with a description of the proven technology (oil filled, etc.)

### 3.3.2 Electrical interlinks

The electrical interlinks constitute the links between the Manifold connection panel and the nodes.

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*Figure 8 : Electrical interlink*

### Electrical characteristics of the Interlink :

- AC network
- Number and type of conductor : 1 conductor in tin-plated copper
- Cross-sectional area of conductor: consistent with the current and resistance values specified below (area should be minimized; current density ideally  $2\text{A/mm}^2$ ).
- Flexibility of cable and conductor at termination exit: flexible, class 5.
- Permanent voltage (normal conditions) : 5 kV RMS
- Permanent current (normal conditions) : 12 A RMS
- Linear resistance :  $<0.004 \Omega/\text{m}$
- Insulation resistance :  $> 10 \text{ G } \Omega$
- Dielectric strength :  $> 45 \text{ kV DC 5 min, } > 36 \text{ kV RMS AC 1 min}$
- Extra length of electrical conductor at exit of termination on the node side: 3m
- Electrical conductor at exit of termination on node side with dismounting option.

### Mechanical characteristics of the Interlink:

- Length of electrical interlinks : 130 m, standardized value based on theoretical positions defined in Chapter 2.1, to which a security margin of 25 m has been added to take account of the placement precision during deployment (5 m radius around target position) as well as the need to deploy additional cable length (20m).
- Connection of the interlink to the container of nodes 3, 4 and 5 is made via a drymate connector. In the event that the candidate cannot fulfill this condition, alternative solutions may be proposed.
- Connection of the interlink to the Manifold is made via a wetmate connector.
- The candidate will supply the technical specifications of the proposed solution, in particular :
  - o Dimensional details, description of the proven technology (oil filled, number of canisters, etc.)
  - o Connection/disconnection force
  - o The number of connection/disconnection cycles allowed without maintenance
- The handles which allow manipulation of the interfaces by a ROV (work class or light ROV) must be interchangeable.

### 3.3.3 Electrical test interlinks

- 1 electrical test interlink equipped with a wetmate connector to connect to the socket on the manifold connection panel, with a short-term protection cap + connection box (equipped with contacts for easy connection, robust and safety qualified) on the other end.  
Length : 10m
- 1 electrical test interlink equipped with a wetmate connector which connects to the flying connector of the node interlink, with short-term protection cap + connection box (equipped with contacts for easy connection, robust and safety qualified) on the other end.  
Length : 10m

### 3.3.4 Additional elements "on demand" to be ordered on the basis of a unit price schedule (BPU)

- 1 electrical test interlink  
The company will provide the price for 1 or more additional units
- 1 electrical test interlink equipped with a wetmate connector to connect to the socket on the manifold connection panel, with a short-term protection cap + connection box (equipped with contacts for easy connection, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- 1 electrical test interlink equipped with a wetmate connector which connects to the flying connector of the node interlink, with short-term protection cap + connection box (equipped with contacts for easy connection, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- In the case of a solution with interlink with drymate connector: 1 electrical test interlink which connects to the drymate connector of the node, with a short-term protection cap + connection box (equipped with contacts for easy connection, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- ROV handle



The specifications are described in chapter 3.3.2

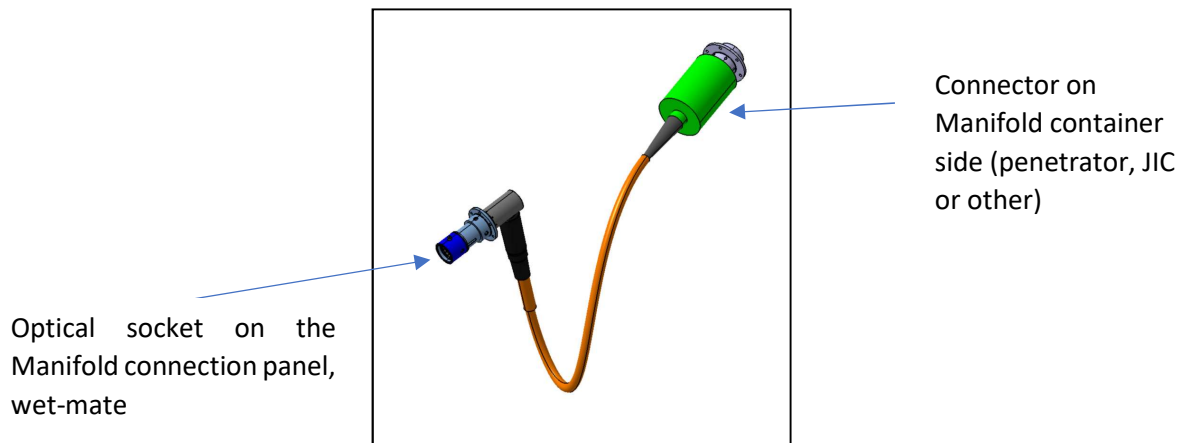
### 3.4 Lot 4 : optical connections Manifold, Node 3, Node 4, Node 5

Lot 4 consists of the supply of :

- 3 optical jumpers
- 2 optical interlinks
- 3 long-term protection caps for optical sockets
- 3 short-term protection caps for optical sockets
- 4 short-term protection caps for optical interlinks
- 1 optical test interlink equipped with a wetmate connector to connect to the manifold connection panel with a short-term protection cap.
- In the case of a solution with an interlink with penetrator : 1 optical test interlink which connects to the interlink of the node, with a short-term protection cap.
- In the case of a solution with interlink with dry-mate connector : 1 optical test interlink which connects to the drymate connector on the node.
- 2 ROV handles
- 2 long-life optical sockets ('parking position') to be integrated in nodes 3 and 4.

## 3.4.1 Optical jumpers

The optical jumpers constitute the links between the Manifold distribution container via a penetrator and the Manifold connection panel via a wetmate socket.



*Figure 9 : optical jumper*

### Optical characteristics of the jumper :

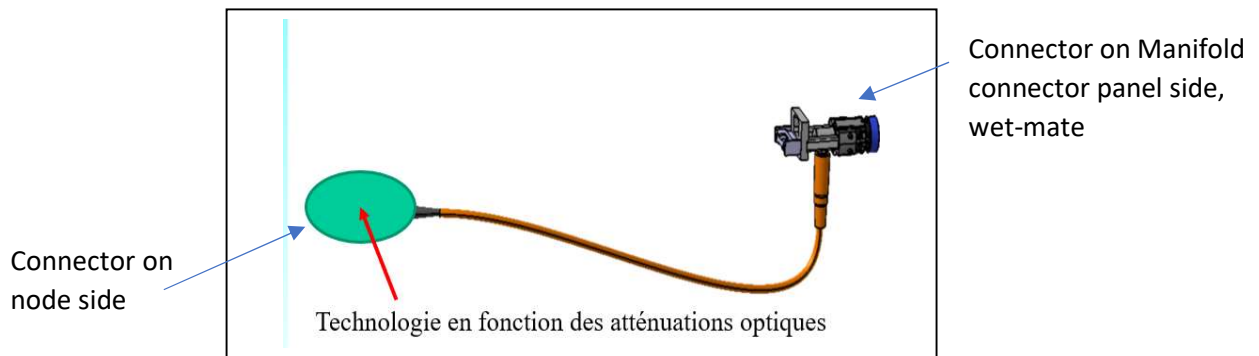
- Number of contacts : 8 minimum, ideally 12, in the framework of a 'variant at the initiative of the candidate'
- Type of optical fiber: monomode G655 NZDSF LEAF-EP
- Type of polishing on optical termination of socket : UPC
- Extra length of optical fibers at exit of penetrator : 3m
- Type of connector and polishing on optical terminations of penetrator : SC/APC

### Mechanical characteristics of the jumper :

- Length of optical jumper: 3m
- Optical socket connection panel side type wetmate
- The candidate will specify dimensional details and the technology used (oil filled, choice of materials, sealing details, etc.)

## 3.4.2 Optical interlinks

The optical interlinks constitute the links between the Manifold connection panel and the nodes via a flying wetmate connector.



*Figure 10 : Optical interlinks*

### Optical characteristics of the interlink :

- Number of optical contacts : 8 minimum, ideally 12, in the framework of a 'variant at the initiative of the candidate'
- Type of optical fiber: monomode G655 NZDSF LEAF-EP
- Type of polishing on optical terminations of the wetmate connector on the connector panel side : UPC
- Extra length of optical fibers at exit of connection on the node side : 3m
- Type of connector and polishing on optical terminations of penetrator : SC/APC

### Mechanical characteristics of the interlink :

- Length of optical interlinks : 130 m, standardized value based on theoretical positions defined in Chapter 2.1, to which a security margin of 25 m has been added to take account of the placement precision during deployment (5 m radius around target position) as well as the need to deploy additional cable length (20m).
- The connection of the interlink to the container of Nodes 3, 4 and 5 is made with a drymate connector. In the event that the candidate cannot fulfill this condition, alternative solutions may be proposed.
- Connection of the interlink to the Manifold container on the connector panel side is made via a wetmate connector.
- The candidate will supply the technical specifications of the proposed solution, in particular :
  - o Dimensional details, description of the proven technology (oil filled, number of canisters, etc.)
  - o Connection/disconnection force
  - o The number of connection/disconnection cycles allowed without maintenance
  - o The optical attenuation along the interlink, in particular at the connectors
- The handles which allow manipulation of the interfaces by a ROV (work class or light ROV) must be interchangeable.

### 3.4.3 Optical test interlinks

- 1 test interlink equipped with an optical wetmate connector to connect to the socket on the manifold connection panel, with a short-term protection cap + connection box (equipped with SC/APC connectors, robust and safety qualified) on the other end.  
Length : 10m
- 1 optical test interlink equipped with a wetmate connector to allow connection to the flying connector of the node interlink, with short-term protection cap + connection box (equipped with SC/APC connectors, robust and safety qualified) on the other end.  
Length : 10m

### 3.4.4 Additional elements "on demand" to be ordered on the basis of a unit price schedule (BPU)

- 1 electrical test interlink  
The company will provide the price for 1 or more additional units
- 1 test interlink equipped with an optical wetmate connector to connect to the socket on the manifold connection panel, with a short-term protection cap + connection box (equipped with SC/APC connectors, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- 1 optical test interlink equipped with a wetmate connector which connects to the flying connector of the node interlink, with short-term protection cap + connection box (equipped with SC/APC connectors, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- In the case of a solution with interlink with drymate connector: 1 optical test interlink which connects to the drymate connector of the node, with a short-term protection cap + connection box (equipped with SC/APC connectors, robust and safety qualified) on the other end.  
Length : 10m  
The company will provide the price for 1 or more additional units
- 1ROV handle  
The specifications are described in chapter 3.4.2

## 4 QUALIFICATION

The winning bidder must ensure the qualification (mechanical, electrical,...) of each of the lots that they supply. Two cases must be considered :

- For already-qualified elements, the winning bidder will provide suitable paperwork justifying this qualification. This paperwork must be validated by CPPM before delivery of the elements concerned.
- For non-qualified elements, the winning bidder will provide a qualification plan to CPPM. This plan must conform to industry standards. The qualification tests will be carried out by the winning bidder together with a detailed report prior to being accepted by CPPM.

## 5 DOCUMENTATION

The following list indicates the minimum documentation to be supplied to CPPM :

- Detailed technical specification :
  - o Weight in air and weight in water of the group of components in the lot.
  - o Pressure-balanced components (PBOF) will be explained together with their air and water characteristics.
  - o Dimensional and assembly drawings.
- Detailed electrical specifications :
  - o Cabling schemes
  - o Characteristics of the components chosen
  - o Applied standards
  - o Etc.
- Qualification procedures and reports.
- Material certificates.
- Certificate of conformity (including declaration CE).
- Instruction manual, storage instructions and warnings.

The documentation must be supplied electronically, preferentially in PDF format, before sending the product to CPPM. The documents must be written in French and English.

## 6 ITEMS TO BE SUPPLIED

The list of items to be supplied are indicated in Chapter 3.1 for Lot 1, in Chapter 3.2 for Lot 2, in Chapter 3.3 for Lot 3 and in Chapter 3.4 for Lot 4.

## 7 FACTORY ACCEPTANCE TESTING (FAT)

The FAT procedure consists of verification of the equipment with respect to this technical specification. It is carried out by the winning bidder, or if necessary by a qualified laboratory designated by the winning bidder.

CPPM reserves the right to participate in the FAT. The winning bidder must communicate the date of the FAT 3 weeks in advance.

The FAT consists of :

- A review of the documentation.
- Dimensional and visual checks of the equipment.
- Functional test validating the performance of the full assembly.

The detailed results of the testing must be provided by the winning bidder in a report which mentions 'Pass' or 'Fail' for each of the tests.

## 8 TECHNICAL AND FINANCIAL OFFER

The technical and financial offer must provide detailed information. The price list must include each item from each of the lots.

## 9 QUALITY CONTROL

Candidates must present in their offer a quality control plan which conforms to the ISO 9001 standard or equivalent, defining the procedures put in place.

Any abnormalities or non-conformities identified during the production must be treated and controlled in accordance with the quality control plan of the winning bidder.

Major abnormalities or non-conformities, which could introduce defects which place the product outside of the acceptance tests, must be communicated as soon as possible to CPPM.

Proposed corrective actions must be approved by CPPM.

Any modification of the procedures, design or testing of the product must be submitted for validation by CPPM.