Progetto IDMAR Azione 1.5.1

Infrastruttura Multidisciplinare Distributiva Sul Mare.

CUP: G66J17000360007

Technical Specifications

for

Junction Boxes

Phase 1.1 and Phase 2

Abstract

This document contains the technical requirements for the design and construction of Junction Boxes for a multiuser submarine network. Two versions of the Junction Boxes are foreseen, to be connected to Phase 1.1 and Phase 2 systems. The network is expected to be operative for a period of 20 years. The companies participating at the tender must provide the INFN sufficient warranties to accomplish this goal.

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2 References

List of Acronyms

AC	Alternating Current
CTF	Cable Termination Frame
DC	Direct Current
EOIB	Electro Optic Interface Box
INFN	Istituto Nazione di Fisica Nucleare
JB	Junction Box
MEOC	Main Electro Optical Cable
MVC	Medium Voltage Converter
OPA	Optical & Power Assembly
PFE	Power Feeding Equipment
ROV	Remotely Operated Vehicle
PDR	Preliminary Design Review
CDR	Critical Design Review
RUP	Responsible Unique of Procedure

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3 Introduction

The IDMAR project aims is the upgrading of Sicily's terrestrial and marine infrastructures in the field of multidisciplinary research of the marine environment from shallow water to deep water.

These infrastructures are used to connect observatories and sensors of multidisciplinary scientific and technological interest and, once the initial research and development phase has been completed, they will remain in use for monitoring the environment and the ecosystem.

The investment envisaged at Portopalo di Capo Passero (SR) site consists of the upgrade of the research laboratory and, in particular, of the terrestrial and marine infrastructural backbone (shore station, electro-optical cable and seabed network). It will host several users providing them electrical power and high-speed communication lines based on optical fibres.

The marine infrastructure, located in the Mediterranean Sea at a depth of 3,500 m, offshore the Italian coasts, approx. 100 km far away Portopalo di Capo Passero, Sicily, is currently organised in two construction phases, identified as **Phase 1.1** and **Phase 2.0**. This organisation in two phases was planned to better organise the construction of the network.

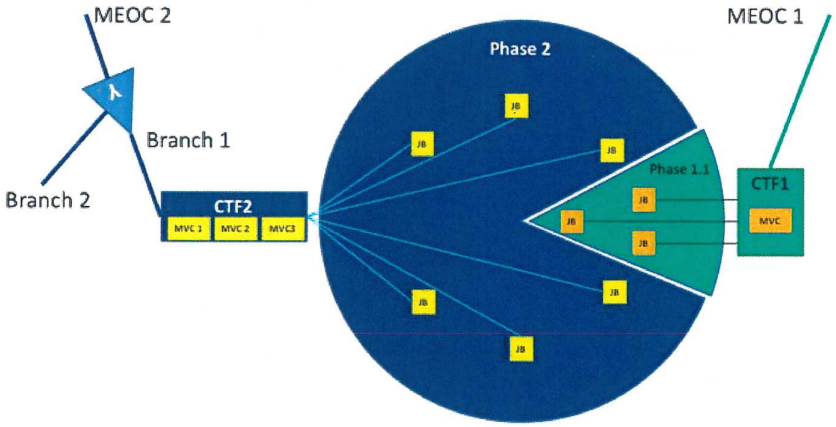

Fig. 1 General layout of the infrastructure -

For the **Phase 1.1**, an onshore laboratory accommodates a Power Feeding Equipment (PFE), that generates a 10 kV DC. The PFE is connected to a 100 km long Main Electro-Optical Cable (MEOC1) that is used to distribute electrical power and optical fibres offshore. The MEOC1 houses a copper conductor and 20 optical fibres. The MEOC1 is terminated by a Cable Termination Frame (CTF) which contains a Medium Voltage Converter (MVC), that is used to provide 375 Vdc offshore.

For the **Phase 2.0**, a second PFE, a dedicated MEOC 2 and a CTF 2 are required for the realization of the IDMAR project.

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4 Scope of the call for tender and general condition

The aim of this tender is the production of the JBs for Phase 1.1 and Phase 2. The number of 5 JBs, 3 for Phase 1.1 and 2 for Phase 2.

The Contractor shall comply with all the requirements reported in this document.

The JB design must mainly accomplish the following basic requirements:

- **A service life of 20 years**
- **Working environment at a sea depth of 3.500 m**
- **Zero-maintenance approach in the lifetime**

The mechanical design of the JB must include a pressure vessel for dedicated electronics and optical components. The specific electronics for power management, control management, optical amplification and their integration base plate will be under INFN responsibility and provided by INFN.

The Contractor may propose alternatives with respect to the reference solution if he deems they advantageously provide equal or better performances, e.g. by using some of his standard designs and construction techniques. The INFN reserves the right to analyse the proposed solutions and possibly accept them if deemed to be advantageous and consistent with the general specifications and objectives of the project.

The Contractor will carry the full responsibility for the design, construction, integration and testing of the system. He shall provide all the necessary equipment, materials, tools, instruments, facilities and labour to manufacture and test the items and demonstrate that the specifications have been met. The proposal shall include a List of Compliance for each specification and shall describe how the company intends to match the required specifications.

5 Technical Specifications

5.1 General

The JBs will constitute the nodes for the electro-optics interconnections in the IDMAR Infrastructure.

A high reliable operation is mandatory for the lifetime of 20 years, with a zero-maintenance approach.

The immersion in the sea shall request the use of an on-board winch. Proper eye bolt shall be installed in the top of the frame to allow a safe operation.

The installation of the system, at sea bottom level, will request the use of a Remote Operated Vehicle [ROV] Heavy Work Class, to lead the JBs to the proper position and to provide the cables connections.

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High quality materials and controlled production processes will be considered as mandatory requirements.

The JB consists of the following parts:

- Main Mechanical Frame
- Pressure Vessel hosting Optical and Power Assembly (OPA)
- Electro-Optical Interface Box (EOIB)
- Auxiliary Instruments (Hydrophone, Acoustic Beacon and Laser Beacon)
- Dry Connectors and related Cabling
- A set of 32 protective long term caps

5.2 Environment

The JBs, after the installation on the seabed, will operate in an environment where the temperature is quite constant at +13 °C. Once it has been installed, the mechanical solicitations shall only be the hydrostatic pressure at a water depth of 3500 meters.

Due to the main requirement of 20 years of lifetime in operation with a zero-maintenance, any preventive measure should be applied in the choice of materials, surface treatments and durability of the hardware.

5.3 Top Level Schematic of JBs – Phase 1.1 and Phase 2.0

The cabling schemes are shown in the following figures for JB1.1 and JB2.0 respectively.

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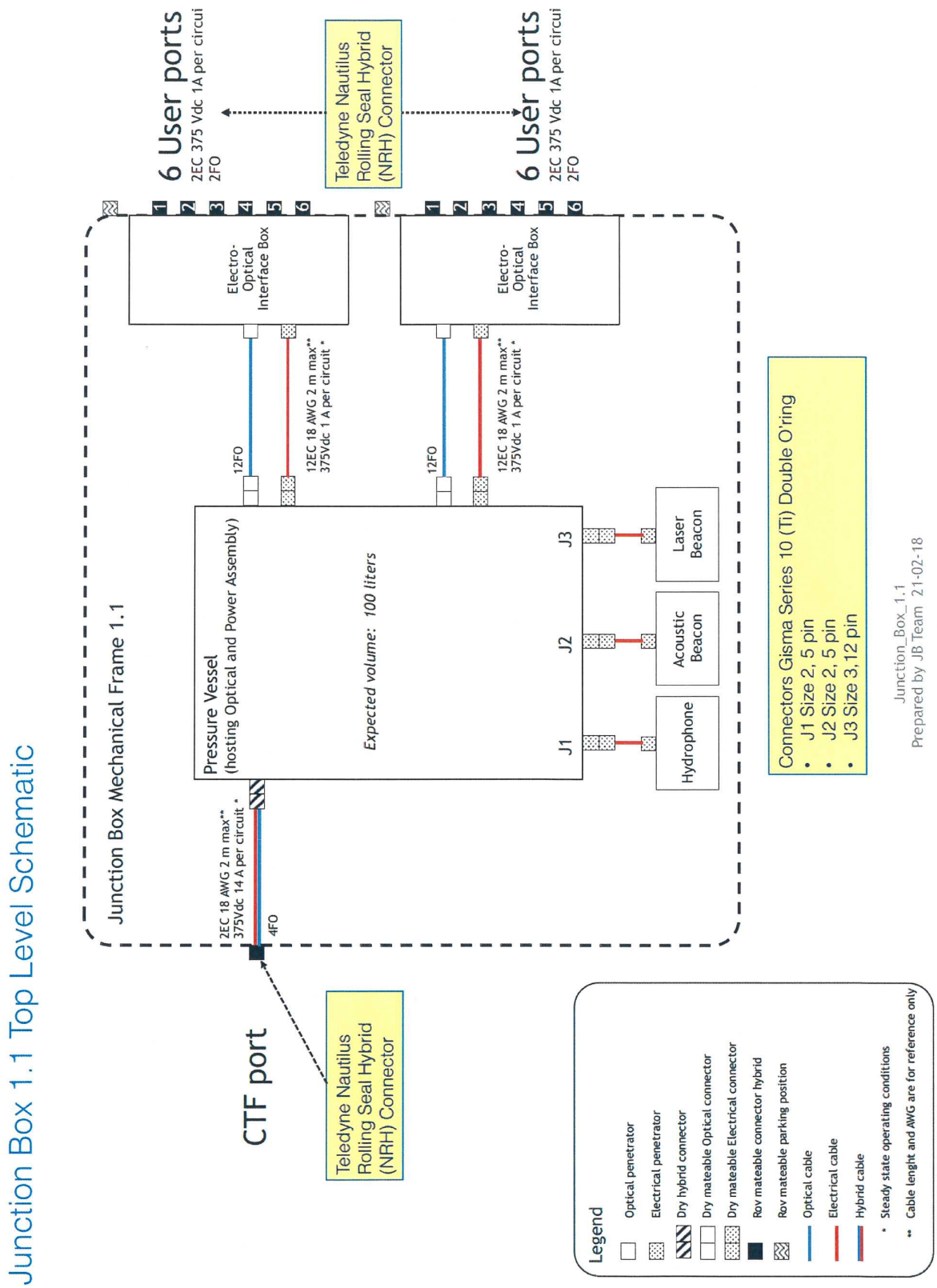

Fig. 2 - JB 1Phase 1.1 Cabling scheme

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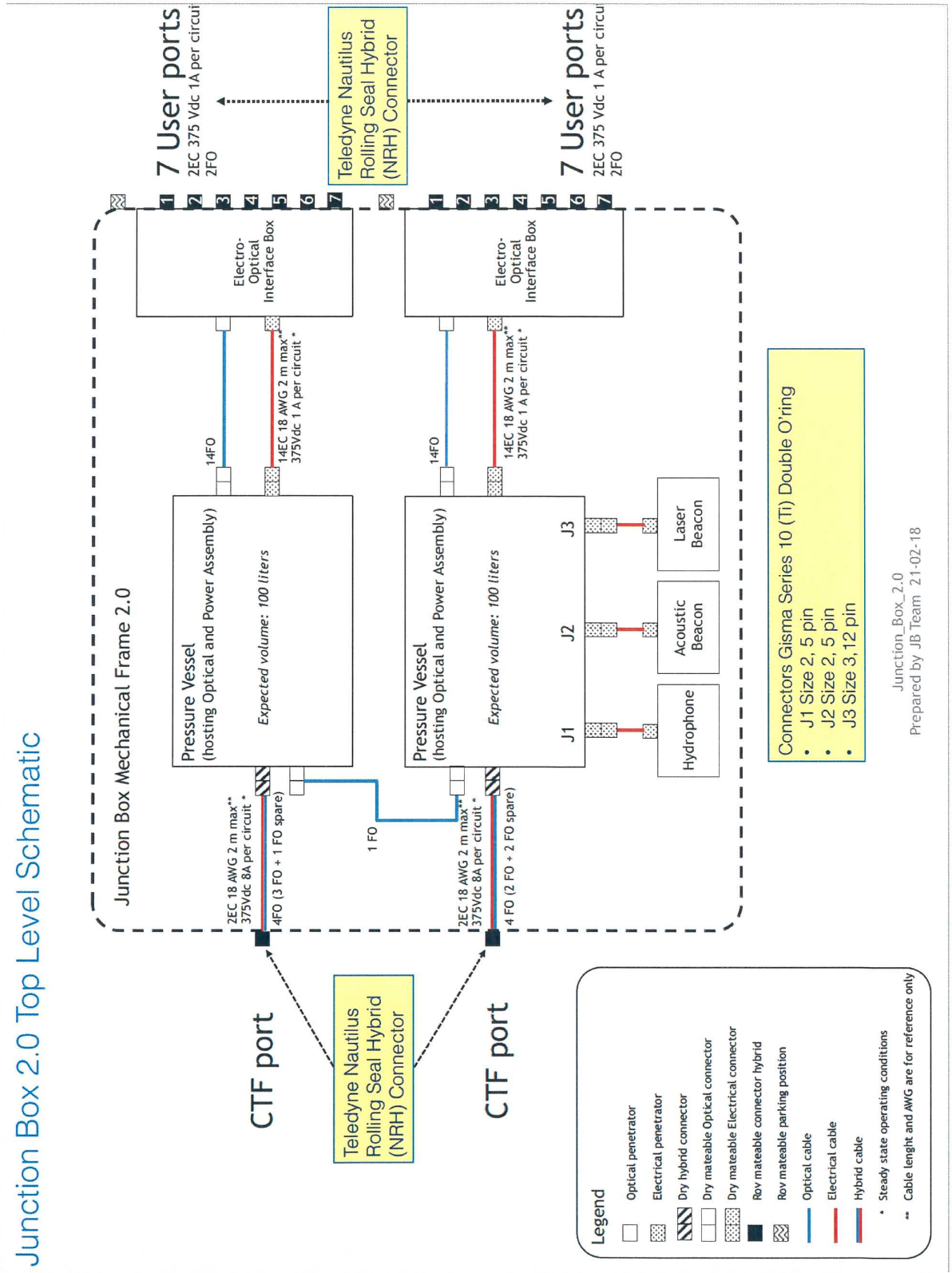

Fig. 3 - JB 2.0 Cabling scheme

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5.4 Mechanical Frame

The frame will be the mechanical support for the system. Its realization could take into account the following materials:

- Titanium is the preferred material for the frame realization.
- Steel it could be considered if a suitable corrosion protection system is used.

The corrosion resistance of all applied materials must be documented and guaranteed for the referred lifetime.

The Contractor, considering the environmental parameters (average temperature, salinity, etc.), must provide data on the corrosion resistance of the metal alloys used to make the outer reinforcement and any protection methods it intends to use.

The alloy chosen should be based on the Contractor experience for underwater application down to 3500 m.

Suitable lashing points shall be considered where is allowed attach a line to secure the JB during transit at high sea.

A mud mat should be applied to the bottom of the frame to prevent the structure sinking too far into the sediment layer, this also works as a suction anchor and protects the unit from bouncing between landing and releasing from the lift line.

The frame must be equipped of grab bars to allow the ROV Work Class to perform operations connections.

Proper points shall be outlined where the ROV can hold on to the structure to stabilise during connection. Alternately, foresee a dedicated reel for the ROV.

The Frame structure must be equipped by 2 Universal Parking Position for flying leads, installed on two side of the Frame, to use during periods of disconnection. Each one is equipped with 2 ROV Cable End Receptacle.

The weight of the JB would be greater than 1 ton.

The main frame will host 3 mechanical support in order to sustain the auxiliary instrumentation, shown in Fig. 4, whose main characteristics are:

1) Qt.1 acoustic beacon, titanium cylinder with ceramic head dimensions (h 541 mm, diameter 100 mm), weight in water 2.650 gr, weight in air 5.890 g. The ceramic head must not be shielded and must be at a distance of approximately 2.480 mm from the sea floor.
2) Qt.1 hydrophone, cylinder in POM-C, with ceramic head dimensions (h 367 mm, diameter 63 mm), weight in water 10 g, weight in air 450 gr. The support must be mechanically decoupled from holding structure with plastic supports. The ceramic head must not be shielded and must be at a distance of approximately 2.500 mm from the sea floor.
3) Qt.1 laser beacon, cylinder titanium, with quartz head, dimensions (h mm 580, diameter 163 mm), weight in air 26.700 g, weight in water 13.500 g. The quartz head must not be shielded and must be at a distance not less than 1.500 mm from the seabed.

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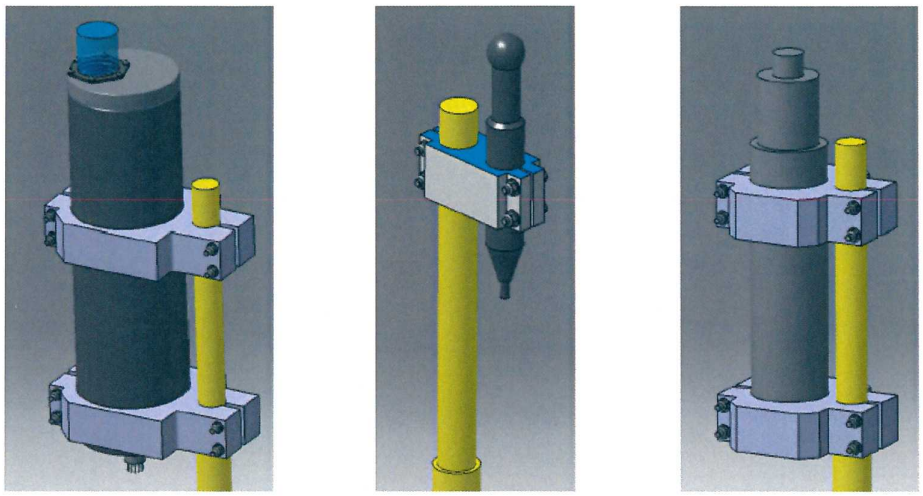

Fig. 4 – Aux Instrumentation.

The final shape of above item will be defined during the PDR meeting.

The weight balance is a mandatory requirement, so the eyebolt shall be on the vertical intercepting the centre of gravity, allowing the JB to be balanced and operated in a safe mode.

5.5 Pressure Vessel

The pressure vessel will be the housing of the Optical and Power Assembly (OPA) that constitutes the heart of the system.

The pressure vessel mechanic shall be designed by the Contractor as part of the job.

Its realization could take into account the following materials:

- Titanium is the preferred material for the frame realization.
- Steel it could be considered if a suitable corrosion protection system is used.

The corrosion resistance of all applied materials must be documented and guaranteed for the referred lifetime.

The Contractor, considering the environmental parameters (average temperature, salinity, etc.), must provide data on the corrosion resistance of the metal alloys used to make the outer reinforcement and any protection methods it intends to use.

The alloy chosen should be based on the Contractor experience for underwater application down to 3500 m.

The OPA will consists of a number of electronic boards and optical components mounted on a mechanical support used also as heat sink.

The pressure vessel internal estimated volume needed for the integration of the OPA is 100 litres; the former is a preliminary estimation which could be subject to slight variations and which final value will be confirmed 4 weeks before CDR.

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Due to the limited volume available inside the pressure vessel, the preferred heat transfer will be based on conduction between the hottest part of the electronics and the mechanical structure.

The Contractor shall provide, at the PDR, the mechanical drawings (3D CAD files, format to be agreed) of the pressure vessel and related external flanges.

The integration design of the electronics into the mechanical vessel will be under INFN responsibility.

The construction of the internal mechanical base plate will be in charge of INFN.

INFN will provide to the Contractor, at design completion, the integration drawings requiring comments, suggestions, approving for the manufacturing.

The OPA will be assembled, tested and qualified under INFN responsibility at INFN facilities.

The pressure vessel integration on the JB frame shall use proper devices as shock absorbers that improve the shipment of the JB, reducing the risk of shock and vibrations transmission to the internal components.

5.6 Electro Optic Interface Box (EOIB)

EOIB is the assembly where separated electrical and optical cabling will be joint into the electro-optic ROV operable connectors.

JB 1.1 shall include 6 x 2 ROV operable connectors, JB 2.0 shall include 7 x 2 ROV operable connectors. A common mechanical design would be preferable.

The two EOIB units must be installed in the opposite sides of the JB to make connections easier.

The EOIB shall be positioned at 1 meter high from the seabed, allowing a suitable operation with a working class ROV. They will be mounted inclined (25° typ.) to make easy the connection and the inspection.

Each EOIB must be tested and verified as following:

- Electrical insulation resistance
- Electrical resistance
- Insertion loss
- Return loss
- Optical microscope inspection of the optical pin surface

5.7 Connectors and cabling characteristics

The JB external interface connectors must be the models Teledyne Nautilus Rolling Seal Hybrid (NRH) Bulkhead Plug.

The supply must be equipped of a set of protective cap for long term duration whose total quantity is 32.

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All internal dry connectors and cabling must follow the basic principle of the 20 years lifetime and zero-maintenance.

The cabling between the external interfaces and the internal units shall be designed in order to optimize the voltage drops and the optical power loss.

The figures 2 and 3 indicate the cables length and copper section for reference only. Final cables characteristics and pinout will be defined during the PDR.

The cables length and the installation position of the instruments will be defined during PDR.

Each connector and cable assembly must be tested and verified as following:

- Electrical insulation resistance
- Electrical resistance
- Insertion loss
- Return loss
- Optical microscope inspection of the optical pin surface

The auxiliary instruments and their cables will be provided by INFN; the relative bulkhead connectors must be as following:

- J1 Hydrophone: GISMA Series 10 (Ti) with additional O-ring, SIZE 2,
- J2 LBL Beacon: GISMA Series 10 (Ti) with additional O-ring, SIZE 2,
- J3 Laser Beacon: GISMA Series 10 (Ti) with additional O-ring, SIZE 3.

J1, J2 and J3 part numbers will be defined at PDR.

6 Qualification procedures

The Contractor must provide evidence of the compliance with the environmental requirements by means of qualification activities. The demonstration might be done by test or analysis or similarity.

Adequate documentation support must be provided for the last two methods.

Qualifications shall demonstrate that the system, in the lifetime, will successfully operate at least for the following:

- Corrosion resistant capability
- High pressure resistant capability
- Life-time environmental exposure
- Transport handling
- Laying handling
- Shock and vibration

The Qualification Reports will be part of the deliverables.

The Qualifications will be part of the evaluation criteria of the tender.

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7 Documentation

The Proposal shall include:

- Detailed description of the JB (both models)
- Proposed layout showing the location of the main components and the size of the entire system.
- Detailed information on possible proposed alternative solutions
- Major components data sheets
- Material selection report
- Report on the corrosion protection system
- Preliminary Product Assurance Plan

The following documents shall be considered as part of the delivery. A printout of them will be provided as well as the electronic format:

- Full set of electrical and mechanical drawings, updated to the as built system
- Test plan, procedures and reports
- Qualification plan, procedures and reports
- Operation User Manual

8 Design reviews

8.1 Kick Off

At contract award, a kick off meeting should be held, reviewing the contract and confirming the delivery in detail. The Time Schedule will start at this time.

8.2 Preliminary Design Review

A Preliminary Design Review [PDR] meeting should be held in early phase of the contract, according to the project schedule. During the meeting, the Contractor will provide all applicable documents necessary to describe, identify, discuss and approve the system characteristics.

The Contractor shall deliver the Pressure Vessel mechanical drawings to allow INFN to start the design of OPA integration.

The System Family Tree including all part numbers should also be part of the Deliverable Document Package [PDR-DDP].

The Quality Assurance Plan and a preliminary Acceptance Test Plan should be presented too.

8.3 Critical Design Review

A Critical Design Review [CDR] meeting should be held when all design and manufacturing drawings as well as all necessary documents have been completed and available.

During this meeting the Contractor shall describe and discuss all results, sharing with customer any potential problem or criticality that may affects the technical performances or the time schedule.

The Contractor will provide the qualification reports of the already qualified parts of the delivery.

The Acceptance Test Plan will be provided, discussed and approved.

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A preliminary System Operation Manual shall also be part of the Deliverable Document Package [CDR-DDP].

At this meeting the project shall be formally approved, so in the following phase of the contract any Engineering Change Request [ECR] or Non-Conformance Report [NCR] will be presented to the customer for information and/or approval according to the impact to the delivery.

9 Acceptance Tests

The acceptance of the delivery will be executed in two following phases:

1. In Factory Tests, at production completion
2. Final Tests, after the shipment to the customer facility

The Acceptance Test Procedure, covering both acceptance phases, according to the approved Acceptance Test Plan shall be delivered at least 4 weeks before the estimated Tests start date for what is concerning the Factory Tests.

The delivery of all the qualification reports of the products is considered part of the Factory Acceptance phase.

INFN will witness all test phases included sub-systems.

9.1 In Factory Tests

As part of the acceptance the functionality shall be tested by using a custom test setup provided by INFN.

The Acceptance Test Plan shall at least include the followings:

- Visual inspection of assemblies and of electrical and optical cables routing
- All cables and connector must be supplied with test reports
- Each EOIB must be supplied with test reports
- Functionality tests

9.2 Final Acceptance Test

The Final Acceptance Test should verify the functionality of the entire system after the shipment at INFN premises. It shall at least include the followings:

- Visual inspection of assemblies
- Functionality tests

10 Packing and Shipment

The packaging and shipment of the JB will be included in the conditions of supply.

Suitable shock detectors shall be applied on the JB packaging allowing the verification of extra solicitations during the transport.

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11 Quality Requirements

The Contractor should prepare a Quality Assurance Plan describing all procedures and processes adopted during the contract execution in order to guarantee a successful.

INFN should be authorized to visit the Contractor facilities in order to verify the work progress, according to the agreed time schedule.

12 Follow-Up of the order

INFN is aware that discussion with the manufacturer, during the design and development period, as well as a good follow-up of the order during manufacturing is important conditions for success.

The Contractor shall nominate a Project Manager responsible toward the INFN for all technical and administrative aspects of this contract throughout the contractual period.

An updated detailed time schedule covering design, material procurement, manufacturing and testing shall be submitted to the INFN.

When needed, the Project Manager should organize proper meetings to discuss possible issues with the INFN representatives.

Representatives of INFN must be allowed to visit at any time, during the contract, the manufacturer's and subcontractor's premises.

The persons in charge of follow-up of the contract on behalf of INFN-LNS is:

Mario Sedita RUP

Tel: +39 095 525449

Fax: +39 095 7141815

E-mail: sedita@lns.infn.it

13 Deviation from specifications

All deviations from these technical specifications must be highlighted by the Supplier and submitted in writing to the INFN-LNS for approval. INFN-LNS will provide approval or refusal in writing.

14 Proposed Time Schedule

The first delivery will be the 3 x JB1.1 model and subsequently the 2 x JB2 model. The system will be acquired after the contract signature according to the following timetable:

1. Placing of the order (week)	To = 0
2. Kick Off Meeting	To = 2
3. Preliminary Design Review	To = 6
4. Critical Design Review	To = 14
5. Start on JB1.1 FAT	To + 32
6. JB 1.1 Delivery	To + 33
7. JB1.1 Final Acceptance Test at INFN-LNS	To + 36
8. Start on JB 2 FAT	To + 66
9. JB 2 Delivery	To + 67
10. JB 2 Final Acceptance Test at INFN-LNS	To + 68

The Seller can propose a different time-schedule if he deems the delivery time could be different and, in any case, not more than the point 10.

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