

Chapter 9: [Sea operations](#)

ANTARES takes advice from IFREMER for the sea operations, which concern the installation and recovery of the different components of the detector : Junction Box, Strings, Interconnecting Link Cables. The experience gained by the collaboration in previous prototype deployments have demonstrated the feasibility of the sea operations, with good logistics and careful preparation. In this chapter, we present the sea operation programme for the 0.1 km² project, and the different procedures for installation and recovery.

- [Overview](#)
 - [Long BaseLine positioning](#)
 - [Junction Box installation and recovery](#)
 - [String installation and recovery](#)
 - [Installation and recovery of Interconnecting Link Cables](#)
 - [Test Programme](#)
 - [Sea operation PBS list](#)
-

Overview

This section discusses the operations related to the installation and maintenance of the detector. To perform these tasks, three different types of operations are required which involve special ship equipment, dedicated tools and procedures. These are:

- [Junction Box](#) installation and recovery.
- [String](#) installation and recovery.
- [Interconnecting Link Cable](#) installation and recovery.

The installation and maintenance of the experiment require access to ship-borne resources and in some case the use of manned submarines or remote operated vehicles (ROV), together with their support personnel and ancillary equipment.

The operation planning of the sea deployment is dependent on the construction schedule of the ANTARES equipment. The operational programme consists of the main operations listed below together with some test operations performed before:

1. *Site Survey with the Cyana manned submersible (cf pictures 1- [Cyana](#), 2- [Cyana on board the Castor](#) , 3- [Cyana on Castor](#), 4- [Cyana pilot installing the water tightness seal](#))*
2. *[Main Electro-Optical Cable \(MEOC\)](#) installation by Alcatel (under CPPM responsibility).*
3. *[Long Baseline installation](#) and calibration*
4. *[Junction Box installation](#) with 16 connectors*
5. *[Instrumentation Line](#) installation*
6. *[Prototype Sector Line installation](#)*
7. *[Interconnecting Link Cables 0 and 1](#) installation with ROV*
8. *Prototype Sector Line recovery*
9. *String 1 installation*
10. *String 2 installation*
11. *Interconnecting Link cables 1,2 installation with ROV*
12. *String 3 installation*
13. *String 4 installation*
14. *String 5 installation*
15. *String 6 installation*
16. *Interconnecting Link Cables 3,4,5,6 installation with ROV*
17. *String 7 installation*
18. *String 8 installation*
19. *String 9 installation*
20. *String 10 installation*
21. *Interconnecting Link Cables 7,8,9,10 installation with ROV*

Typically each operation requires one day of mobilisation and one day of demobilisation at La Seyne sur Mer (at Foselev Marine base or at IFREMER base for operations with manned submarine).

One [String installation or recovery](#) operation requires 12 hours on site; one [Interconnecting Link Cable installation](#) with the submersible, 12 hours; [Junction Box installation](#), 24 hours.

For the Junction Box and String installation, in addition to the vessel crew, deck crew and diver team (3), the ANTARES crew consists of the operation manager, the navigation team (2), and the operation team.

For [Interconnecting Cable Link installation](#), in addition to the vessel crew and deck crew, the ANTARES crew consists of the operation manager, the navigation team (2), the operation team and the submarine (8 for Cyana) or ROV crew.

After various studies with Dynamic Positioning (DP) vessels and submarines vehicles, it is presently envisaged to use:

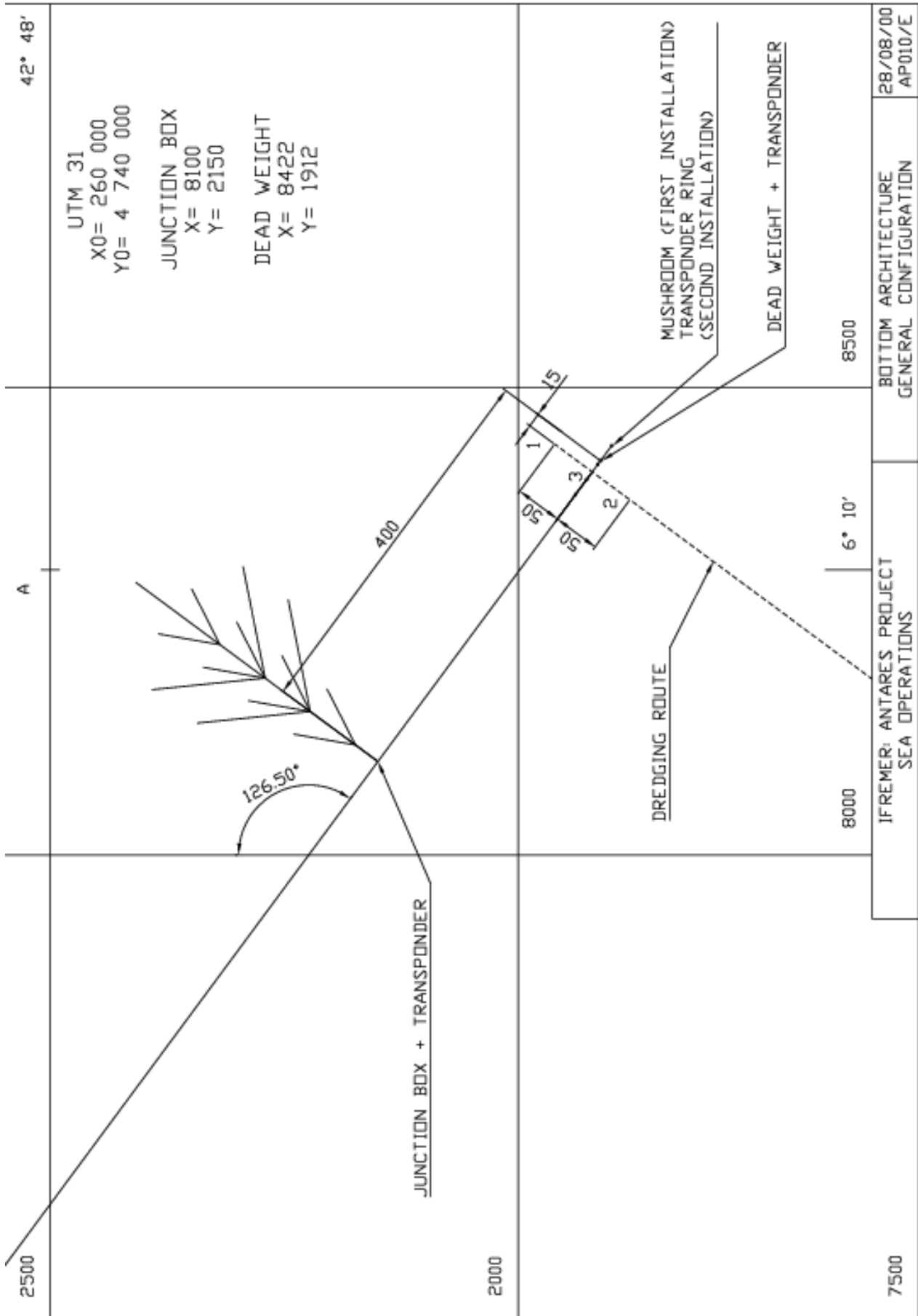
- The [Castor](#), a DP vessel of [Foselev Marine](#) (formerly Serra) to install and recover the Junction Box and the strings.
- The IFREMER manned submarine [Cyana](#) operated from the Castor.
- The IFREMER Remote Operated Vehicle (ROV) [Victor](#) or another ROV, operated from the Castor, to install the [Interconnection Link cables](#).

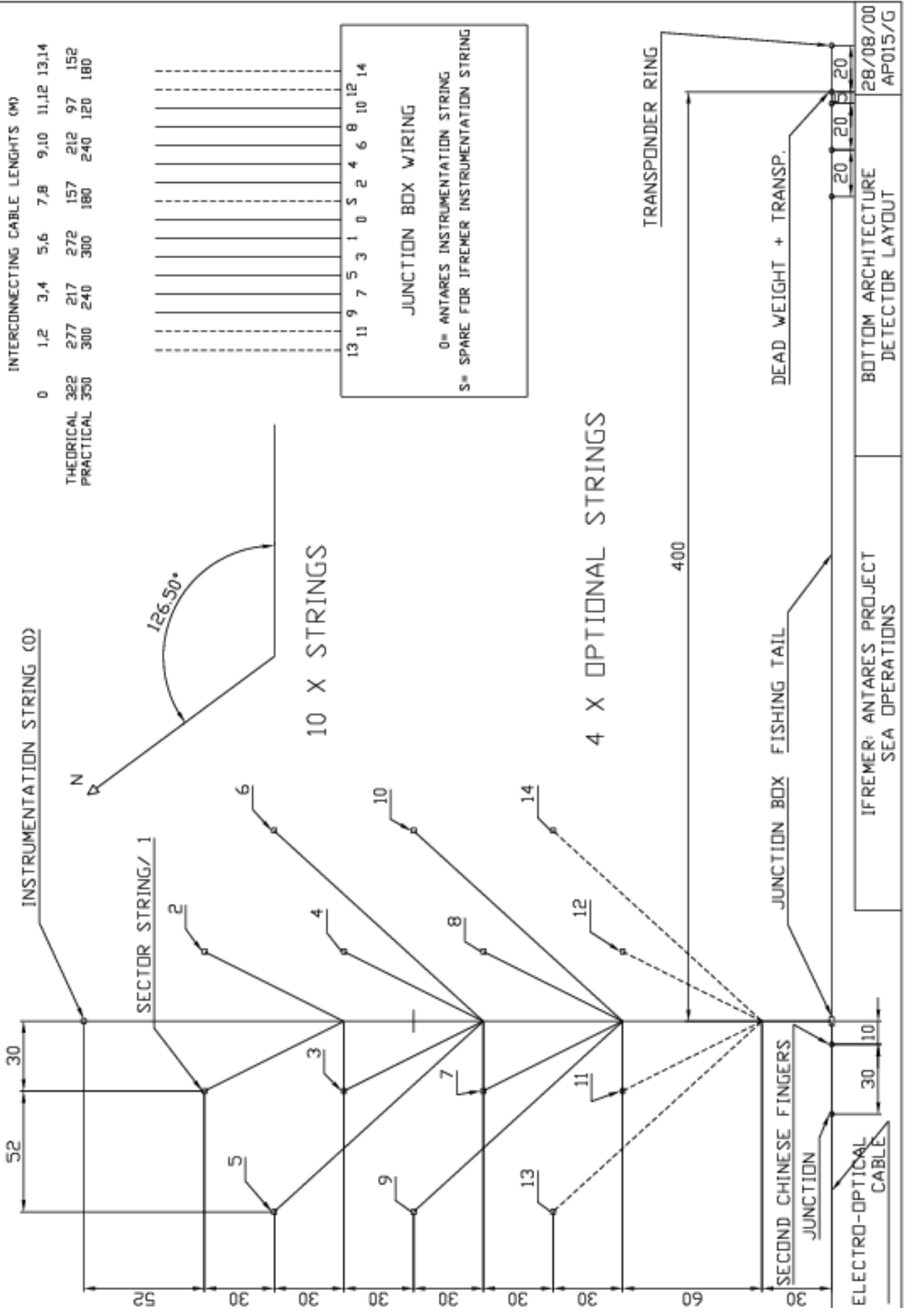
Due to the general direction of the sea current on the bottom, the direction of the cable and operational safety, a general configuration in which the Junction Box is positioned to be South West of the detector ([AP010](#)) is considered.

The strings will be installed according to the numbering shown on the [layout](#) (also [AP015](#)) : Strings 1 and 2 are installed and connected first, then Strings 3 to 6, then Strings 7 to 10. This allow the ROV to work in a free area under the current of the strings and avoids the crossings the Interconnecting Link Cables on the sea bed.

The 1000 m x 1000 m site has been surveyed in March 2001 using the submarine Cyana and the location of the Junction Box is defined taking into account the size and position of objects found on the bottom ($x_B = 268100$ / $y_B = 4742150$ / UTM31).

All three types of operations require a [Low Frequency Long BaseLine positioning](#) system permanently installed on the seabed at the site. It has four reference transponders installed around the detector site and positions the Junction Box equipped with one transponder and the [BSS](#) equipped with two releasable transponders. The submarine vehicle (Cyana or the ROV and its depressor) and the Interconnecting Link Cable deployment reel are also equipped with a transponder.





[Up](#)[Next](#)[Previous](#)[Contents](#)

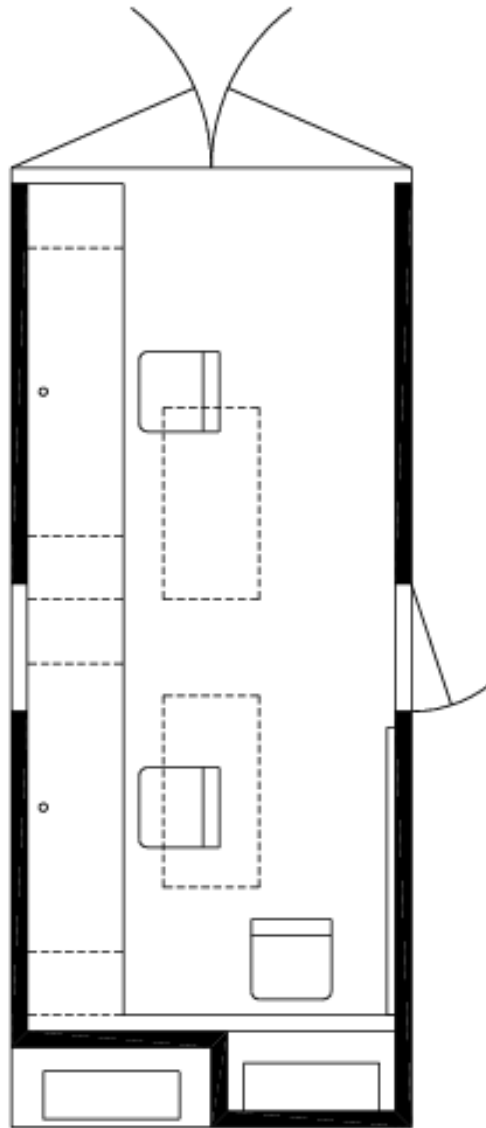
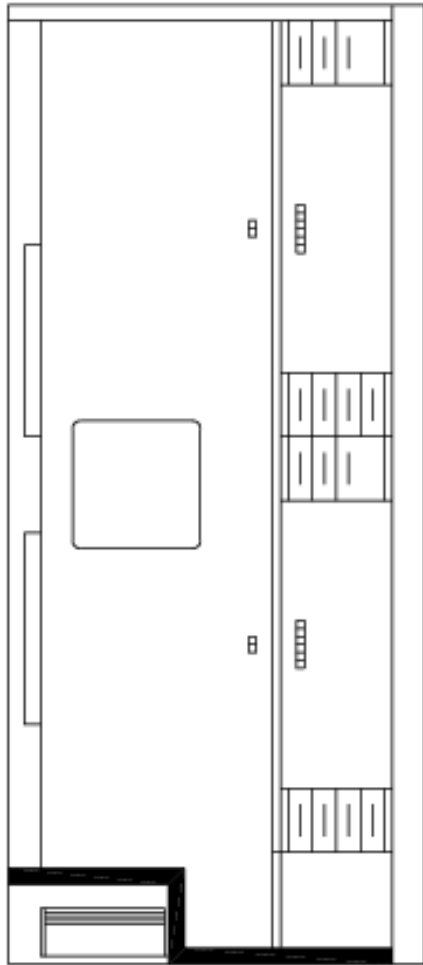
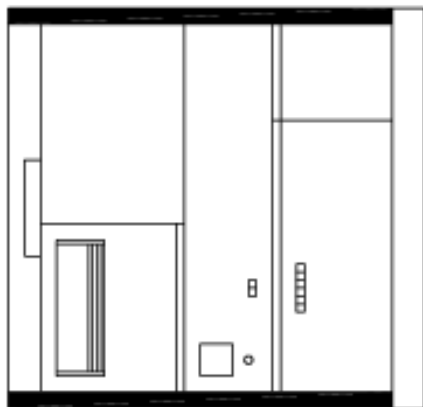
Long BaseLine navigation

The operation of the [Low Frequency Long BaseLine](#) navigation system is described in the [Absolute Positioning](#) section of the [Calibration](#) chapter.

Long BaseLine electronics and computers for navigation, post-processing and archiving are installed in a special 20' navigation container ([AP410](#)) positioned at the second level on Castor deck with easy access to the bridge (a special gangway has been built for that purpose).

The acoustic transponder is installed on an [ORE fish](#) deployed from a special boom permanently installed starboard side on Castor bow ([AP433](#)).

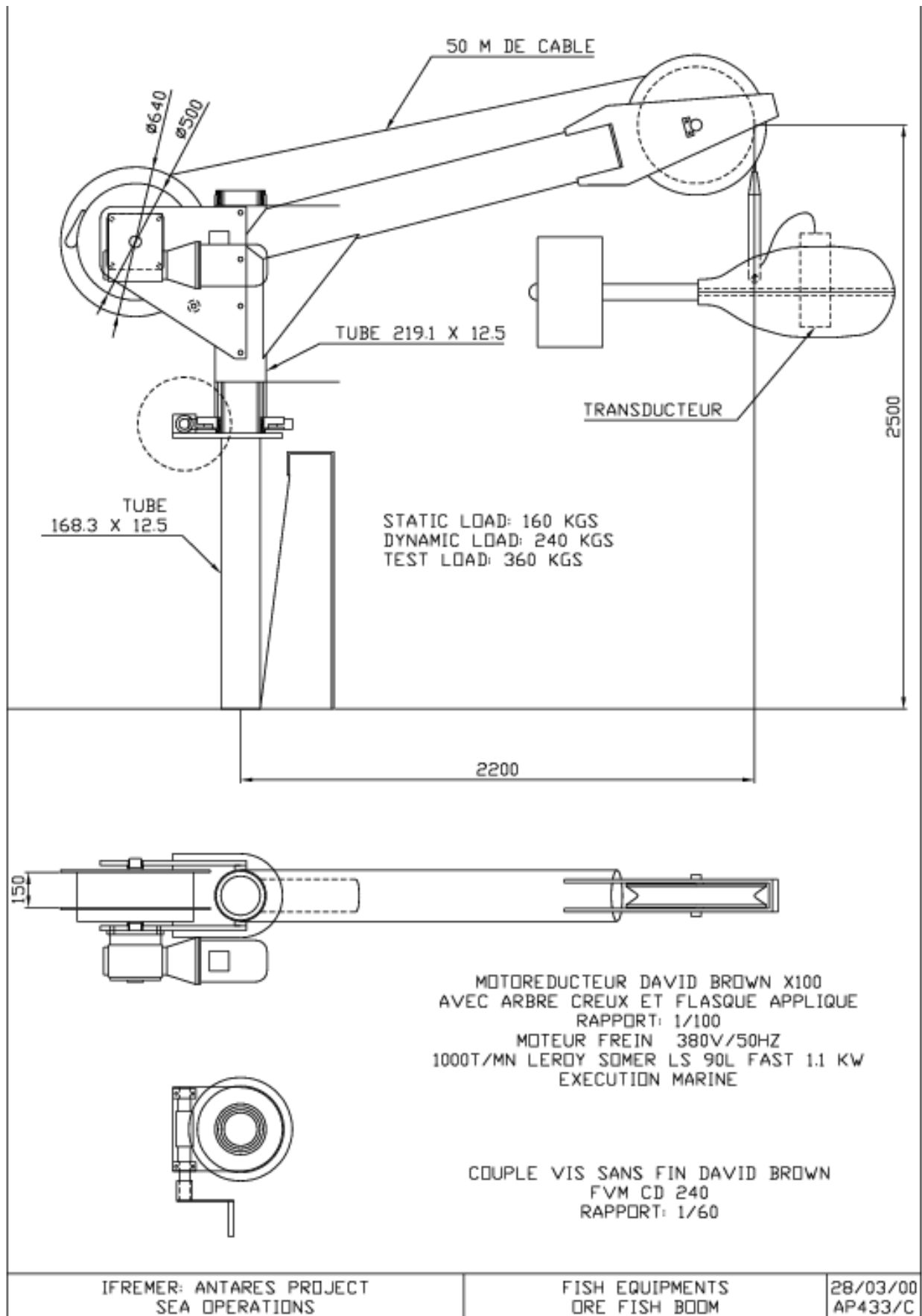
A second identical boom is also permanently installed on the port side of the Castor bow and is ready to receive the ORE fish of the acoustic phone (TUNX) used to communicate with the manned submarine.



IFREMER: ANTARES PROJECT
SEA OPERATIONS

SHIP EQUIPMENTS
NAVIGATION CONTAINER

15/10/99
AP410/A



Junction Box installation and recovery

A preliminary 400 m long fishing tail ([AP050](#)) connected to the main "Chinese fingers" (load taking devices) is installed with the Main Electro-Optical Cable ([MEOC](#)). Secondary Chinese fingers are located 10 m behind the main ones. The end of the cable has to be recovered and connected for [Junction Box](#) installation.

Ship mobilization ([AP100](#)):

In addition to the permanently installed equipment (gantry, [deep sea winch](#), deck winches, [ORE fish](#) booms,...), the main equipment to mobilise is:

- The ANTARES Navigation Container ([AP410](#))
- The ANTARES Workshop Container ([AP420](#))

The special tools required are:

- The [Deniel grapple](#) with a 1000 kg depressor
- The 400 m replacement fishing tail with 1000 kg dead weight ([AP051](#))

The Junction Box is installed under the 25 tonne block of the Castor. The organisation on board is defined by the [AP105](#) chart. The navigation and communication installations are defined by the [AP106](#) chart.

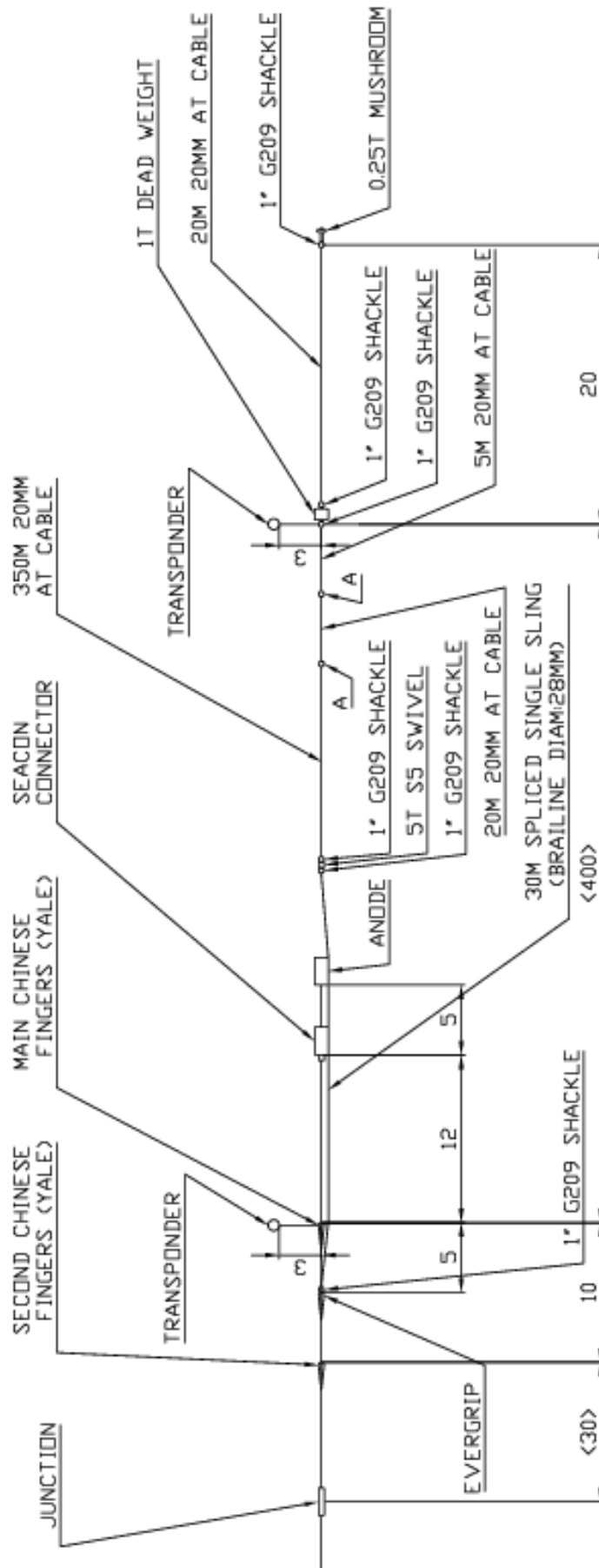
Installation procedures:

The cable recovery operation is performed using the deep sea winch.

1. The fishing tail connected to the main Chinese fingers is dredged with the Deniel grapple positioned with a transponder ([AP110-1](#)).
2. Once the grapple depressor is on board, the grapple head is connected by the divers to the 5 tonne lateral block ([AP110-2](#)).
3. The grapple is lifted at maximum.
4. The 20 tonne central block is connected to the fishing tail master link and the grapple is released ([AP110-3](#)).
5. The grapple and the depressor are recovered on board.
6. The deep sea cable is connected to the master link ([AP110-4](#)).
7. The deep sea cable is tensioned and the 25 tonne central block is released by the divers ([AP110-5](#)).
8. The fishing tail is spooled on the deep sea winch.
9. When the connector arrives at the surface, the 5 tonne lateral block is connected by the divers to the second Chinese fingers.
10. The second Chinese fingers are lifted and slack is given to the main ones ([AP110-6](#)).
11. The fishing tail is disconnected and the main Chinese fingers and the connector are

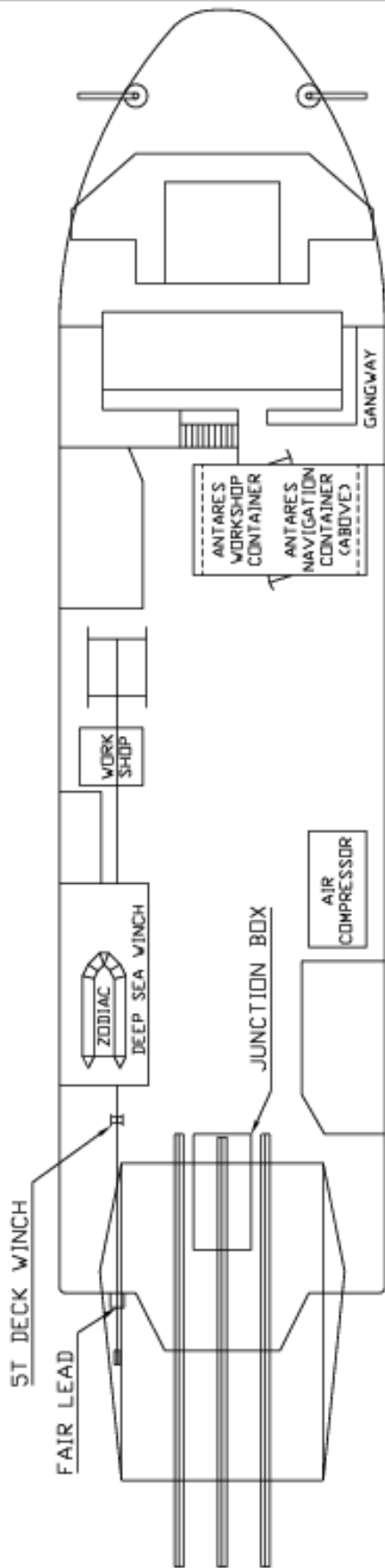
connected to the Junction Box.

12. The Junction Box is tested.
13. The fishing tail is connected to the Junction Box swinging arm .
14. The Junction Box is launched using the central block and the 2 m two-legs sling ([AP110-7](#)).
15. The second Chinese fingers are lowered.
16. The main Chinese fingers are tensioned and the 5 T lateral block is released by the divers ([AP110-8](#)).
17. The fishing tail is tensioned and the two-legs sling is disconnected by the divers. The Junction Box is lowered with the deep sea winch.
18. When the end of the fishing tail is in the water, the 1000 kg fishing tail dead weight is connected to the end of the fishing tail and the dead weight is launched using the 5 tonne lateral block ([AP110-9](#)).
19. The dead weight is tensioned and the deep sea cable end is disconnected.
20. The deep sea cable end is connected to the transponder. The transponder is launched and the deep sea cable is tensioned. The lateral block is released by the divers ([AP110-10](#)).
21. The deep sea cable is paid out and the Junction Box is laid on the sea bed under navigation control (Junction Box transponder) and tensiometer control..
22. The fishing tail dead weight is laid on the sea bed under LFLBL navigation control (transponder with release). The dead weight is then released.
23. The fishing tail is in place ready for future Junction Box recovery.
24. The deep sea winch cable is recovered at the surface.

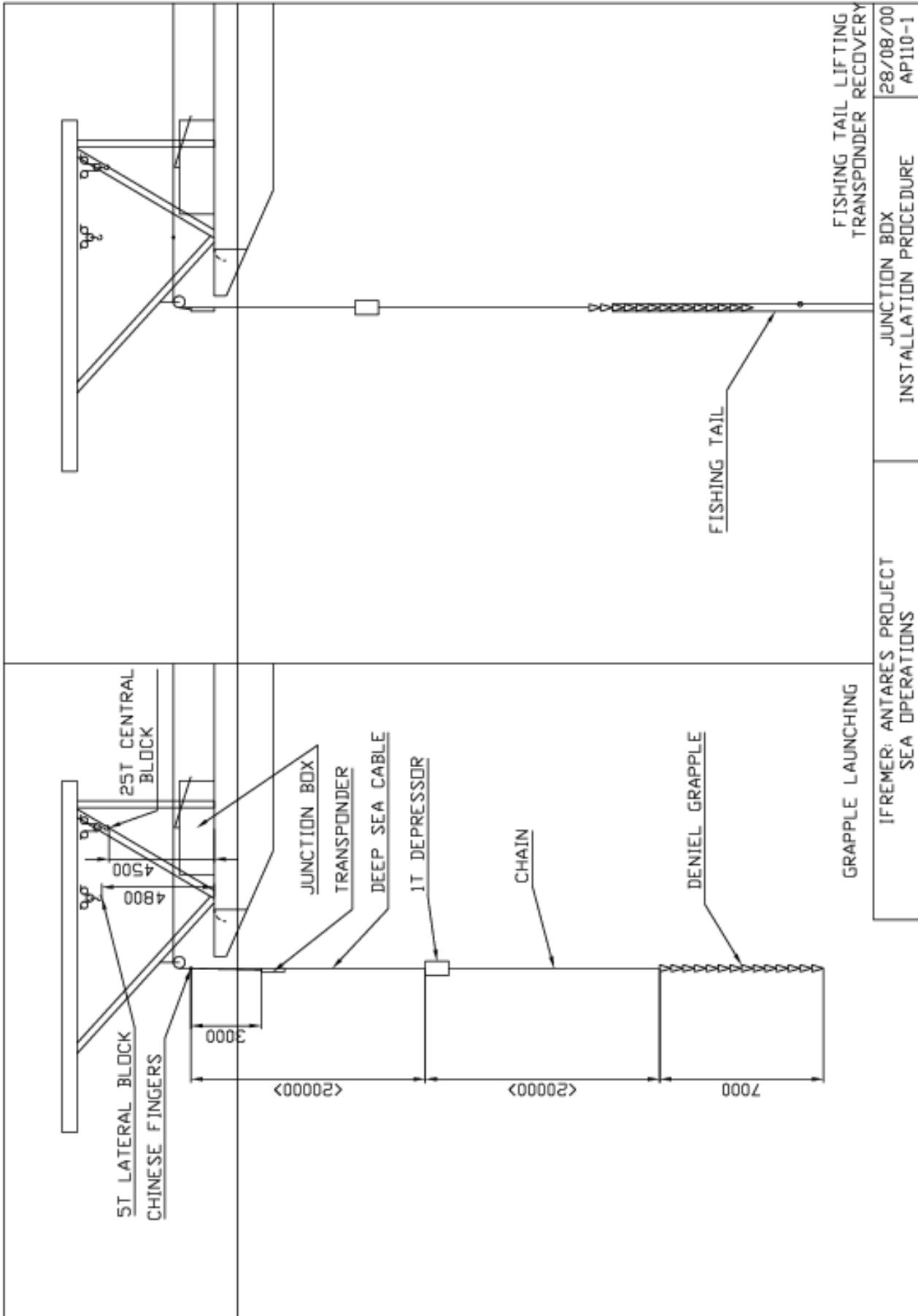


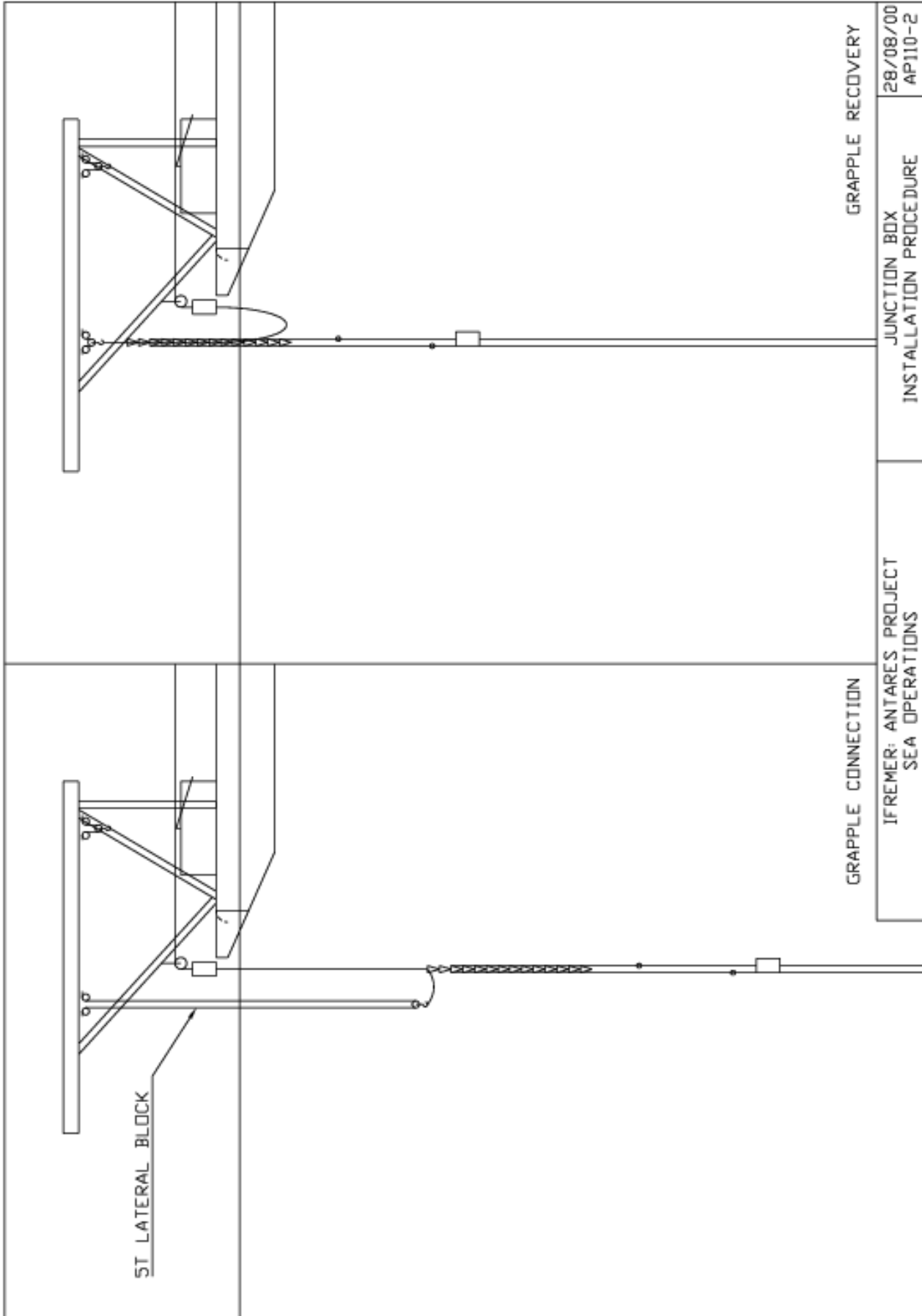
A=
 1" G209 SHACKLE +
 MSCAB MASTER LINK +
 1" G209 SHACKLE

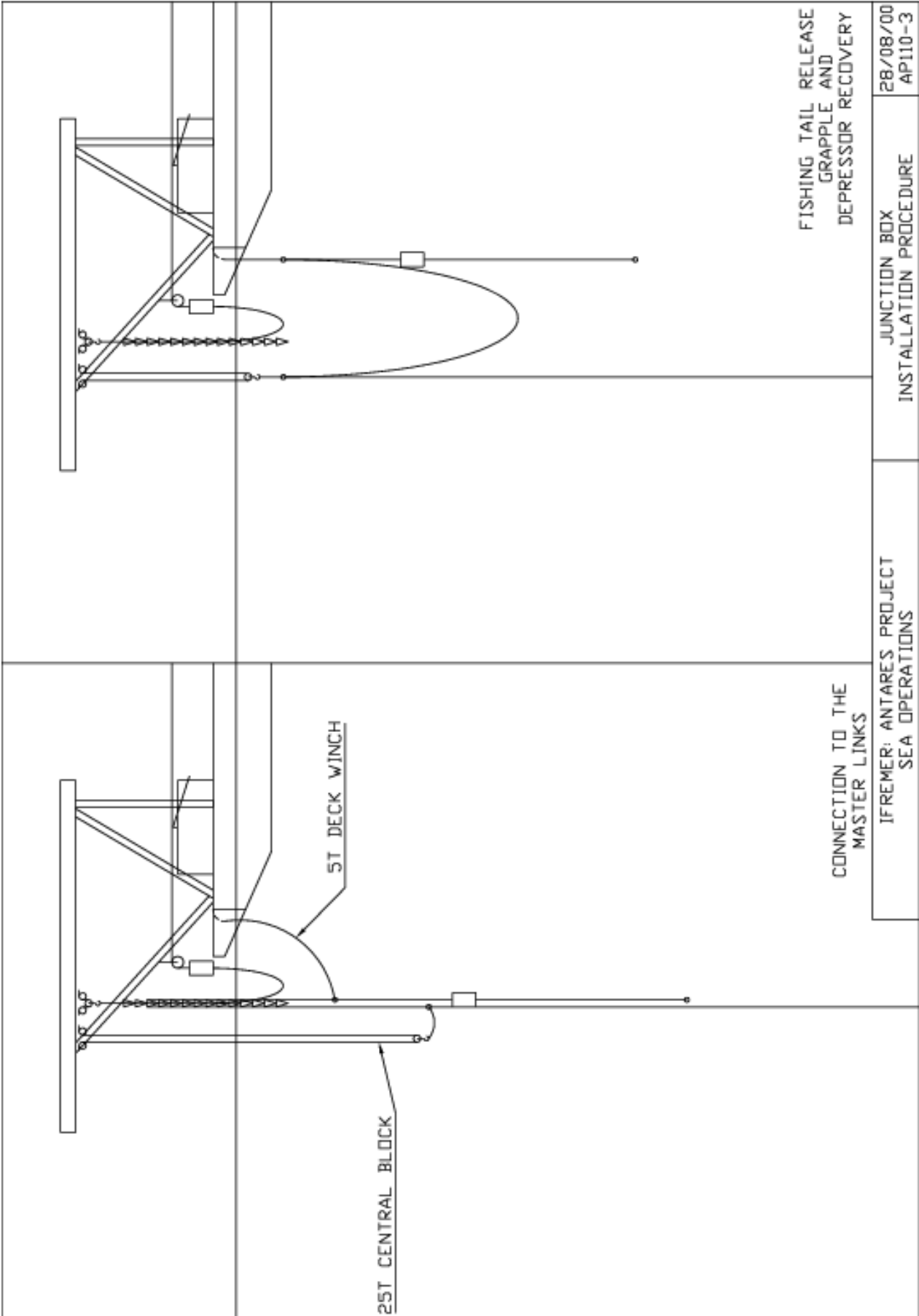
IFREMER: ANTARES PROJECT SEA OPERATIONS	FISHING TAIL FIRST INSTALLATION	08/11/00 AP050/C
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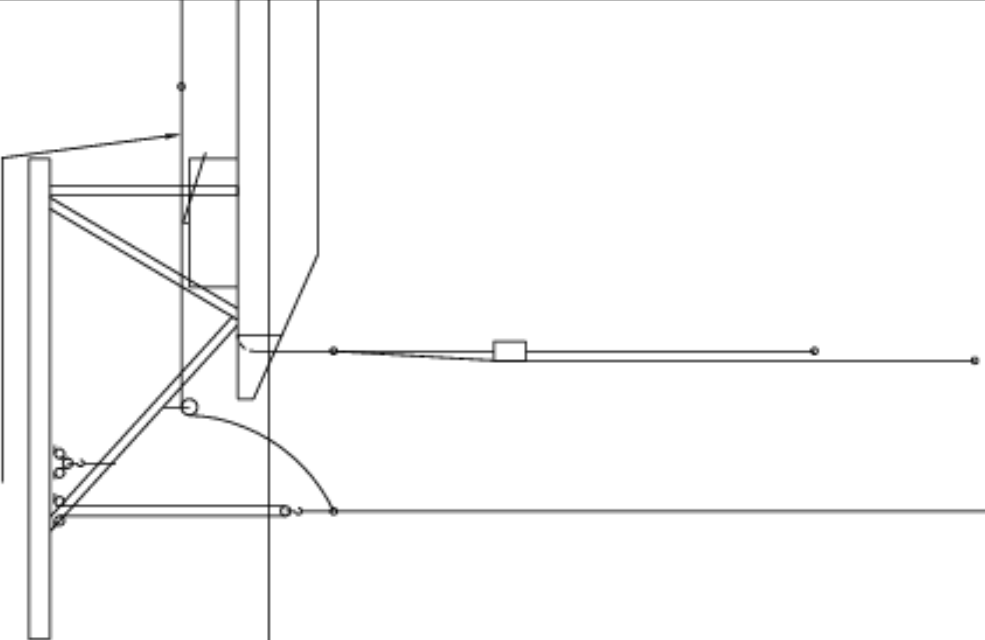
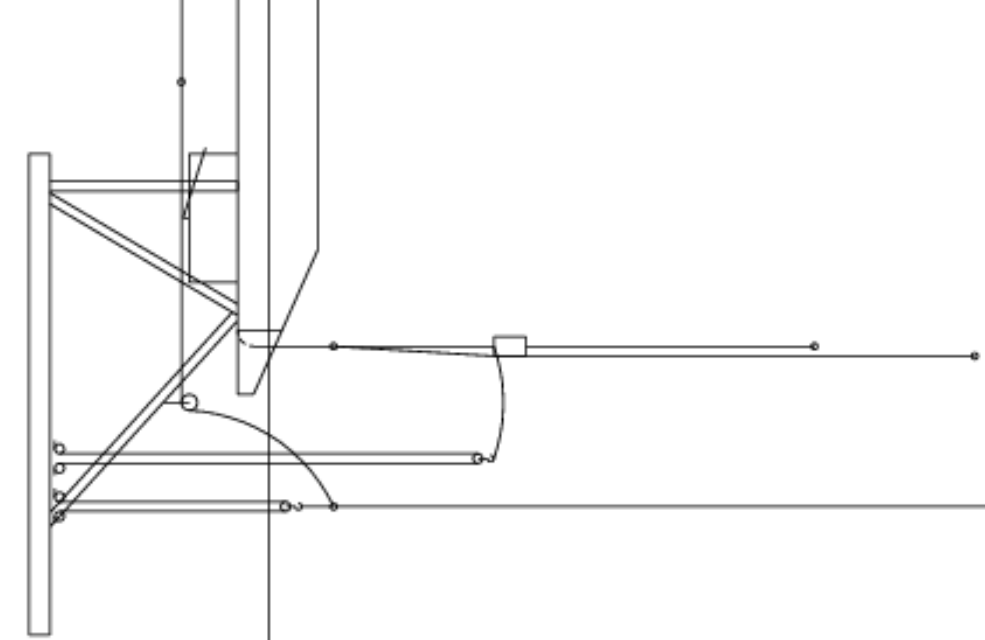


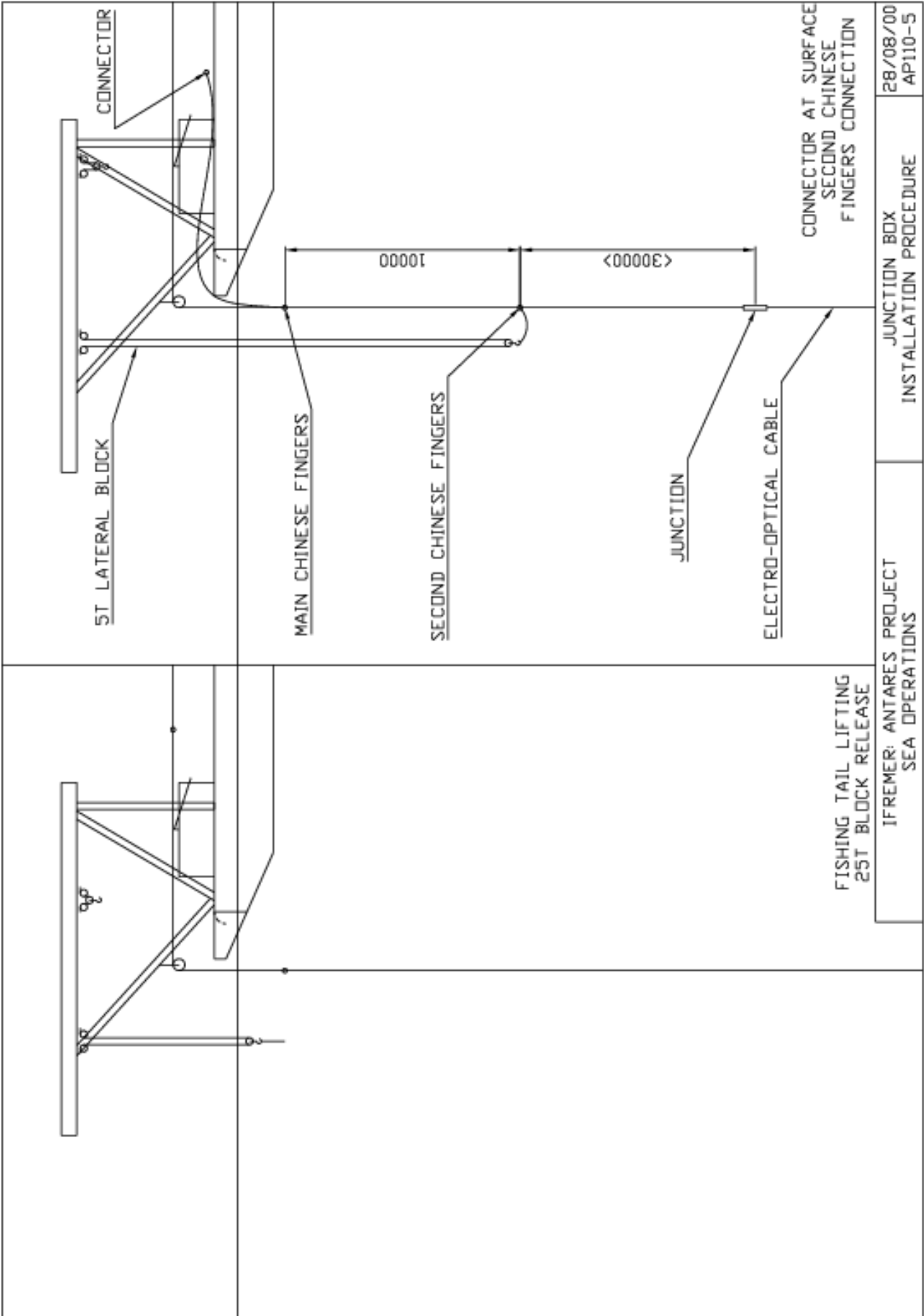
<p>IFREMER: ANTARES PROJECT SEA OPERATIONS</p>	<p>JUNCTION BOX GENERAL SHIP INSTALLATION</p>	<p>15/10/99 AP100/B</p>
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 <p>NEW 20M FISHING TAIL</p> <p>NEW 20M FISHING TAIL CONNECTION FISHING TAIL SLACK RELEASE</p>	 <p>DEAD WEIGHT RECOVERY</p>	<p>IFREMER: ANTARES PROJECT SEA OPERATIONS</p>	<p>JUNCTION BOX INSTALLATION PROCEDURE</p>	<p>28/08/00 AP110-4</p>
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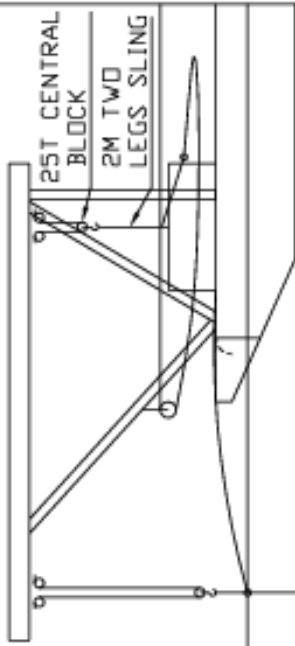
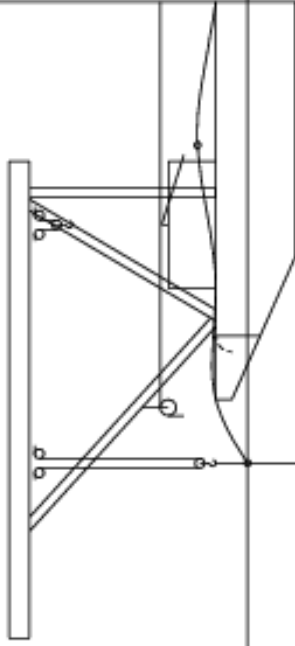
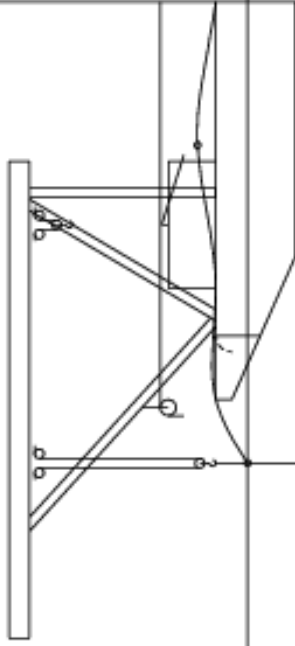



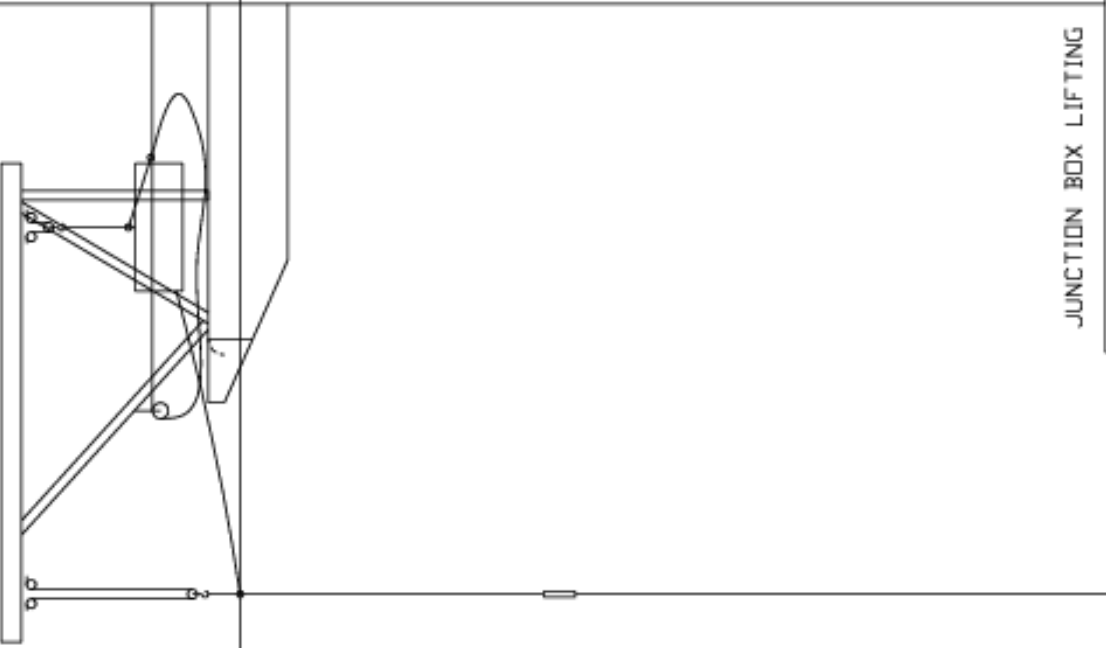
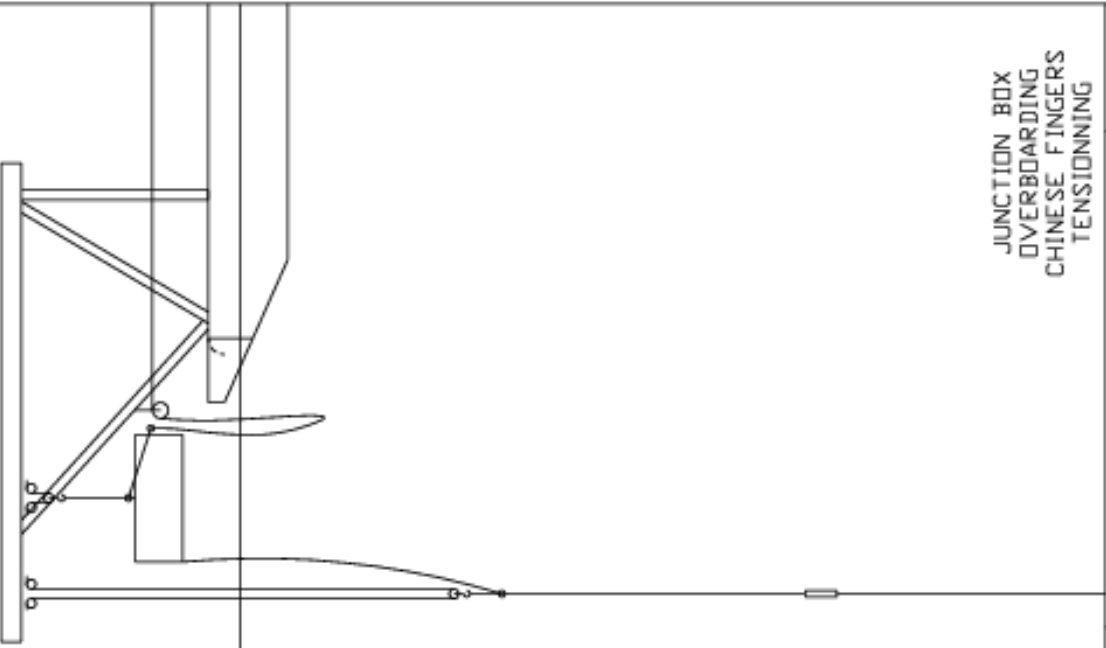
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AP110-5

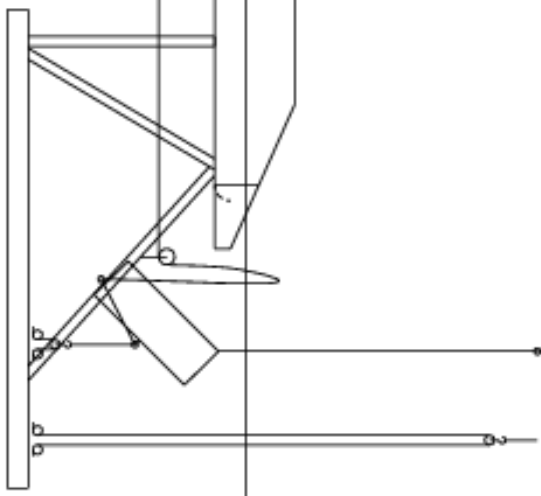
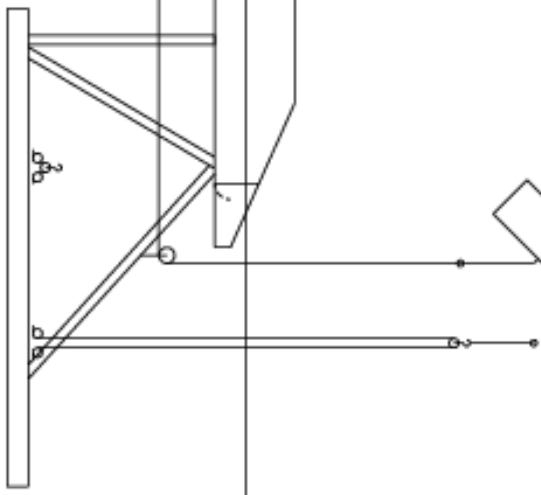
JUNCTION BOX
INSTALLATION PROCEDURE

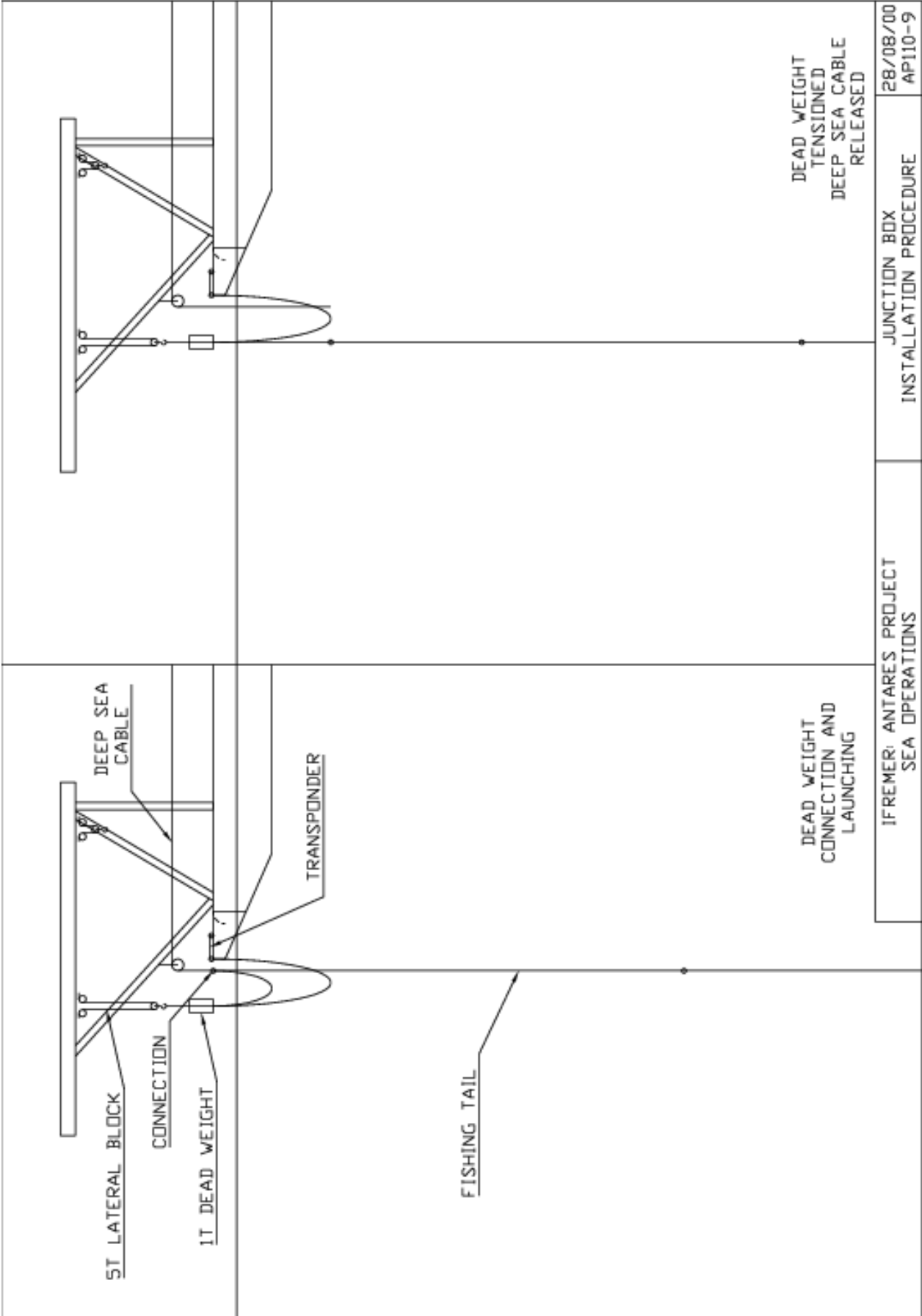
IFREMER: ANTARES PROJECT
SEA OPERATIONS

FISHING TAIL LIFTING
25T BLOCK RELEASE

 <p>2ST CENTRAL BLOCK 2M TWD LEGS SLING</p>	 <p>2ST CENTRAL BLOCK 2M TWD LEGS SLING</p>	<p>JUNCTION BOX CONNECTION FISHING TAIL CONNECTION</p>	<p>JUNCTION BOX INSTALLATION PROCEDURE</p>	<p>28/08/00 AP110-6</p>
 <p>2ST CENTRAL BLOCK 2M TWD LEGS SLING</p>	 <p>2ST CENTRAL BLOCK 2M TWD LEGS SLING</p>	<p>SECOND CHINESE FINGERS LIFTING MAIN CHINESE FINGERS RELEASE CABLE ON BOARD</p>	<p>IFREMER: ANTARES PROJECT SEA OPERATIONS</p>	

 <p style="text-align: center;">JUNCTION BOX LIFTING</p>	 <p style="text-align: center;">JUNCTION BOX OVERBOARDING CHINESE FINGERS TENSIONING</p>	<p style="text-align: center;">IFREMER: ANTARES PROJECT SEA OPERATIONS</p>	<p style="text-align: center;">JUNCTION BOX INSTALLATION PROCEDURE</p>	<p style="text-align: center;">28/08/00 AP110-7</p>
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 <p>CHINESE FINGERS TENSIONED SECOND CHINESE FINGERS RELEASED</p>	 <p>FISHING TAIL TENSIONED 25T BLOCK RELEASED</p>	<p>IFREMER: ANTARES PROJECT SEA OPERATIONS</p>	<p>JUNCTION BOX INSTALLATION PROCEDURE</p>	<p>28/08/00 AP110-8</p>
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DEAD WEIGHT
TENSIONED
DEEP SEA CABLE
RELEASED

28/08/00
AP110-9

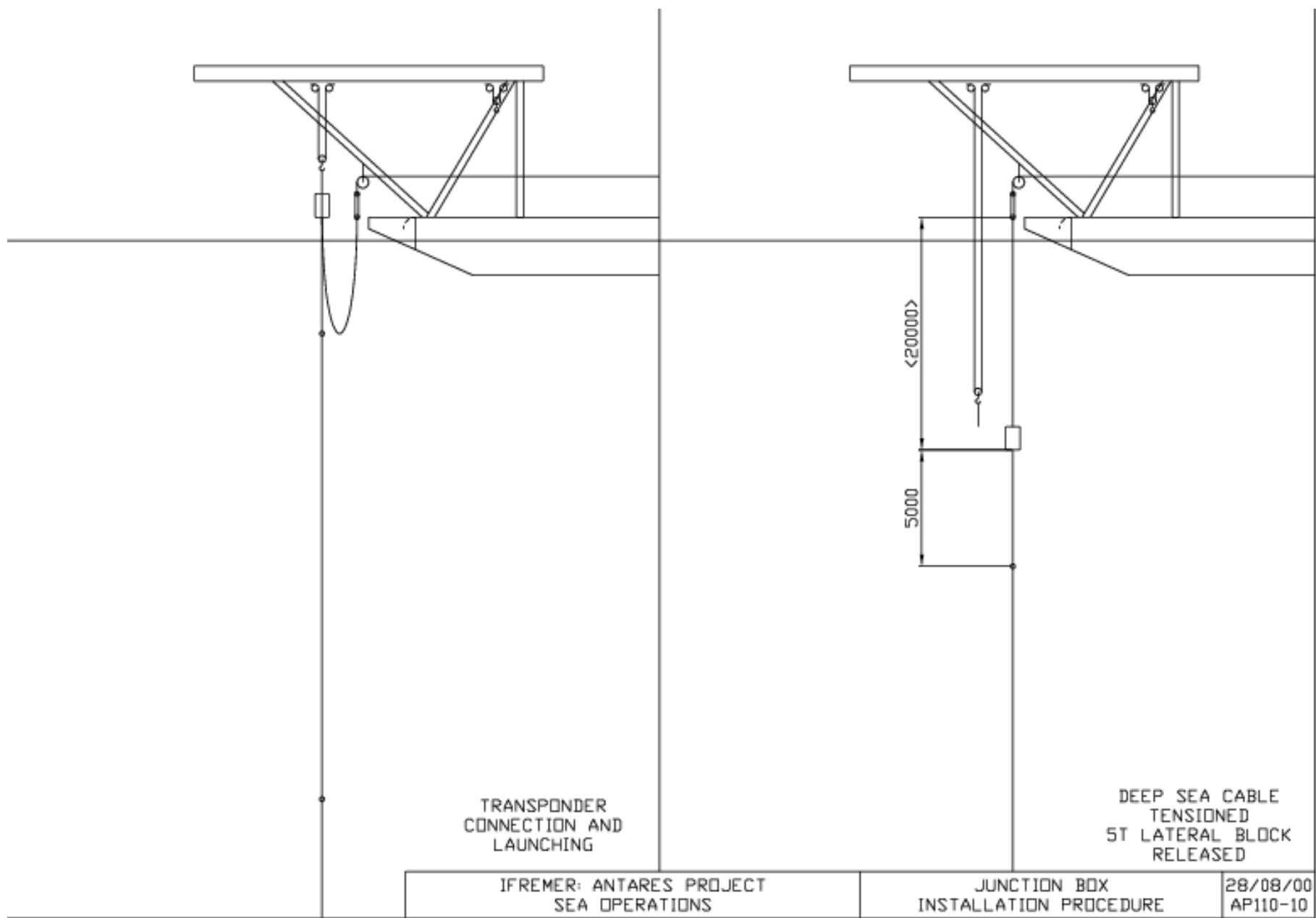
JUNCTION BOX
INSTALLATION PROCEDURE

IFREMER: ANTARES PROJECT
SEA OPERATIONS

DEAD WEIGHT
CONNECTION AND
LAUNCHING

ST LATERAL BLOCK
DEEP SEA CABLE
CONNECTION
1T DEAD WEIGHT
TRANSPONDER

FISHING TAIL



TRANSPONDER
CONNECTION AND
LAUNCHING

DEEP SEA CABLE
TENSIONED
5T LATERAL BLOCK
RELEASED

IFREMER: ANTARES PROJECT
SEA OPERATIONS

JUNCTION BOX
INSTALLATION PROCEDURE

28/08/00
AP110-10

String installation and recovery

Ship mobilisation ([AP200](#)):

In addition to the permanently installed equipment, the main equipment to mobilise is:

- The ANTARES Navigation Container ([AP410](#))
- The ANTARES Workshop Container ([AP420](#))
- The 5 tonne deck winch equipped with 150 m axial rope (for recovery operations only)

The special tools to mobilise are:

- The deck support for the string ([AP530](#), [AP531](#), [AP532](#))
- 2 launching and recovery hooks ([AP525](#)) and a spare

The OMF wheel supports ([AP531](#)) are installed in single file on each rail under the lateral blocks. The Buoy is installed forwards on its wheel support. The BSS is installed on the starboard side under the lateral block. The hooks are connected on the lateral blocks ([AP426](#)).

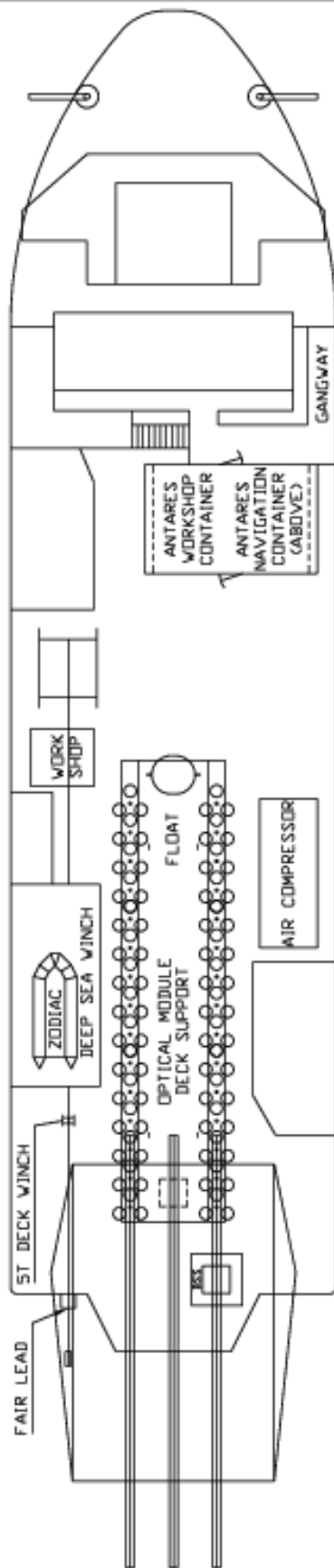
Launching procedures ([AP210](#)):

1. The BSS is launched using the starboard block and launching hook. The BSS is deployed at 100 m depth ([AP210-1](#)).
2. OMF number 1 is launched with the port lateral block and launching hook.
3. The starboard lateral block is paid out until the weight of the BSS is taken by OMF number 1. The starboard lateral block is paid out again until the launching hook disengages from the BSS ([AP210-2](#)).
4. The starboard lateral block and launching hook are recovered and OMF number 2 is launched with the starboard lateral block ([AP210-3](#)).
5. The port lateral block is paid out until the weight is taken by OMF number 2. The port lateral block is paid out again until the launching hook disengages from OMF number 1.
6. The same procedure is resumed until OMF number 30 is launched.
7. The Buoy is removed from its support using the central block and the two-legs sling ([AP210-4](#))
8. The Buoy is launched with the port block and the ring of the extension cable is connected through a transponder with release to the deep sea winch ([AP210-5](#)).
9. The string is lowered until the BSS is positioned at 500 m above the mooring point.
10. When all is clear, the string is lowered until the BSS touches the bottom under transponder and tensiometer control.
11. The transponder is released and the deep sea cable is recovered at the surface ([AP210-6](#)).

Recovery procedures:

1. The anchor of the BSS is released with one of the two transponders.
2. When the Buoy reaches the surface, the Zodiac takes the axial rope and connects it on the top of the Buoy ([AP220-1](#)).
3. The Buoy is then towed with the 5 tonne deck winch . The subsequent recovery procedure is the reverse of the launching procedure.

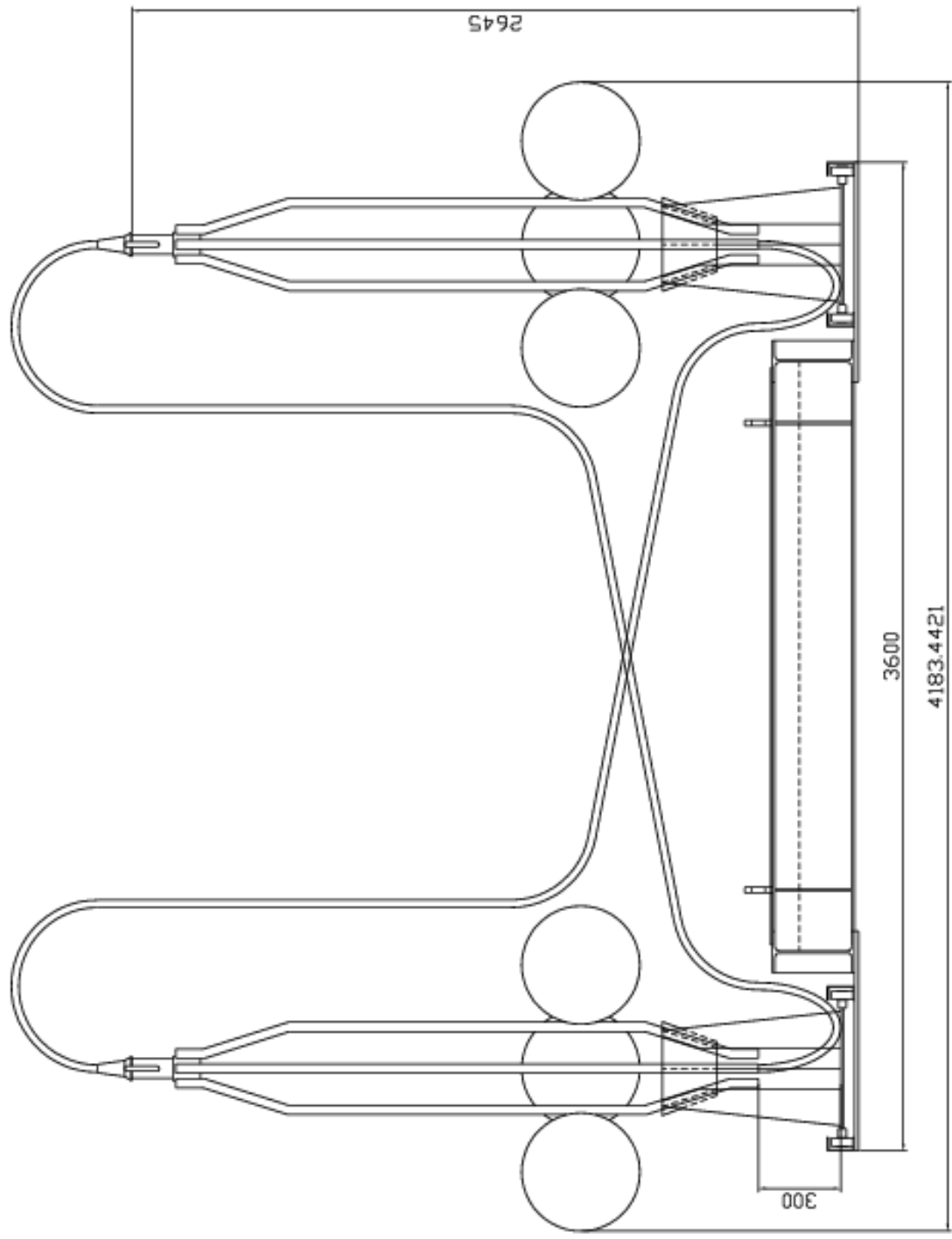
These procedures using automatic launching and recovery hooks are safe because divers are not required. However, in case of emergency, a diver team is available on board, at least in the first operations.



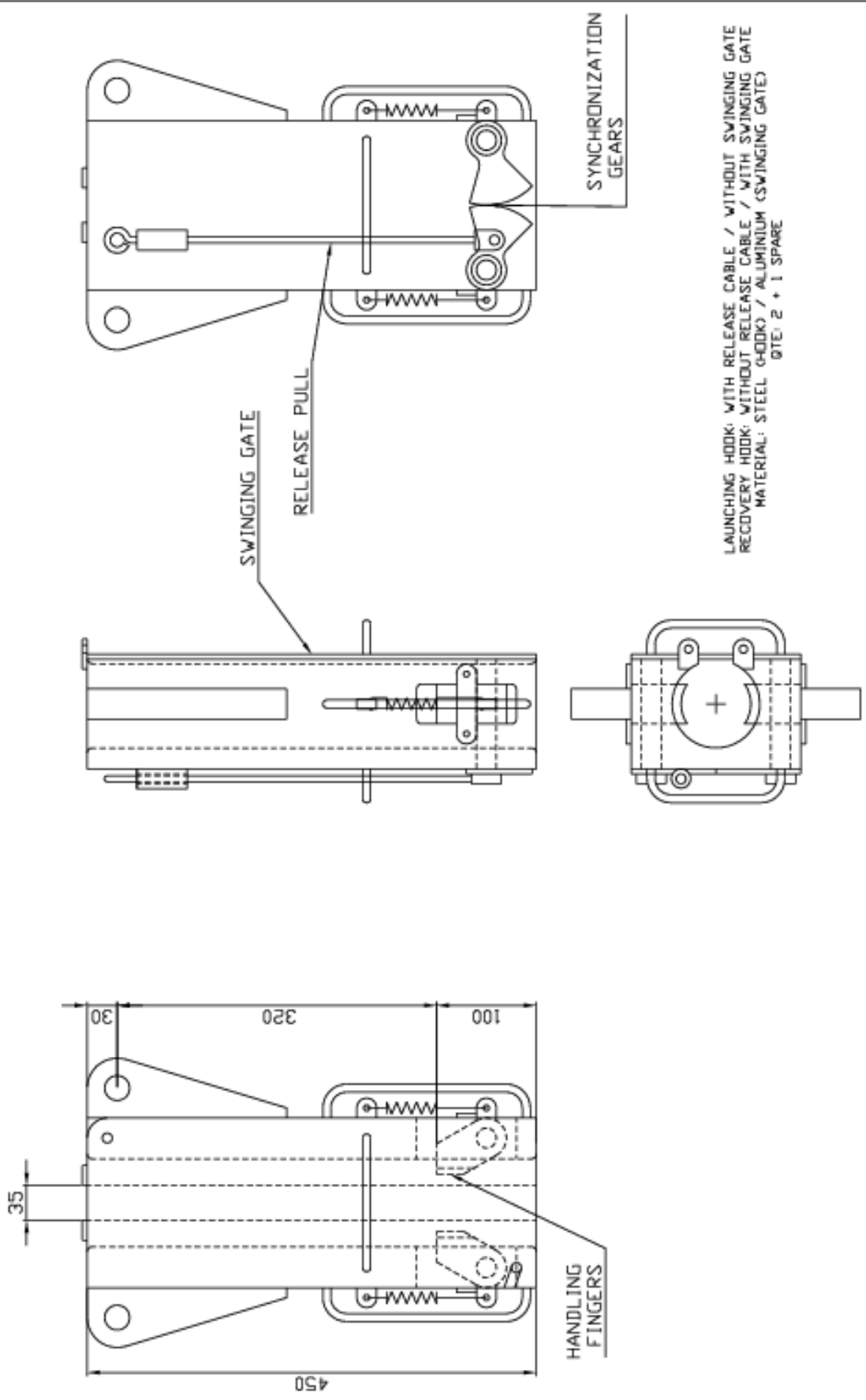
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AP200/C

GENERAL SHIP INSTALLATION

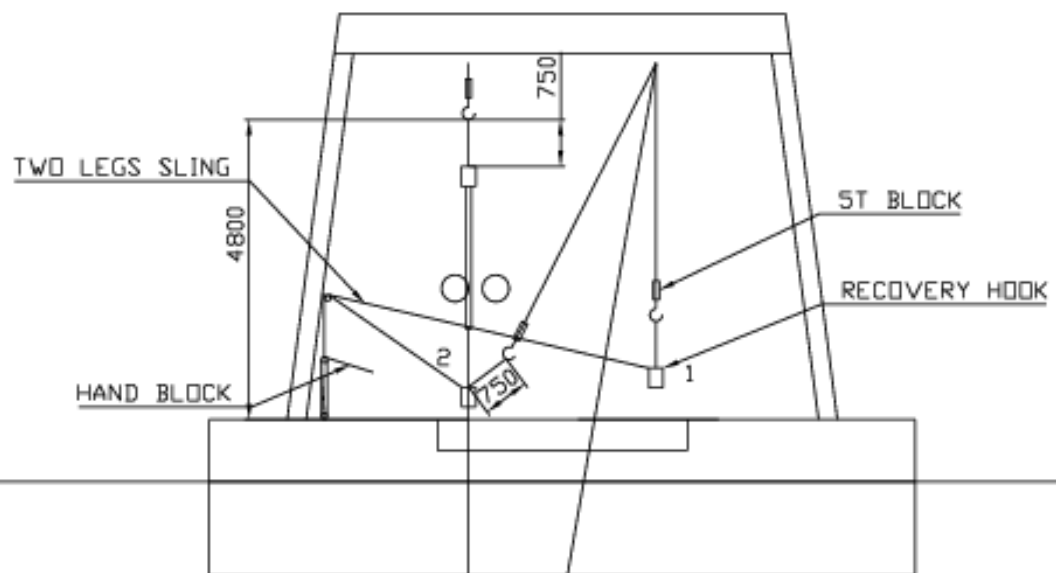
IFREMER: ANTARES PROJECT
SEA OPERATIONS



IFREMER: ANTARES PROJECT SEA OPERATIONS	STRING TOOLS: DECK SUPPORT (GEN. ASSEMBLY)	15/03/00 APS30/D
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IFREMER: ANTARES PROJECT SEA OPERATIONS	STRING TOOLS LAUNCHING AND RECOVERY HOOKS	15/10/00 AP525/A
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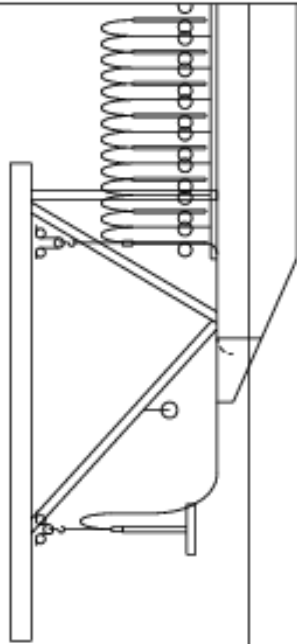
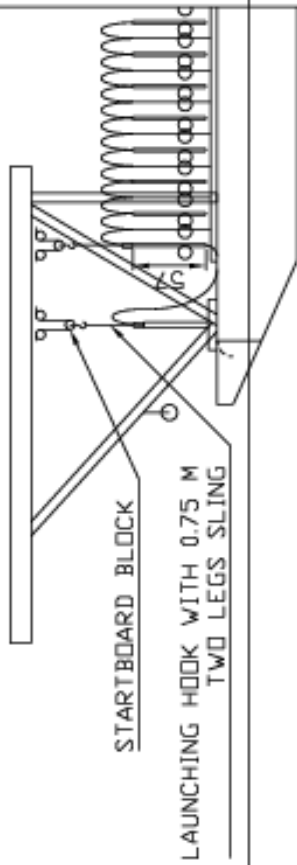


- 1: CONNECT THE TWO LEGS SLING ON THE HOOK
- 2: PULL THE HAND BLOCK TO ENGAGE THE HOOK / CLOSE THE SWINGING GATE / DISCONNECT THE TWO LEGS SLING
- 3: PAY OUT THE ST BLOCK TO CONNECT THE HOOK

IFREMER: ANTARES PROJECT
SEA OPERATIONS

STRING TOOLS
RECOVERY HOOK RIGGING

15/04/01
AP426/A



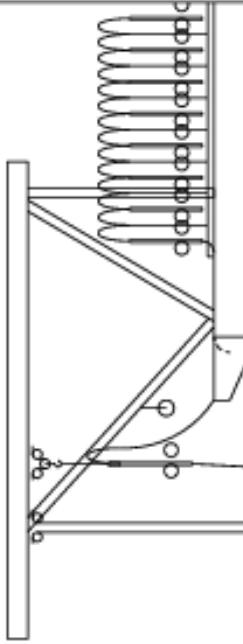
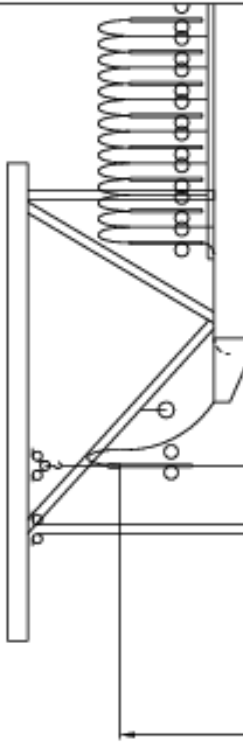
READY FOR
LAUNCHING

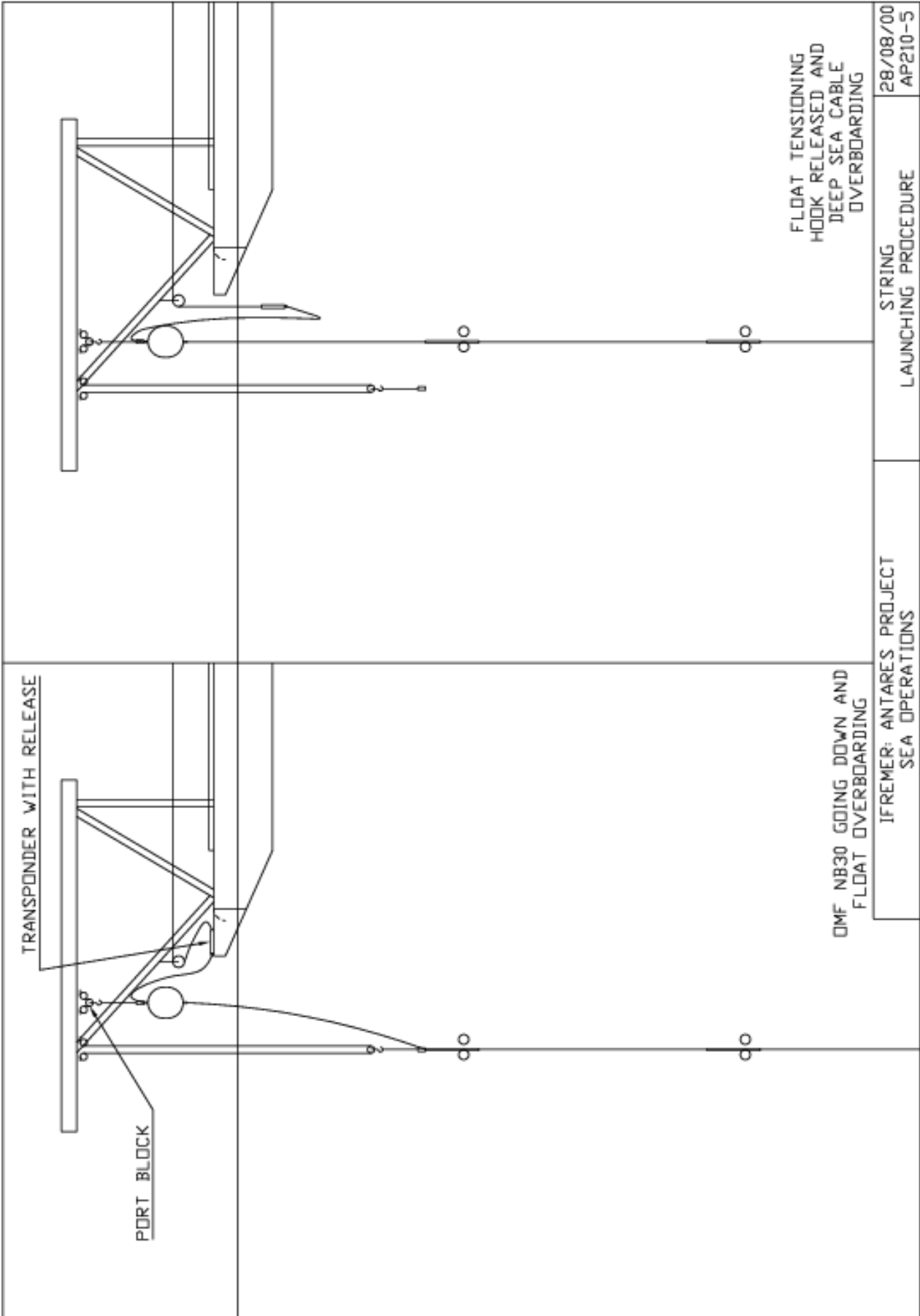
IFREMER: ANTARES PROJECT
SEA OPERATIONS

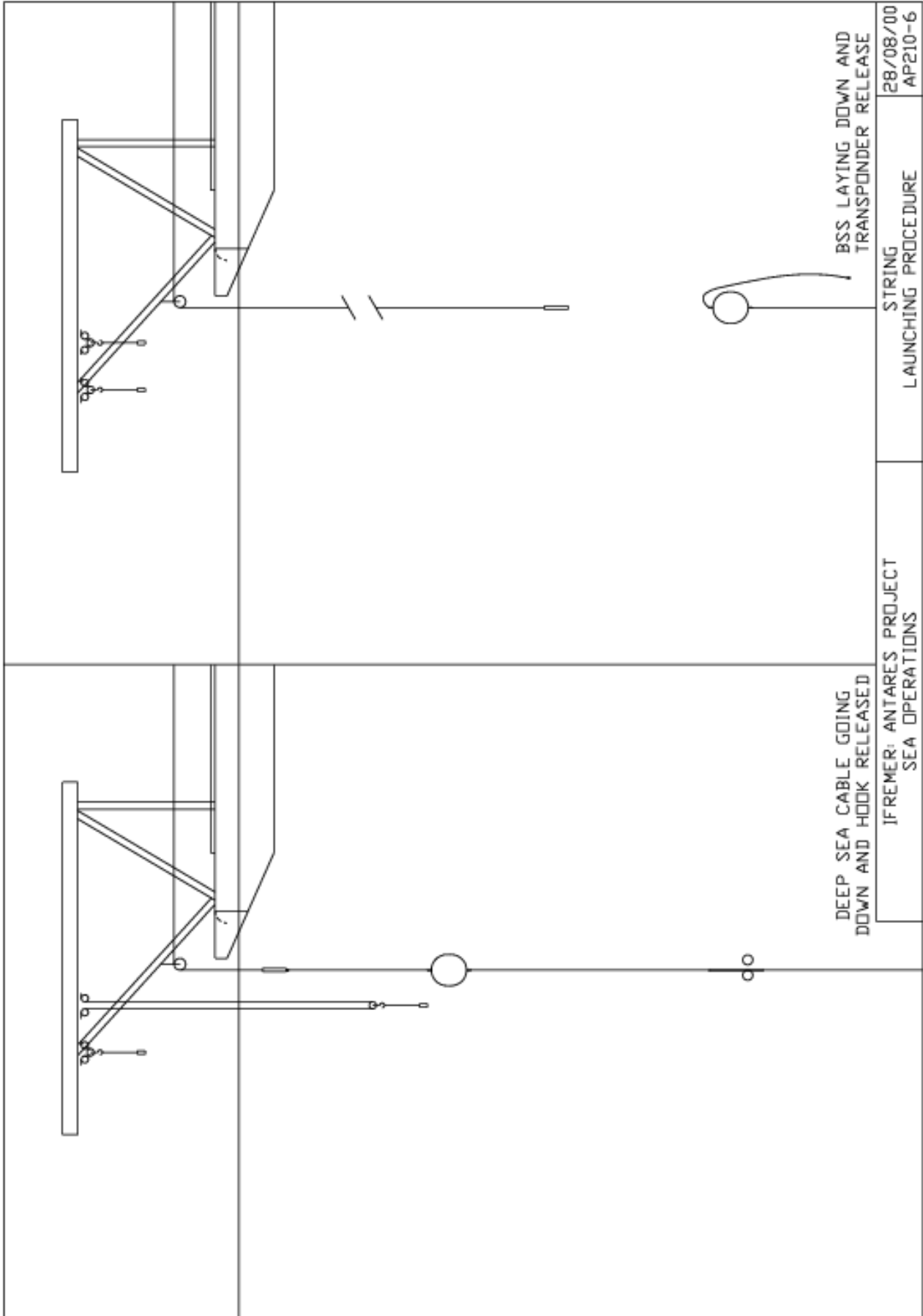
BSS OVERBOARDING

STRING
LAUNCHING PROCEDURE

28/08/00
AP210-1

	<p>BSS GOING DOWN AND DMF NB1 OVERBOARDING</p> <p>IFREMER: ANTARES PROJECT SEA OPERATIONS</p>
	<p>DMF NB1 TENSIONING AND HOOK RELEASED</p> <p>28/08/00 AP210-2</p>
<p>STRING LAUNCHING PROCEDURE</p>	





DEEP SEA CABLE GOING
DOWN AND HOOK RELEASED

IFREMER: ANTARES PROJECT
SEA OPERATIONS

BSS LAYING DOWN AND
TRANSPONDER RELEASE

STRING
LAUNCHING PROCEDURE

28/08/00
AP210-6

Installation and recovery of Interconnecting Link cables

These operations relate to the deployment and the connection of the Interconnecting Link Cables (IL) using a manned submarine or a ROV.

The related tools and procedures have been qualified using the Nautilie on board the Nadir during the 'Neutrinaut' operation in December 98. These procedures have been presented to the IFREMER submarine safety commission (CSEH) in 97. However, after the numerous safety recommendations following the latest presentation in June 2000, it is foreseen that the use of a manned submarine will not be allowed when a few strings will be in place.

ROV operations must now be considered, and the installation of Victor or another ROV and associated procedures are in preparation.

In any case, the deployment reel of the Interconnecting Link Cable is defined and may be used by a submarine or a ROV. Due to the new length of the interconnecting cables, the deployment reel now includes a rotating drum instead of a fixed one as tested with Nautilie during the Neutrinaut operation.

The following describes the operation with Cyana and will be modified for operation with a ROV.

Ship mobilization ([AP300](#)):

In addition to the permanently installed equipment, the main equipment to mobilise is:

- [Cyana](#) with its deck berth
- The Cyana mechanical workshop container
- The Cyana electronic workshop container
- The Cyana spare parts container
- The ANTARES Navigation Container ([AP410](#))
- The Cyana Zodiac
- The TUNX ORE fish installed on the second boom
- The 5 tonne winch equipped with 300 m axial rope
- The 5 tonne winch equipped with two lateral ropes

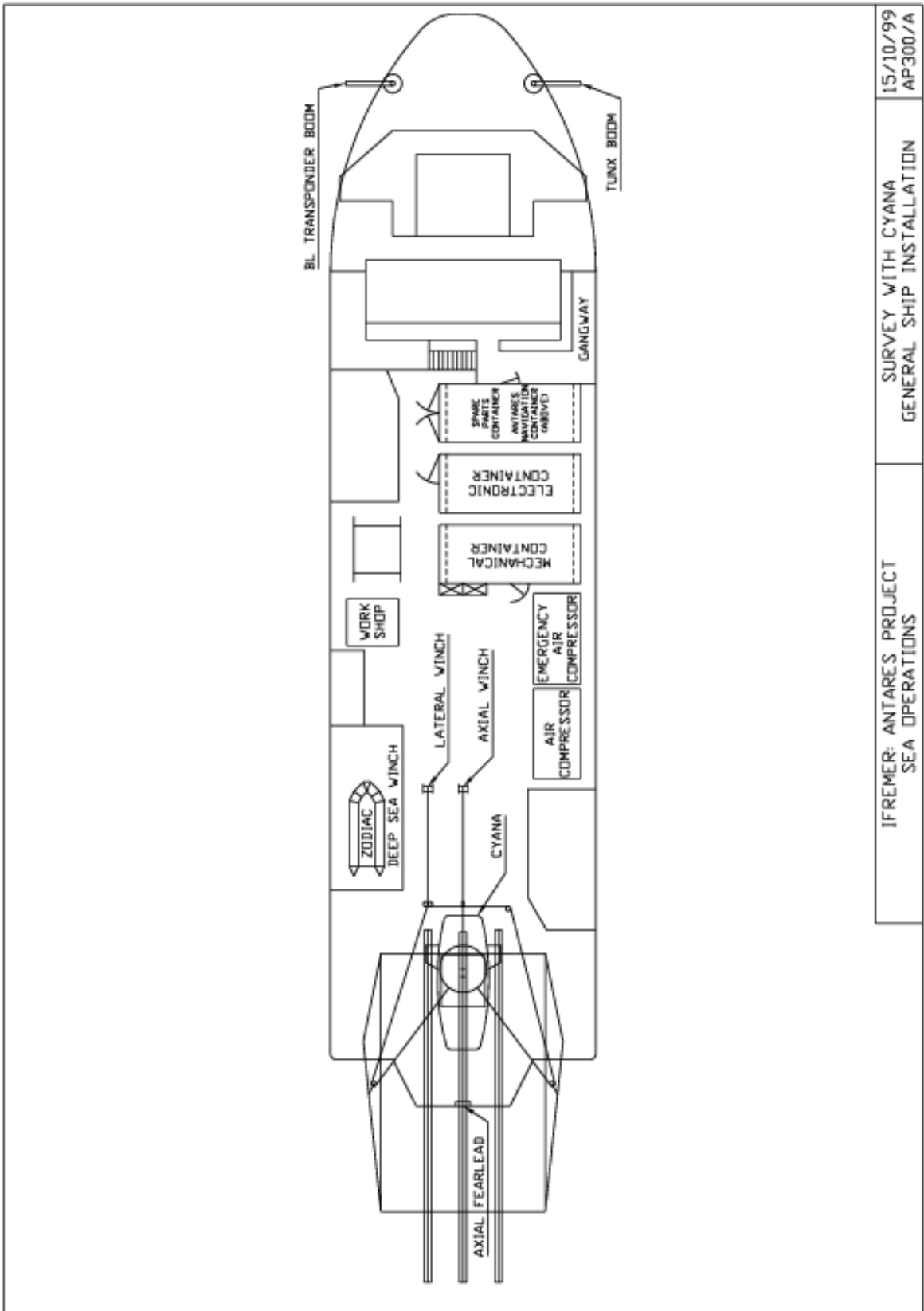
The special tools to mobilise are:

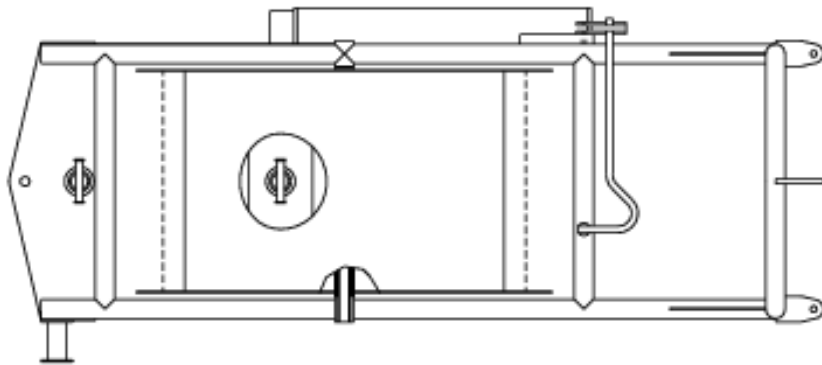
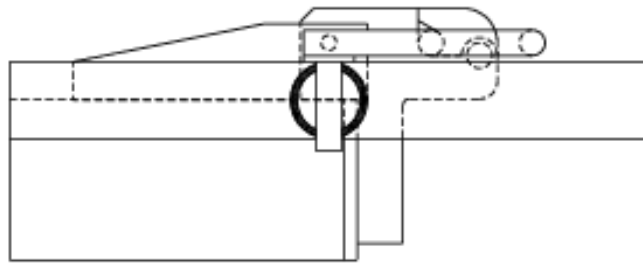
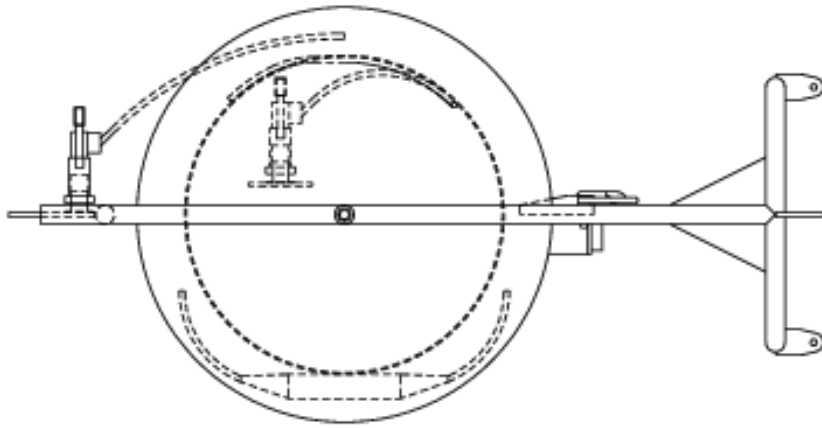
- The Interconnecting Link Cable reel ([AP550](#))
- The Interconnecting Link Cable and spare

Installation procedures:

1. The reel equipped with the Interconnecting Link Cable and its float is launched outside the site under transponder control.

2. The submarine is launched outside the site and recovers the reel on the bottom.
3. The sinking weight line of the reel is cut and the submarine brings the reel 10 m NE of the Junction Box.
4. It takes the connector, pulls the cable and connects the connector to the Junction Box receptacle in flying mode.
5. Once the connector is connected, the submarine takes the reel and heads under surface navigation instructions towards the BSS to be connected.
6. The submarine continues beyond the BSS to unspool completely the cable.
7. The submarine takes the connector, returns to the BSS and connects the connector to the receptacle, laying the cable slack around the BSS.
8. Then the submarine disengages the locking device of the receptacle rotating housing, turns down the connector and re-engages the locking device. The connector is ready to be released for future string maintenance.
9. The connection is tested by the ANTARES onshore station. When the connection is confirmed, the submarine brings the reel out of the site ready to be recovered by transponder release.
10. The submarine is recovered at the surface.
11. The reel is recovered at the surface ready for other Interconnecting Link Cable installation.





15/03/00
AP550/B

TOOLS
INTERCONNECTING CABLE REEL

IFREMER: ANTARES PROJECT
SEA OPERATIONS

Test Programme

At Foselev Marine base:

Deniel grapple qualification: The grapple is tested with a 10 tonne crane with a short fishing tail loaded on one part with the 1000 kg dead weight and on the other part with a bigger dead weight simulating Junction Box and electro-optical cable weight in water. Test factor is 1.5 (dynamic) x 1.5 (test).

Fishing tail spooling: The passage of the fishing tail with the shackle connected to the deep sea cable is tested through the deep sea winch to see if there are problems in the capstan sheaves.

Launching and recovery hooks qualification: The launching hook and the recovery hook are tested with a 10 tonne crane using an end fitting test mock-up ([AP505](#)) loaded with a dead weight simulating the weight in air of the BSS (this is the biggest load applied during deployment). Test factor is 1.5 (dynamic) x 1.5 (test).

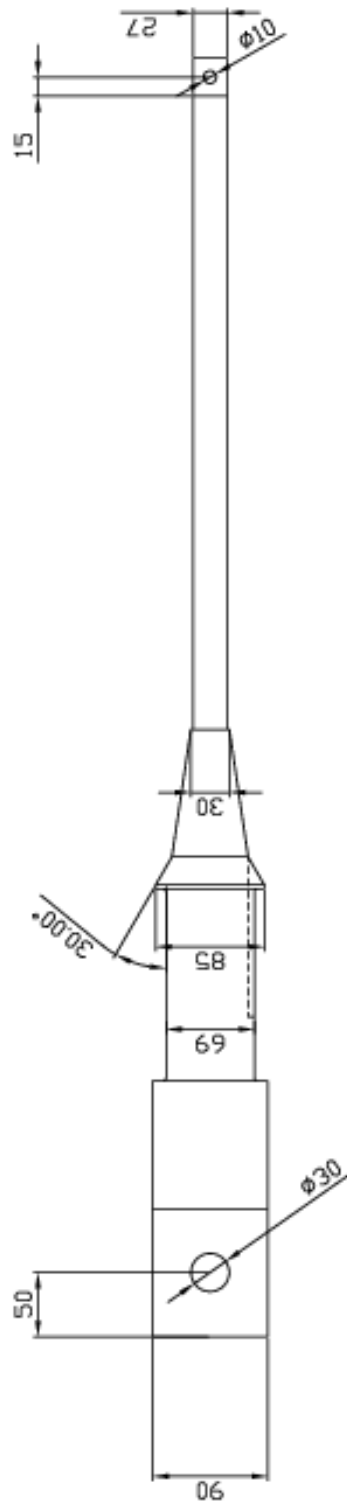
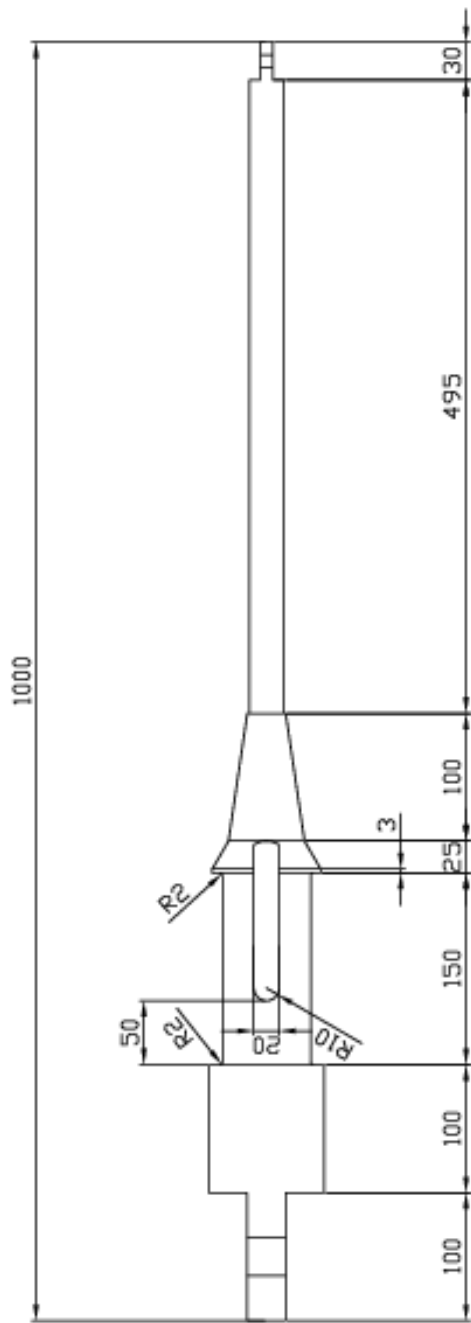
At sea on Castor:

Junction Box installation and recovery test:

1. The Junction Box is installed on board. Launching and recovery procedures are tested at 40 m depth with a 15 m electro-optical cable and dead weight (1000 kg) simulating the static load of the 2500 m electro-optical cable.
2. The Junction box is launched, the fishing tail is paid and its 1000 kg dead weight is released.
3. The fishing tail is recovered with the Deniel grapple and the Junction Box is recovered.

String installation and recovery test:

A string mock up with 5 OMF mock-up is deployed at 2500 m depth under Long Baseline control. The string is recovered after release.



MATERIAL: STEEL

STATIC LOAD: 3470 KGS
 DYNAMIC LOAD (X1.5): 5205 KGS
 TEST LOAD (X1.5): 7807.5 KGS

IFREMER: ANTARES PROJECT SEA OPERATIONS	STRING TOOLS END FITTING TEST MOCK UP	15/02/00 AP505/D
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[Up](#)[Next](#)[Previous](#)[Contents](#)

PBS 8 : Sea operation objects

Objects	Description	PBS number
LFLBL	Low Frequency Acoustic Long BaseLine Navigation system	8.1
SHIP_EQUIPT	Workshop Container, Navigation Container, ORE Fish, Booms	8.2
SEA_TOOLS	Launching and Recovery Hooks, Deck Support, OMF supports, IL Reel	8.3

PBS 8.1: Low Frequency Acoustic Long BaseLine Navigation system

The Low Frequency Acoustic Long BaseLine Navigation System (LFLBL) is used to measure in real time the positions of objects under the sea. The LFLBL system is used to perform 3 main objectives :

- to monitor the positions of the Line anchors and the Junction Box during their deployment operation, in order to place them as close as possible to their nominal geographic position,
- to monitor the positions of the submarine vehicle, or of the ROV and its depressor, to perform its navigation during the interconnection operations,
- to accurately measure the geographical positions of the Line anchors, and of the LFLBL acoustic reference beacons, in order to determine the absolute positioning of the ANTARES detector, as explained in the [Absolute Positioning section](#).

The LFLBL system is based on transit time measurements of 8-15 kHz acoustic signals between reference beacons (transponders) anchored on the sea bed around the detector, acoustic beacons (transponders) installed in the sub-system to be positioned and a rangemeter with its remote transducer placed on a surface boat. The transducer is installed on an ORE fish and deployed at typically 30 metres below the sea surface. The transducer is linked to the rangemeter by 50 metres of electro-mechanical cable supporting the ORE fish and 30 metres of electrical cable. The rangemeter is driven by a dedicated computer and software, interfaced to a DGPS receiver and a gyrocompass giving the position and heading of the surface boat.

The elements of the Low Frequency Long BaseLine Acoustic Navigation system are the following :

Objects	Description	PBS number	Location
LF_REF_TRANSP	LFLBL acoustic reference transponder	8.1.1	Sea floor around the detector
BSS_RELEASE_TRANSP	Releasable acoustic transponder for BSS	8.1.2	BSS
CABLE_RELEASE_TRANSP	Releasable acoustic transponder for winch cable used for deployments	8.1.3	Winch cable
SUBMARINE_TRANSP	Acoustic transponder for submarine vehicle	8.1.4	Submarine or ROV & Depressor
JB_TRANSP	Acoustic transponder for Junction Box	8.1.5	Junction Box frame
LF_TRANSP_TELECOMMAND	Autonomous telecommand for LF transponders	8.1.6	Surface boat

LF_RANGEMETER	LBL multi-channel rangemeter for LF transponders	8.1.7	Surface boat
LF_RANGEM_TRANSD	Remote transducer for the LF rangemeter	8.1.8	ORE fish
LF_TRANSD_EM_CABLE	Electro-mechanical cable for the remote transducer of the rangemeter	8.1.9	Surface boat
LF_TRANSD_LF_CABLE	Electrical cable for the remote transducer of the rangemeter	8.1.10	Surface boat
LF_LBL_COMPUTER	Control computer of the LFLBL system	8.1.11	Surface boat
LF_LBL_SOFTW	Software for the LFLBL system	8.1.12	LBL computer
DGPS_RECEIVER	DGPS receiver and its antenna	8.1.13	Surface boat
GYROCOMPASS	Gyrocompass	8.1.14	Surface boat

Link to TDR Functional description : [Sea operations](#), [Detector absolute positioning](#)

List of References

- [4 BLO 01 01 A](#) Long BaseLine acoustic navigation system
- [4 BLO 01 02 A](#) Système de navigation acoustique Base Longue Antares : Spécifications techniques