Recovery operation of the submarine "Kursk"

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TABLE OF CONTENTS **Page**

APPENDICES

1. ABSTRACT

The Kursk will be recovered by use of a combination of specialised technologies in use by both Smit International and Mammoet.

The operation is started with surveys of the submarine and surroundings. The next phase is removal of the soil located around the section where the Kursk will be sawed in two parts.

The sawing of compartment #1 will be done by using equipment specially designed for parting shipwrecks. This system consists of a sawing element, which carries bushes prepared with abrasive materials. This very robust system is able to deal with the difficulties, which arise when sawing in a non-solid structure which will start vibrating and deforming during the sawing process.

The lifting of the aft part of the Kursk will be performed by dedicated equipment assembled for this job. The Giant 4 barge will be equipped with a 26-point hydraulic strand jack system. Together this forms a system capable to develop the lifting force required. The static submerged weight of the Kursk is about 9500 ton, however, breaking the Kursk loose from the soil will ask for extra capacity above these 9500 ton. Currently several methods are prepared to handle high suction forces.

The dynamic behaviour, which will occur due to unavoidable motions of the barge is taken care of by a heave compensation system of nitrogen cylinders supporting the hydraulic strand jacks. These cylinders will accommodate the motions of the barge and reduce the dynamic amplification of forces.

At the final stage of lifting, the Kursk will be pulled up to the bottom of the barge where it will be supported by saddles. In this mated configuration the barge with the Kursk will be towed to a floating dock close to Murmansk.

Unfortunately the dock has not enough waterdepth to receive the Kursk in this configuration. Therefore, two additional pontoons will lift the Giant – Kursk assembly sufficiently high out of the water to reduce the draught.

While in the dock with the Kursk above the dockblocks the lifting system will be used again together with the ballast system of the floating dock to lower the Kursk to the blocks.

After disconnection, the Giant with all equipment is able to demobilise and the Russian Federation will take further care of the Kursk.

2. INTRODUCTION

The Russian submarine Kursk sank at August 12, 2000, in the Barents sea North East of Murmansk. The joint venture Mammoet - Smit V.O.F. is going to carry out the recovery of the submarine.
The whole operation will be completed in the following five stages:

- preparatory phase
- sawing compartment #1
- lifting
- towing
- docking

2.1 VESSEL INFORMATION

This section gives basic information of the Kursk, the Giant 4 barge, which is used as the main lifting platform, and the AMT Carrier, a barge accommodating all equipment that is being used for the separation of compartment #1. Data of the diving support vessel (Mayo) and anchor handling tugs (Havilla Champion and Havilla Charmer) can be made available on request. Additionally several vessel services will be provided by the Russian Federation, of which no details are available in this document.

2.1.1 Kursk

The submarine Kursk consists of an assembly of two hulls. An inner hull, designed to resist the pressure at large waterdepths and a streamlined outer hull which is covered with a rubber compound. For a general overview of the Kursk, reference is made to .

General dimensions:

L	:	154.0	m
Width	:	18.2	m
$D_{excl\ sail}$	:	13.7	m
$D_{incl.\ sail}$	:	18.3	m
Pressure hull diameter	:	11.0	m

Position:

Latitude	:	69˚37’	North
Longitude	:	37˚34’	East
Waterdepth	:	115	m

Orientation:

Heading	:	288˚	
Heel angle	:	1.5˚	to port
Trim angle	:	2˚	to bow

2.1.2 Giant 4

The Giant 4 barge will be used as lifting platform for this project.
The Giant 4 is a submersible ocean going deck barge. Some sketches of the Giant with equipment can be found in appendix B.
The main dimensions of the barge are:

$L_{extreme}$	:	140.00	m
$B_{moulded}$	:	36.00	m
$D_{moulded}$	:	8.50	m
Lightweight	:	5500	t

The Giant 4 has to be modified for this operation.
Following modifications are currently carried out:

- mooring winches installed to tie-up in the pre-laid moorings
- accommodation units to be placed in the hold, to accommodate 50 persons
- recess in the bottom for receiving the sail of the Kursk
- saddle construction at the bottom for securing the Kursk during transport
- 26 insert pipes from deck to bottom for leading through the strands of the lifting system
- 4 insert pipes (from deck to bottom as well) for securing the side pontoons
- 1 insert pipe for the main fire fighting pump
- a load spreading steel grillage at deck level
- internal bulkhead reinforcements
- access tubes to accommodate the radiation monitoring equipment

2.1.3 AMT carrier (barge)

The AMT carrier will be used as the working platform for the sawing of compartment #1. The sawing equipment will also be transported to the site onboard of the AMT carrier. The barge has left Rotterdam on Thursday 19 July 2001.

Dimensions:

L_{oa}	:	114.0	m
$B_{moulded}$	:	30.0	m
$D_{moulded}$	:	6.0	m

Final testing of the sawing assembly will take place onboard of the AMT Carrier in the Norwegian village of Kirkenes.

2.2 ABBREVIATIONS

AHT	:	Anchor Handling Tug
B	:	Breadth
BP	:	Bollard Pull
D	:	Depth
NCG	:	Nuclear Co-ordinating Group
nm	:	nautical miles
m	:	metre
mm	:	millimetre
L	:	Length
T	:	Draught
t	:	ton (=1000 kg)
PLC	:	Programmable Logic Controller

3. PREPARATORY PHASE (ONSITE)

3.1 SURVEY

Prior to any operations to be performed near the Kursk, a survey has been performed.
The purpose of this survey was to establish the present state of the Kursk and its environment. At the same time the level of radiation at various energy levels around the wreck has been measured. These levels did not exceed the normal background levels indicative for this area. Apart from that, no ordnance or fragments have been found on the seabed, or in the remains of compartment #1. This has been established both by ROV survey as survey by Russian diver/weapon specialists.

3.2 SOIL WASHING

In order to clear the area for sawing of compartment #1 (reference is made to chapter 4), jetprop equipment has been used. The principle of the jetprop is that the soil is removed by light pressure, large volume water jets.

The survey and soil washing have been finished in week 29 to full satisfaction of all parties concerned.

3.3 CUTTING OF LIFTING HOLES

To accommodate the lifting devices, a total of 26 holes have to be cut in the Kursk. This cutting will be done with an abrasive jet cutting system.
The operation of hole cutting has started on Sunday 22 July, 2001.

3.3.1 Abrasive jet cutting system

An abrasive jet cutting system is based on high pressure water mixed with grit which are transported through a high pressure hose to the nozzle. The water/grit flow accelerates over the nozzle to a very high speed and thereby erodes the material away. Working pressures are typically between 600 and 1500 bar, dependent on material specification, thickness, distance between nozzle and material to be cut, etc. Due to the curvature of the Kursk, each hole will be different. To facilitate the process, for each hole a so-called base plate has been manufactured. These base plates act as a mould for the cutting.

3.3.2 Process

The 26 holes will be cut through the outer and the inner hull. All the equipment and piping in between will be removed at these locations.
Cutting will be done with the abrasive waterjet cutting system, mentioned in paragraph 3.3.1.
The holes in the hull are individually cut, due to different locations around the circumference of the hull, so that the gripper (in closed position) can be lowered vertically into the hull.
The diameter of the holes to be cut in the pressure hull is about 700 mm. The holes in the outer hull will be larger to make it possible to clear the area between the two hulls.

4. SAWING COMPARTMENT #1

4.1 INTRODUCTION

Compartment #1 is the damaged bow section of the Kursk, with a length of about 20 m.
The structural integrity of this section is unknown, lifting of such a section would be too risky. Separation of this section during lifting would cause a major shift in the centre of gravity of the Kursk, and thus a sudden shift in the load distribution on the strand jacks. Compartment #1 will therefore be cut off from the rest of the Kursk.
The bow section will be cut under an angle of about 10 degrees with the vertical. During lifting the bow section will then stay free of the aft part that is being lifted.

4.2 EQUIPMENT

Sawing of compartment #1 will be performed with the “Ship Sawing System”. Smit International has developed this patented system over the foregoing years. This sawing method is a further development of a chain cut system in use by Smit International for many years. It has been tested on a 1:1 scale on a shipwreck. Model tests with the ship sawing system have also been performed on a piece of “Kursk steel”.

The ship sawing system comprises out of the following principal parts:
- two suction anchors
- sawing element
- hydraulic system
- control system

4.2.1 Suction anchors

In this case the suction anchors consist of two large-diameter cylinders, open at the bottom end, welded together by a frame. On top of this configuration a suction pump unit is mounted which is connected to the inside of each cylinder by a manifold. This pump unit is able to reduce the pressure inside the cylinder. This will cause the cylinder to sink in the soil, such that a new equilibrium will develop between the inside and the outside pressure. This controls the penetration of the suction anchor in the seabed.
On top of the suction anchor, a hydraulic cylinder with a tackle is mounted. This cylinder is the actual driving train of the sawing system. The purpose of this hydraulic cylinder - tackle assembly is to increase the stroke and speed available.

4.2.2 Sawing element

The sawing element is constructed out of circular shaped bushes. The bushes are covered with special abrasive material, acting like a saw when the element is pulled through the ship's hull.

4.2.3 Hydraulic system

The hydraulic system consists of a variable pumpset in a closed loop system with a maximum flow of 2100 litre per minute and a maximum system pressure of 240 bar. A boost unit is connected to the low pressure line of the closed loop system. Hydraulic hoses run from the powerpack of the supporting barge to the suction anchors
To control each cylinder, a hydraulic manifold is mounted onto the steel structure of the suction anchor.

4.2.4 Control system

The control system includes a PLC control unit for a safe and fully remote operation from the support barge. Two umbilicals run from the support barge to each suction anchor assembly.
The PLC contains all the information needed for the operation of the system.
Divers will only perform the hook-up of the system.

4.3 PROCESS

The total system will be assembled onboard of the support barge, currently underway to Kirkenes (Norway). After this assembly, the total system will be tested while still based on the barge.
After successful tests the barge will sail to the field. In the field, the barge will be hooked-up in a pre-laid mooring.

The ship sawing system is set up by installing the two suction anchor assemblies, one on each side of the vessel, about 20 m from each sidewall of the Kursk.
The sawing element is positioned across the forward side of the vessel. At each end of the sawing element, a wire rope is attached that is rove through the sheave blocks. Before sawing is possible, the whole system will be tensioned.
Sawing of the Kursk starts from the top side and progresses downwards. The downward angle made by the sawing element needs to be controlled to maintain optimum sawing performance. This is done by progressively pulling down the suction anchors as the cut progresses.

5. LIFTING

5.1 INTRODUCTION

Basically the lifting part of the recovery operation is as follows:

- a lifting barge (the modified Giant 4) is moored above the submarine
- guide wires are lowered from the barge to the submarine and connected to pre-cut holes in the submarine hull
- lifting strands are lowered to the submarine and guided into the holes
- grippers on the lower end of the lifting strands are locked in the holes
- the submarine is lifted by a heave compensated jacking system
- the submarine is mated to the barge by docking its sail in the barge and pulling it tight to pre-installed saddles underneath the barge

In the following these stages will be discussed as well as the equipment used for the lifting.

5.2 EQUIPMENT

The equipment used during the lifting of the Kursk will (amongst others) consist of the following:

- strand lift system
- grippers
- heave compensation system

An overview of the Giant 4 with the lifting equipment can be found in appendix B.

5.2.1 Strand lift system

The strand lift system is a proven design, with a track record containing all kind of different jobs.
A strandlift system is composed out of the following main items:

- strand lifting unit SSL
- compact strand bundle
- hydraulic power pack
- control computer

Strand lifting unit SSL

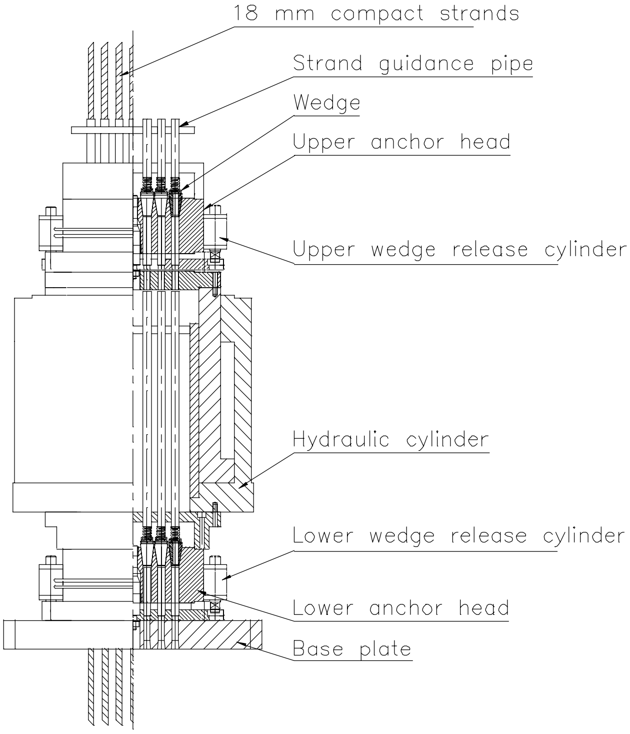
18 mm compact strands are installed through the unit and locked in the lower anchor head.

The upper anchor head closes and grips the strands, the piston of the jack extends and raises the closed upper anchor head including the strands.

In top position, the piston lowers to the starting position after releasing the strands with the load to the closed lower anchor head and opening the upper anchor head.

In case of lowering, the procedure will be reverse, the upper anchor head will be closed and hold the load, while the bottom anchor head will be opened.

Closing and opening of the anchor heads is done by the lower and upper wedge release cylinders.



Strand Lifting Unit

Safety valves are integrated into the strand lifting unit in order to stop the cylinder movement in case of hose break.

During the whole cycle, the stroke, the hydraulic pressure and the position of the wedges is monitored constantly by computer and indicators mounted throughout the system.

Compact strand bundle

The strand bundle is built up out of 54 single strand wires, each strand contains 7 twisted, high capacity, steel strings. They are specially developed for heavy lifting. The length can be upto 1500 m, so lifting the Kursk is far within the operating limits. The strand jack lifting strands are contained within motorised spooling devices located on a platform above each strand jack. This ensures that loose ends of the lifting strands will not lie uncontrolled around each strand jack.

Hydraulic powerpack

For the hydraulic power packs different systems can be used together, diesel or electrically powered.
They deliver a high flow for the main cylinder movement and a constant pressure for movement of the wedge release cylinders.

Control computer

The control computer is a standard computer, equipped with the smart cylinder control-system (SCC). SCC is specially developed to control hydraulic lifting equipment.
The system is stroke-controlled, which means it makes sure all cylinders, despite any difference in oil flow and load, keep the same stroke when loaded.
Besides the stroke, the load in each cylinder will be watched during operation. Movements will be stopped immediately by the computer when a higher load as expected occurs during the lifting or lowering sequence, this in order to prevent any overload of lifting points, structures etc.
16 Lifting Units in total can be controlled at the same time by one computer and several computers can be linked together to control even more lifting units.

Safety and reliability

Due to its unique mechanical gripping action the strand lift system is a fail safe and “fool proof” system. The anchor heads can only be opened using the manual override once the Kursk is picked up, this ensure that the suspension system cannot be changed automatically during any of the lifting operations. Besides this mechanical safety, the computer will always warn the operator if something unexpected is happening. If, for example, the load approaches the pre-set weight, it will stop the operation and raise an alarm that will make the operator check out and solve the problem before continuation.
The movement of the load can be stopped at any position and without displacement, the load can be mechanically fixed through the lifting structure.

5.2.2 Grippers

For lifting the Kursk a new attachment device (gripper) has been designed and fabricated. This device basically consists of two lifting jaws in scissors configuration, that can be pushed out and pulled in by activating the hydraulic cylinder, which is built into the assembly. To overcome any uneven surfaces of the contact zones, the gripper has a pliable material fixed to the contact area of the lifting jaws with the submarine hull to ensure that an even loading is achieved during lifting.

Reference is made to appendix C, where a section of gripper is shown in both open and closed position.

5.2.3 Heave compensation system

Extensive 3D-diffraction calculations as well as model tests are performed to analyse the dynamic behaviour of the Giant – Kursk combination. Although the static submerged mass of the Kursk is "limited" to 9500 ton, the mass active while in motion is a multiple of hereof. This is caused by the large enclosed volume of water inside the submarine together with the added mass of water which has to be taken into account when a submerged body is being moved through the water.

To compensate for the effect of wave action, all strand jacks will be mounted on top of a heave compensating system, each unit comprises of four cylinders filled with nitrogen gas, mounted vertically in a steel support frame. The compensation system is a gas suspension system, the stiffness of which is adjusted by increasing or decreasing the pressure within the system to accommodate the varying circumstances that can occur. Each unit is connected via a ring main to a storage bank, comprising of 16 buffer cylinders, to assure a 250 bar pressurised system is always available to increase the pressure within each individual heave compensation unit. This method of heave compensation has been chosen because of its ease in being quickly adjusted to changing sea states, individual strand jack loads and the speed of response when under load to the sea forces on the barge.

In appendix D a sketch can be found, showing the strand jack unit with a working heave compensation system.

5.3 INSTALLATION OF GUIDE WIRES

After the holes are cut guidance cones will be installed on the flanges of the external frames of the pressure hull, centrally about each hole. Each gripper guide assembly will be individually identified with the hole identification and orientation relative to the hull, to ensure the gripper is correctly orientated within the hull so that the individually profiled lifting jaws will align with the curvature of the inner hull.

Once the barge is moored above the Kursk (reference is made to appendix E for a drawing of the Giant in its mooring), guide wires will be lowered down and attached to the guidance cones. At each guidance cone four 18 mm wires will be attached.

The guidance wires will be pre-tensioned at 15 t each to avoid rotation of the gripper during its travel from the Giant down to the Kursk.

5.4 INSTALLATION OF GRIPPERS

Each strand jack will lower its gripper assembly from within the Giant 4 hull down to the Kursk. The guide wires will be used to ensure the lifting attachment is in the correct orientation, until it is located on top of the depth stop plates on the guide cone assembly. This ensures that the gripper has entered the Kursk hull sufficiently to permit the lifting jaws to be opened. Weight and shape of the gripper will ensure a sufficient penetration into the pressure hull.

The gripper integral hydraulic jack will now be powered in, moving the lifting jaws from the close to the open position.

The strand jack will now lift the gripper assembly until it makes contact with the inside of the pressure hull, at the location of the ring stiffeners.

5.5 BREAK OUT

At the start of lifting the Kursk from the seabed, soil suction forces will be experienced. The average hull penetration in the soil is 1.5 – 2.0 m. Due to the composition of the soil, the suction forces are estimated to be very high (20,000 – 35,000 t), if the Kursk will be lifted horizontally from the seabed.

The maximum lifting capacity of the system is less than the capacity required to overcome soil suction. Therefore an alternative lifting procedure has been developed.

At first a nominal load will be applied to the aft set of jacks. As soon as the suction force decreases, this nominal force will be increased up to 4500 t.

When the suction between the submarine and the seabed is released, force can be applied on the forward set of jacks. This force will smoothly be increased up to the maximum (in static condition) of 5630 t. The force in the aft set of jacks will then come down to 3870 t.

For the decrease of the soil suction force, currently three methods are under investigation:

- Soil washing can be performed with the use of an airlift system. Soil washing will start at the aft end and be working forward to remove soil from the contact areas.
- In the event that this soil removing technique encounters a particularly difficult area of soil, then a seabed dredger (SBD1) can be used to mechanically remove the particular area of soil.
- If required to relieve the soil suction from around the total hull, then a cutting wire will be pulled from aft to forward underneath the submarine by using two AHTs. AHTs will be used with a BP of at least 100 t.
- To limit the risk of getting stuck with the wire in the rubber, the wire needs to be sufficient smooth and long, and port and starboard side of the wire shall be pulled alternately.

Once the Kursk is totally free from the seabottom, it will be levelled in horizontal position and further lifted at a speed of about 10 m per hour.

5.6 POSITIONING IN SADDLES

In order to get a fixed position for the Kursk with respect to the Giant, during the transport form the site to Murmansk, saddles are mounted underneath the Giant. These saddles follow the hullform of the Kursk. The effect of hull bending of the Giant due to the load of the Kursk, as well as bending of the Kursk, has been taken into account in the design.

Once the submarine is positioned correctly in the saddles, the strand jacks will be pre-tensioned in order to get a firm fixation, and to prevent separation of the Kursk and the Giant during transportation to Murmansk. The saddles are designed in such a way that forces between the two bodies are transferred from strong point to strong point.

A drawing of the saddles on the Giant can be found in appendix F.

6. TOW

Already during lifting, the Giant 4 will be disconnected from the mooring system while kept on position by tugs. As soon as the Kursk is pre-tensioned to the saddles, the tow will commence. One tug will be used to tow the Giant, while the second one will be used for steering/escorting.

The expected tow speed is around 3 knots.

At present 2 options are reviewed:

- tow by the bow
- tow over the stern

Modeltests are being performed to get more accuracy on the resistance calculations.

7. DOCKING

7.1 INTRODUCTION

Finally the Kursk will have to be placed in a floating dock close to Murmansk. In the dock, dock blocks will be placed which will support the Kursk. The submergence capabilities of this dock are limited. The draught of the Giant – Kursk combination will be too large to enter the submerged dock. Therefore two pontoons have been designed and built which will be used to add buoyancy to the Giant – Kursk combination, in this way decreasing the draught.

7.2 SIDE-PONTOONS

Two extra pontoons are built in Russia. The dimensions are:

L	:	100	m
$B_{moulded}$	:	15	m
$D_{moulded}$	:	9	m

Each pontoon is fitted out with two buoyancy towers offset to one side, a ballast system, and specialised equipment required for the execution of the works.
The ballast system is an active one, this means that water will be pumped in and out of the pontoon, in order to in- and decrease the draught.

7.3 MATING OF LIFT PONTOONS

On arrival in Murmansk, the Giant 4 with the Kursk underneath will be moored in a pre-laid 4-points mooring system with the assistance of local harbour tugs. While moored in this mooring system the extra pontoons will be connected to the Giant 4.
Once in Murmansk, the operation has entered protected waters, which means that the potential disturbance by adverse weather conditions has been diminished.

Steel guide wires will be connected from the Giant 4 to pad-eyes welded on the pontoons. The pontoons will be submerged and placed in the appropriate position with respect to the Giant by means of their ballast system and guide wires, being operated from the Giant.
The wires will also act as a mean of securing the pontoons.
After fixation, the pontoons will be de-ballasted, thus lifting the Giant 4 just above the water surface. A drawing showing this configuration can be found in appendix G.

7.4 DELIVERY IN DOCK

The whole combination of Giant, Kursk and pontoons will be placed in the dock. This will be done with harbour tugs, the exact procedure is currently being developed in close cooperation with the Russian Navy.
Once exactly positioned in the dock, the Kursk will be lowered down with a combination of lowering of the strands and de-ballasting the floating dock.
With the Kursk in position the grippers will be released, thus making it possible for the Giant – Pontoon combination to leave the dock with the aid of harbour tugs.

8. RISK ASSESMENT

8.1 INTRODUCTION

A huge offshore operation like the recovery of the Kursk will always encounter certain risks. Especially in this case where a nuclear installation is involved.
The risks during the project are minimised in the following way:

- use of rules for Marine Operations (according to 'Det Norske Veritas')
- use of well proven equipment where possible
- the implementation of strict working procedures for the offshore part of the project

8.2 GIANT 4

The modification of the Giant 4 is under construction in accordance with the rules from the Dutch Shipping Inspectorate and Lloyd's Register of Shipping.

8.3 GRIPPERS

The grippers are currently undergoing testing in the Russian Krylov institute. The first test was completed week 29 and showed that an inline tensile load of 2000 t did not cause any material yielding or failure of any of the gripper components.
Currently we are testing two gripper assemblies in a 1:1 scale model on two mock up hull assemblies to represent the most onerous loading conditions that will be incurred during the actual lifting of the Kursk.
These tests will give an overview of the strength of the gripper – hull assembly.

8.4 MODEL TESTS

Model tests and computer analyses on the Giant – Kursk assembly are being performed at the Russian Krylov institute as well. Purpose of these tests is to establish the dynamic behaviour of both vessels during the complete recovery operation. The dynamic analyses, together with, amongst others, the criteria for the loads in the lifting strands and the stroke of the heave compensation cylinders, results in the allowable wave heights during all phases of the recovery operation.

The resistance of the combination during transport will be measured as well.

8.5 GENERAL RISKS

Some general risks, always present during offshore projects are mentioned here.

8.5.1 Adverse weather during lifting

The lifting operation will only start when a favourable long-range weather forecast is given. However, if during the lifting operations bad weather is imminent, the operation can be delayed or cancelled. Depending on the weather it may be decided to stay in the mooring. If the situation worsens, it may be decided to release the mooring and go for shelter to the nearest shore. Detailed procedures for all possible scenarios are under development.

8.5.2 Mooring line failure

The mooring spread is designed in such a way that in each cluster one mooring line can take the load of the other mooring line if it breaks.
On board of the Giant 4 spare mooring lines will be available. Moreover, tugs are available to assist when required.

8.5.3 Engine failure of an AHT

The AHTs that will be used during the project will be equipped with two main engines. So it will not be very likely that a total breakdown will occur. During the tow it is always possible that one of the engines has to be stopped temporarily due to minor repairs. These stops do not effect the operations of the AHT, except that the speed will be reduced during the repair period.

8.5.4 Towline failure

In the event of a towline failure, the AHT will slow down and recover the towing gear. The AHT will prepare her towing gear to reconnect.
An emergency towing gear with the same strength as the main towing gear will be available and ready to use.

8.5.5 Adverse weather during tow

During the tow from the Kursk location to Murmansk there is chance to seek shelter when adverse weather is imminent.
In the case bad weather is encountered this will be ridden out.
The Master will than pay out as much towline as possible with regard to the waterdepth and reduces power of the engines. The barge will be kept on a heading with minimum motions, especially roll will be avoided as much as possible.

The reason for this is:
- to avoid excessive shock loads in the tow line
- to avoid damage to the tow

8.6 NUCLEAR AND RADIATION HAZARDS

Three nuclear experts form together the Nuclear Co-ordinating Group. The remit of the NCG is to review and evaluate all relevant aspects of radiation and nuclear safety arising from the recovery operations.
The NCG communicates with the Russian Federation to get enough information to be able to assess the risks during different stages of the recovery operation.

A full onsite safety management plan has been developed. For details on this plan, reference is made to the separate document dealing with this issue.

APPENDIX A

GENERAL OVERVIEW KURSK

(1 page)

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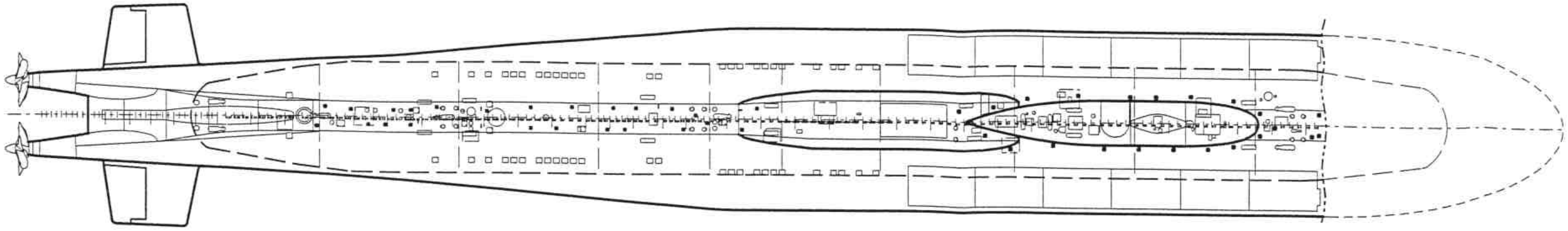
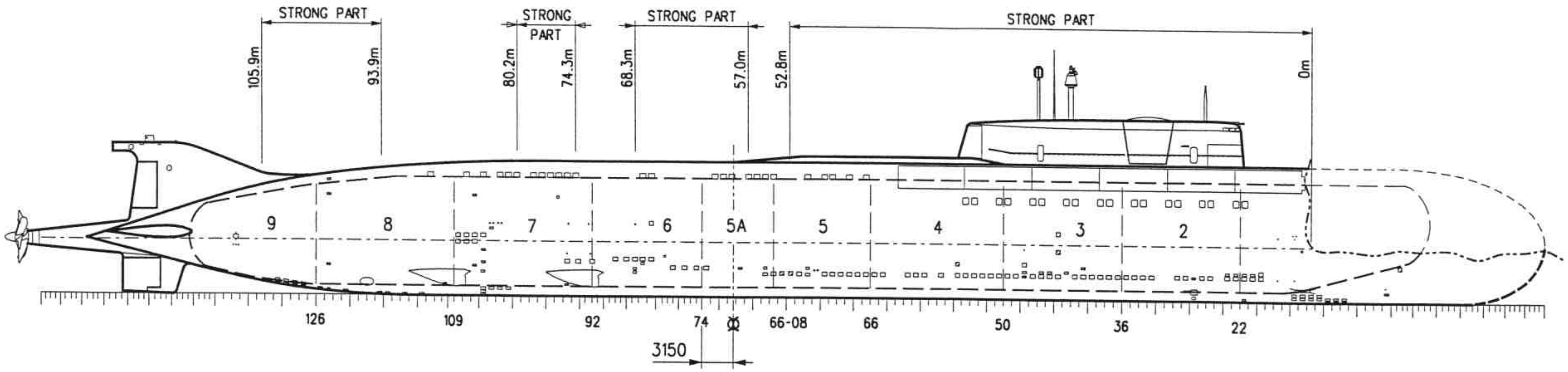
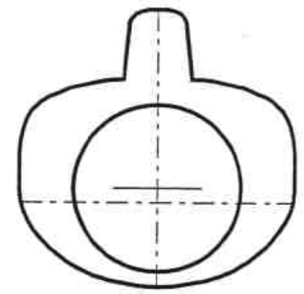


TOP VIEW



SIDE VIEW



CROSS SECTION

Remarks:

Drawing represents Kursk in damaged condition.
On bottom weight: 9200 ton.

Main particulars:

Length o.a.	: 154m (design)
Length o.a.	: 130m (damaged)
Width o.a.	: 18.2m
Depth	: 13.7m (excl. sail)
Depth	: 18.3m (incl. sail & masts)
Draught	: 9.5m (surfaced)
Pressure hull	: 11m (diameter)

Rev	Date	Drawn	Description	Chkd	E.Appr	P.Appr	Client	Date
C4	13-Dec-00	GVe	FOR USE, UPDATED	HvH	CLa	BKa		
C3	21-Nov-00	GVe	FOR USE, UPDATED	HvH	HHo	BKa		
C2	17-Oct-00	GVe	FOR USE, UPDATED	HvH	HHo	BKa		
C1	21-Sep-00	PSI	FOR USE, UPDATED	GVe	HHo	BKa		
C	11-Sep-00	PSI	FOR USE	GVe	HHo	BKa		
A	11-Sep-00	PSI	FOR INTERNAL REVIEW	GVe	HHo	BKa		

Subject: GENERAL ARRANGEMENT KURSK

Project: RECOVERY "KURSK"

Client: SMIT TAK BV

SMIT ENGINEERING BV
P.O.Box 1042, 3000 BA Rotterdam

CAD-drwg not to be changed manually
Orig. Size: A3

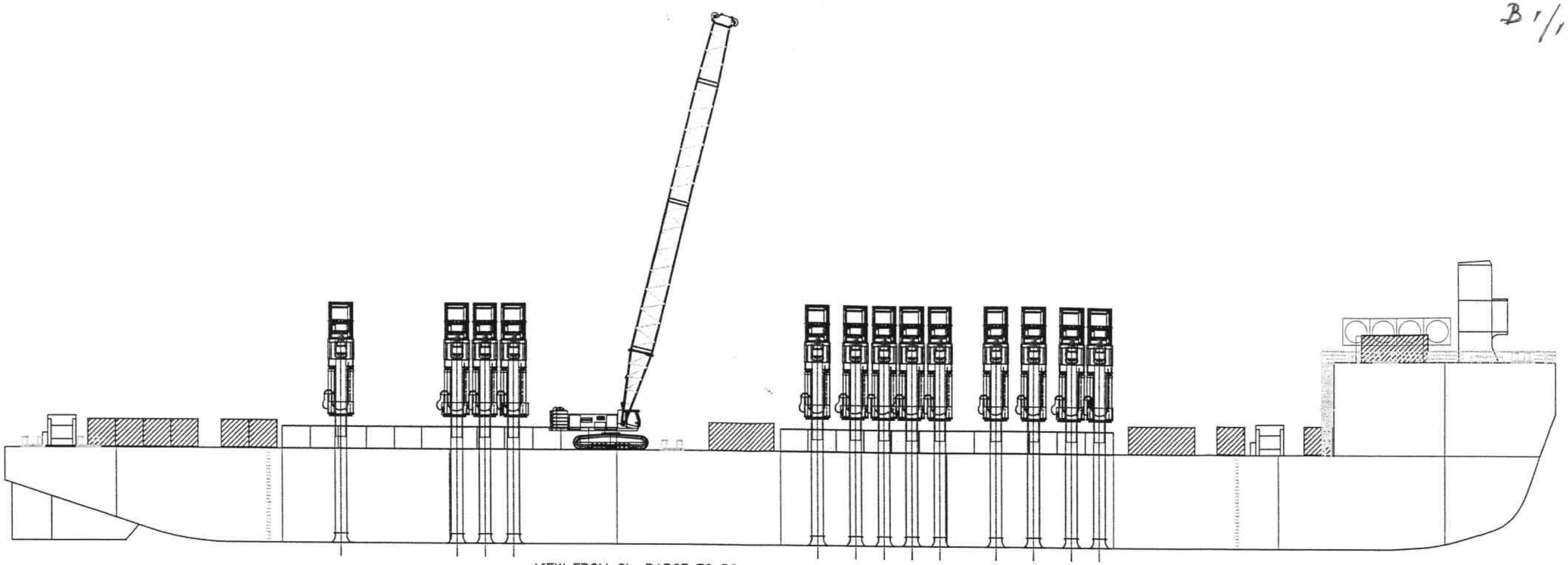
Scale	Drawing No	Sheet	Rev
1:500	00.12.040-D-001	1 of 1	C4

APPENDIX B

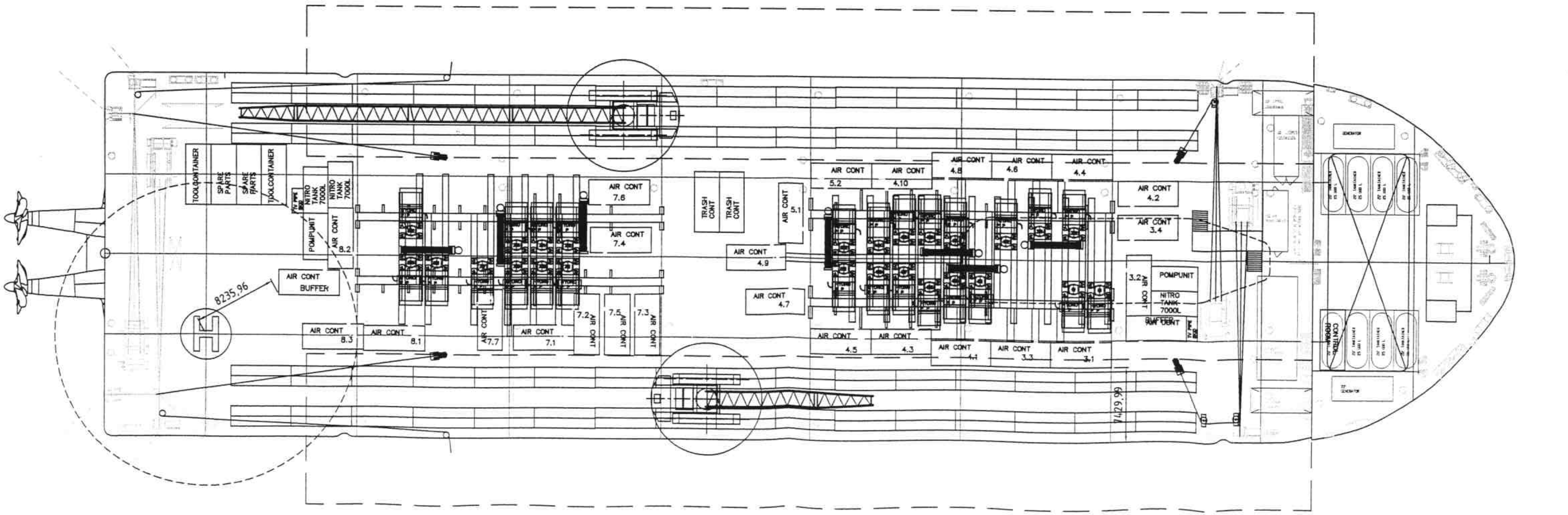
LAYOUT OF GIANT 4

(1 page)

B 1/1



VIEW FROM CL. BARGE TO PS

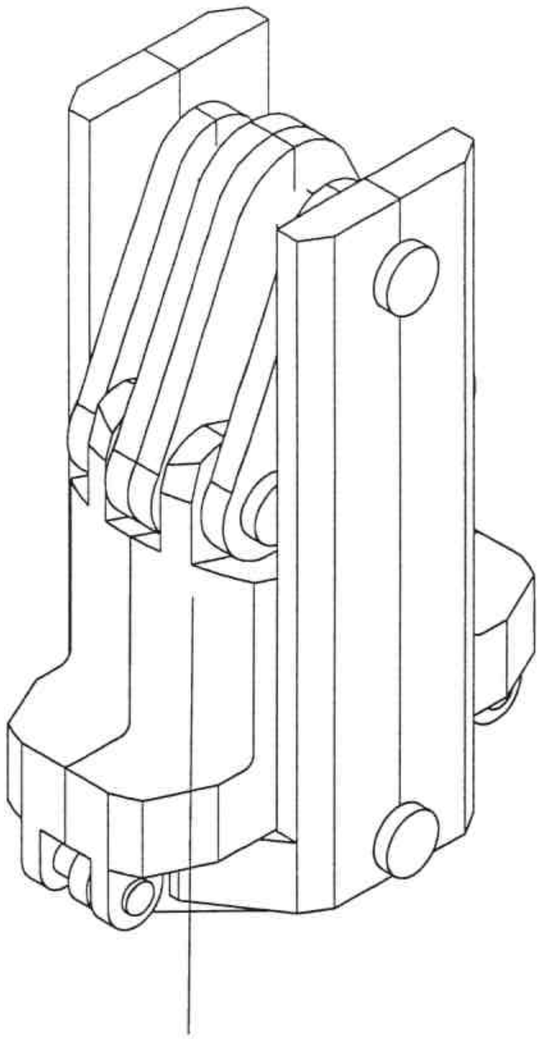


APPENDIX C

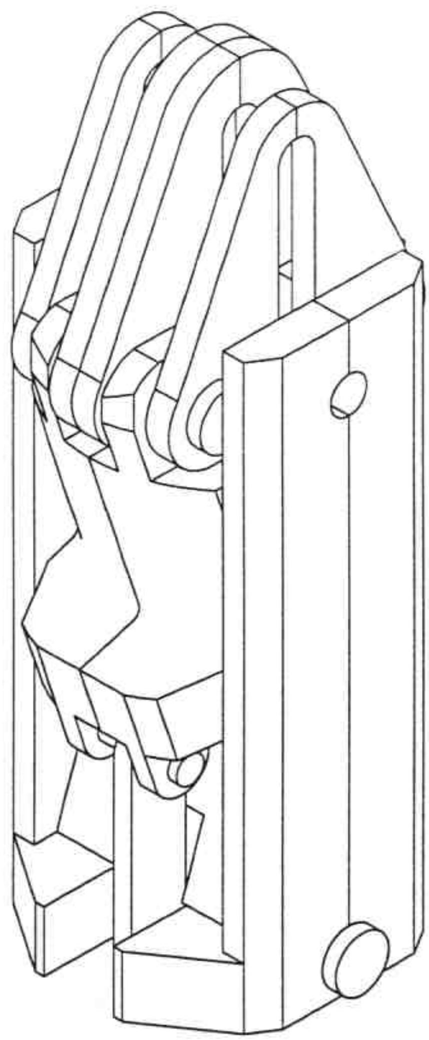
GRIPPER

(2 page)

C 1/2

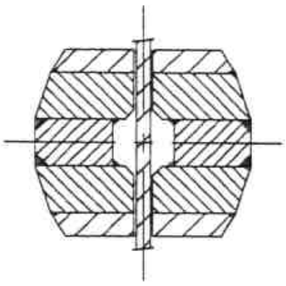


CLAMP IN EXTENDED POSITION

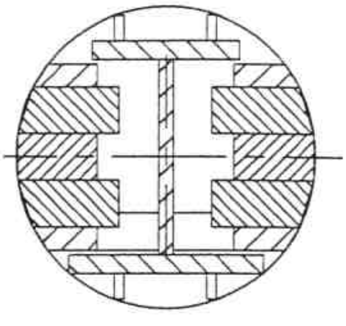


CLAMP IN RETRACTED POSITION

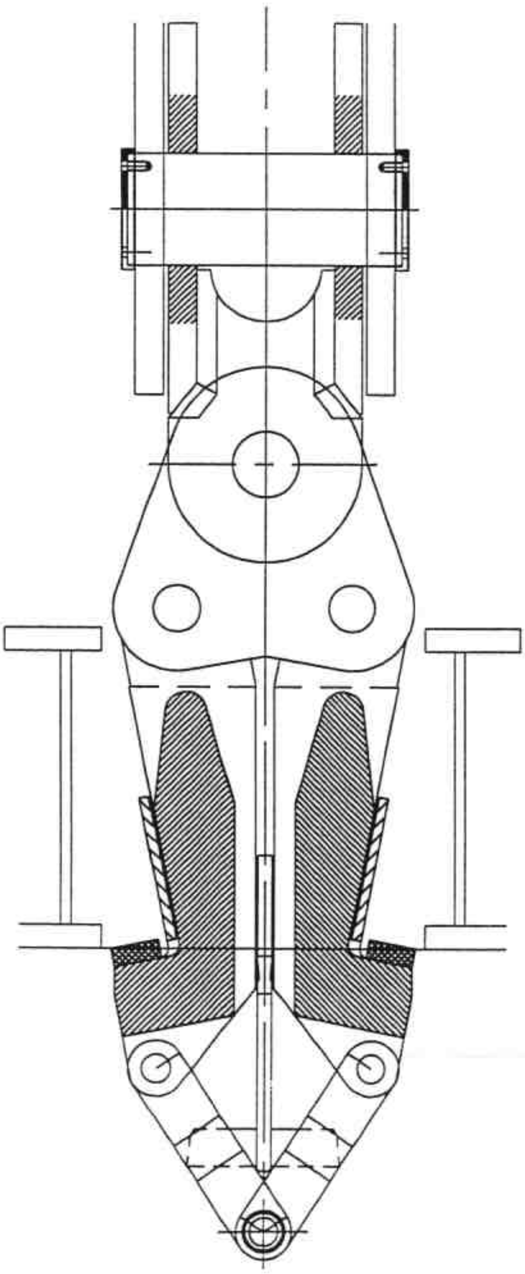
C.2/2



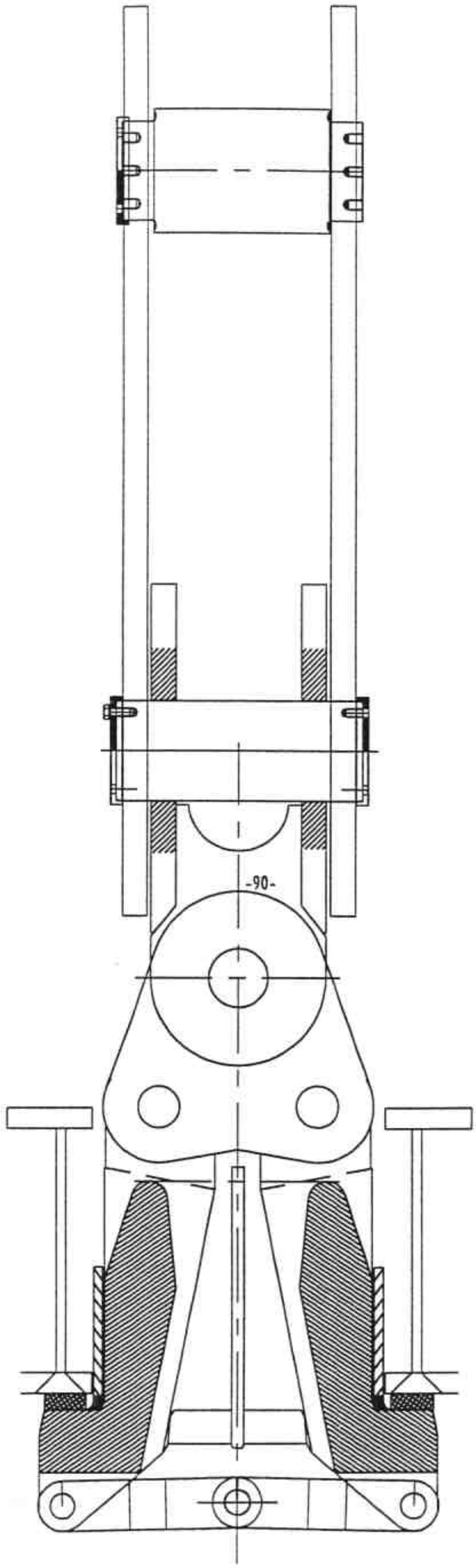
ENTRY POSITION



LOCKED POSITION



ENTRY POSITION



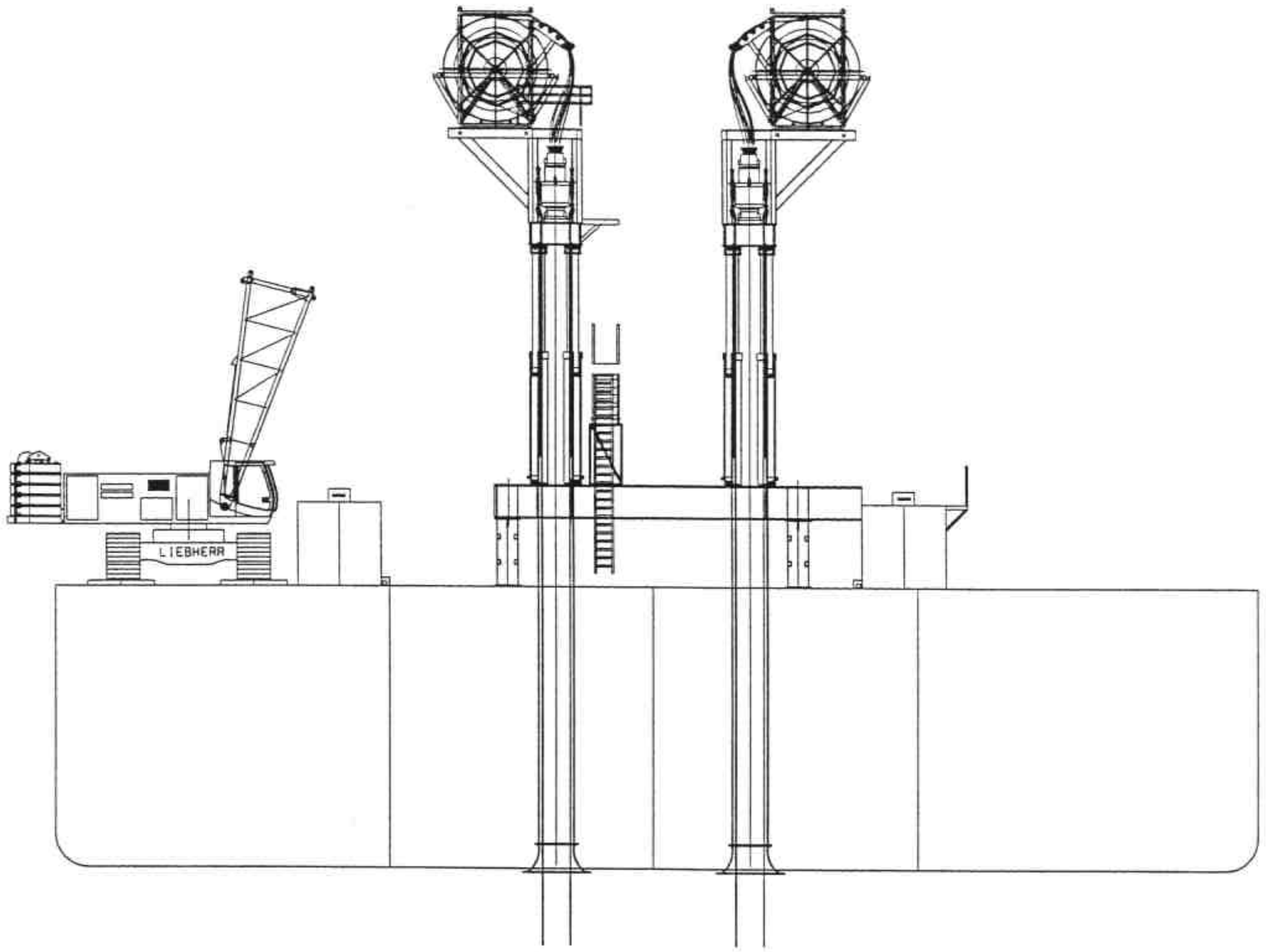
LOCKED POSITION

APPENDIX D

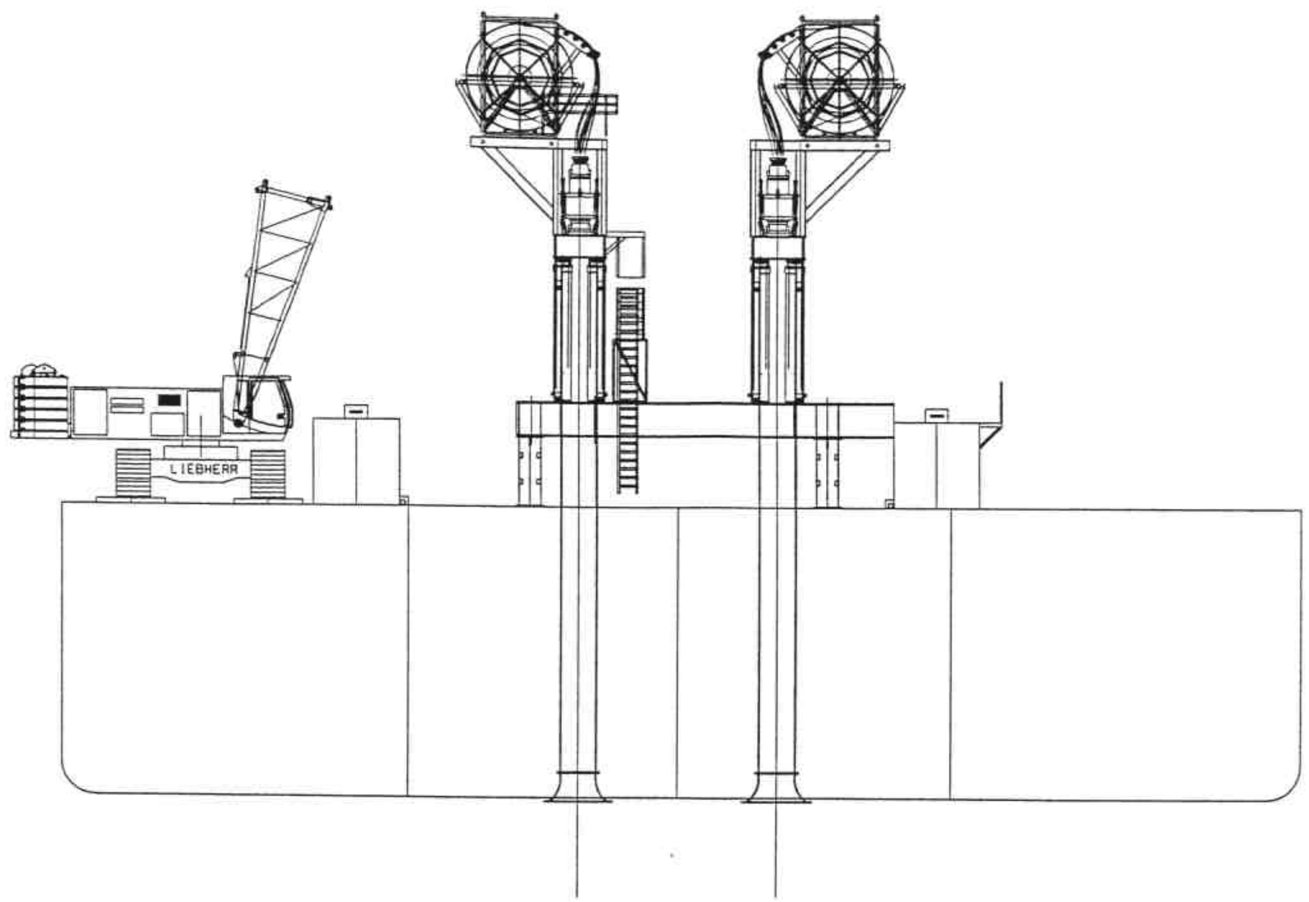
HEAVE COMPENSATION SYSTEM

(1 page)

D1/1



UPWARD POSITION



DOWNWARD POSITION

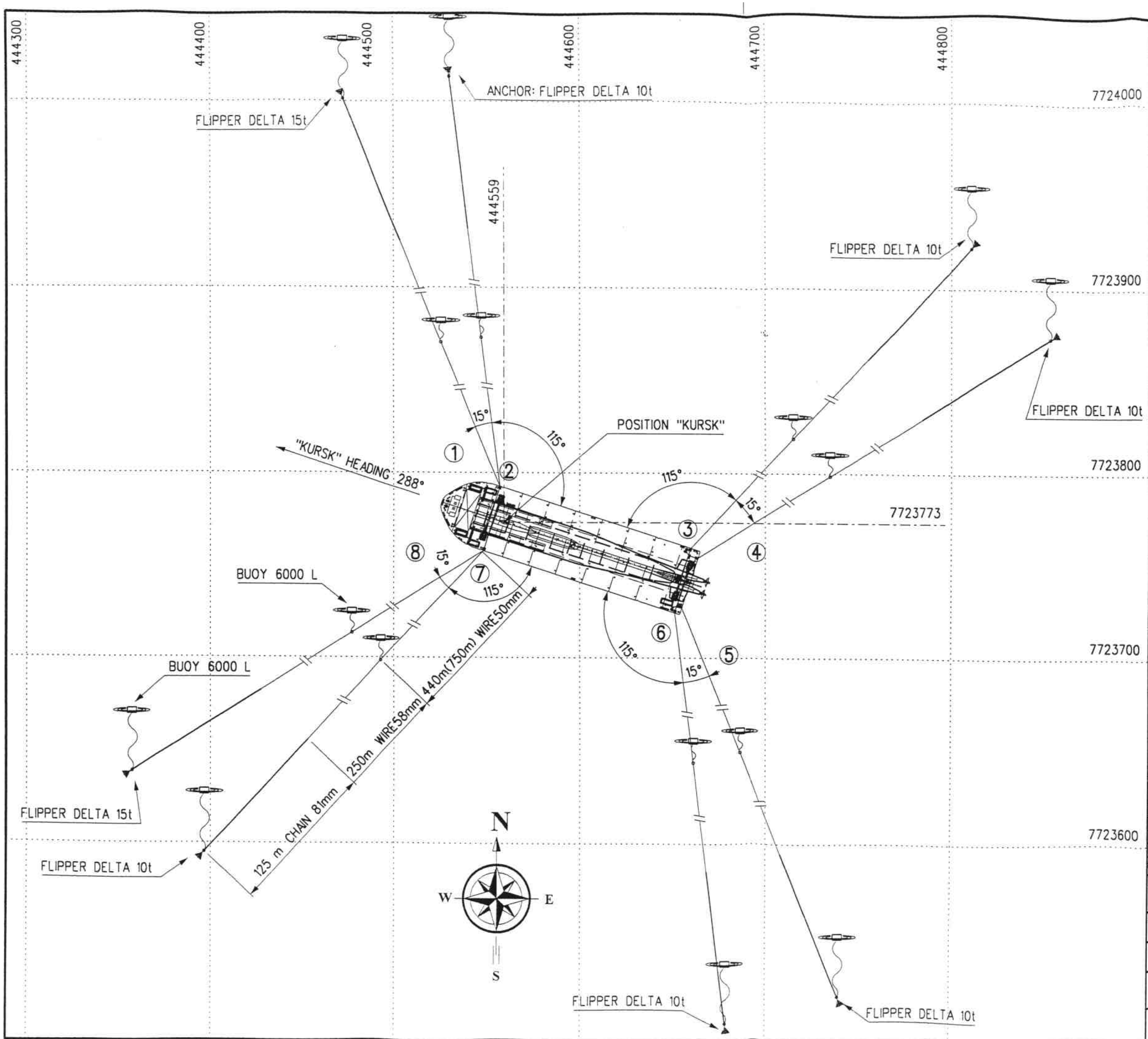
HEAVE COMPENSATION SYSTEM

APPENDIX E

GIANT 4 IN MOORING SYSTEM

(1 page)

E1/1



Notes:

- Length mooring lines not to scale.
- Hor. distance fairlead to anchor 800 m.

Position "Kursk":

Center of entrance tower in sail. According to WGS'84.

Geodetic:		UTM:
Latitude:	69° 37'00"	UTM Northing (m): 7723773
Longitude:	37° 34'25"	UTM Easting (m): 444559
		UTM Zone 37N

Waterdepth: 115-116 m

C1

Positions of anchors:

no.	UTM Easting [m]	UTM Northing [m]	Geodetic Easting [° ' "]	Geodetic Northing [° ' "]
1	444257	7724534	37 33' 55"	69 37' 24"
2	444459	7724586	37 34' 14"	69 37' 26"
3	445205	7724345	37 35' 24"	69 37' 19"
4	445341	7724178	37 35' 37"	69 37' 14"
5	444954	7722986	37 35' 3"	69 36' 35"
6	444748	7722930	37 34' 44"	69 36' 33"
7	444003	7723173	37 33' 35"	69 36' 40"
8	443870	7723334	37 33' 22"	69 36' 45"

Rev	Date	Drawn	Description	Chkd	E.Appr	P.Appr	Client	Date
C1	16-JUL-01	MPW	FOR USE	GVe	HHo	CLa		
C	25-JUN-01	MPW	FOR USE	GVe	HHo	CLa		
A	13-JUN-01	MPW	FOR INTERNAL REVIEW	GVe	HHo	CLa		

Subject: MOORING LINES "GIANT 4"

Project: RECOVERY "KURSK"

Client: SMIT TAK

CAD-drwg not to be changed manually

Orig. Size A3

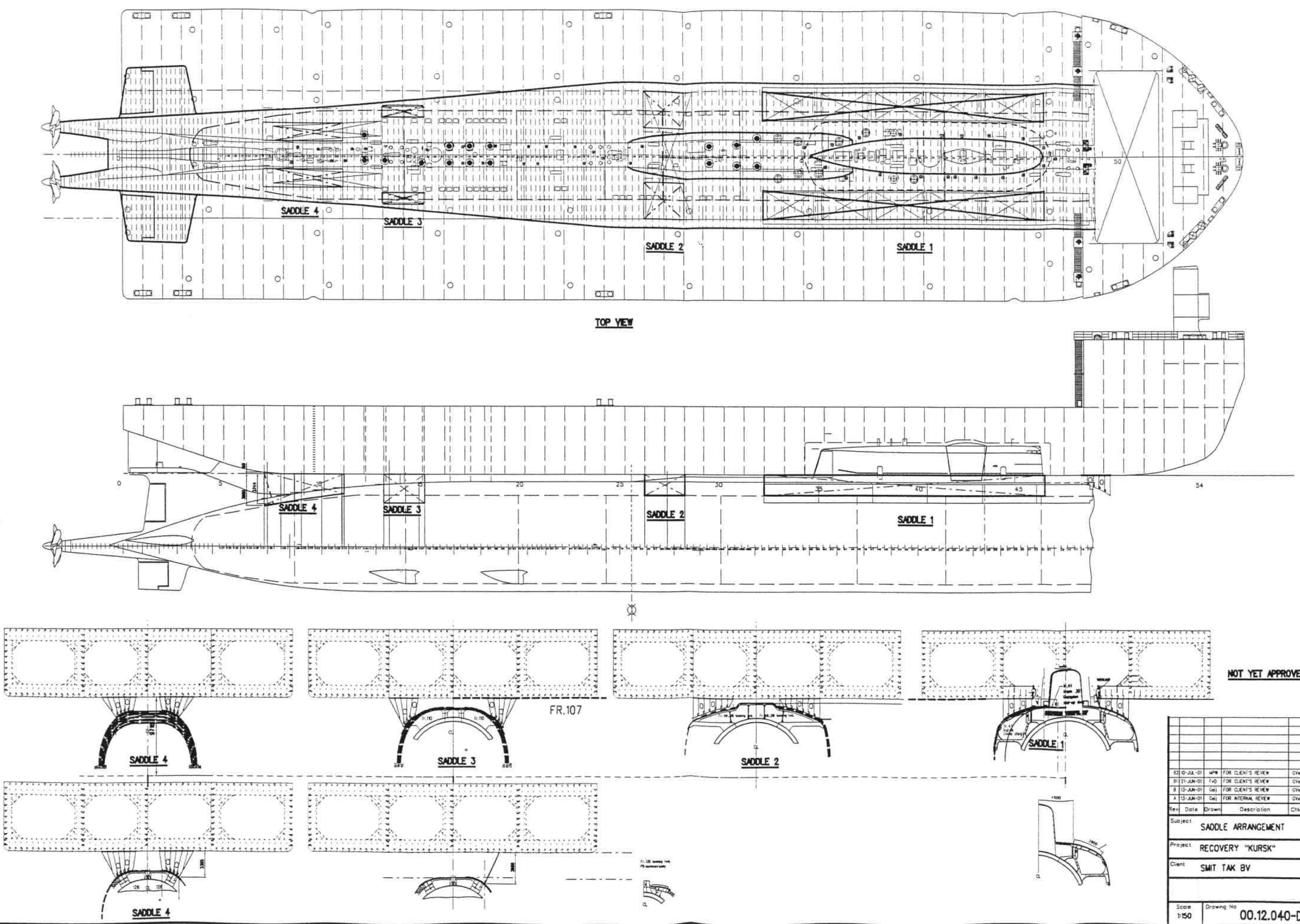
Scale	Drawing No	Sheet	Rev
1:2000	00.12.040-D-501	1 of 1	C1

APPENDIX F

SADDLES

(1 page)

F11



NOT YET APPROVED BY LLOYD'S

Rev	Date	Drawn	Description	Chkd	E.Appr	P.Appr	Client	Date
B2	10-JUL-01	WPW	FOR CLIENT'S REVIEW	CVe	HHe	BKa		
B1	21-JUN-01	FvO	FOR CLIENT'S REVIEW	CVe	HHe	BKa		
B	13-JUN-01	Geij	FOR CLIENT'S REVIEW	CVe	HHe	BKa		
A	13-JUN-01	Geij	FOR INTERNAL REVIEW	CVe	HHe	BKa		

Subject: SADDLE ARRANGEMENT

Project: RECOVERY "KURSK"

Client: SMIT TAK BV

CAD-drwg not to be changed manually

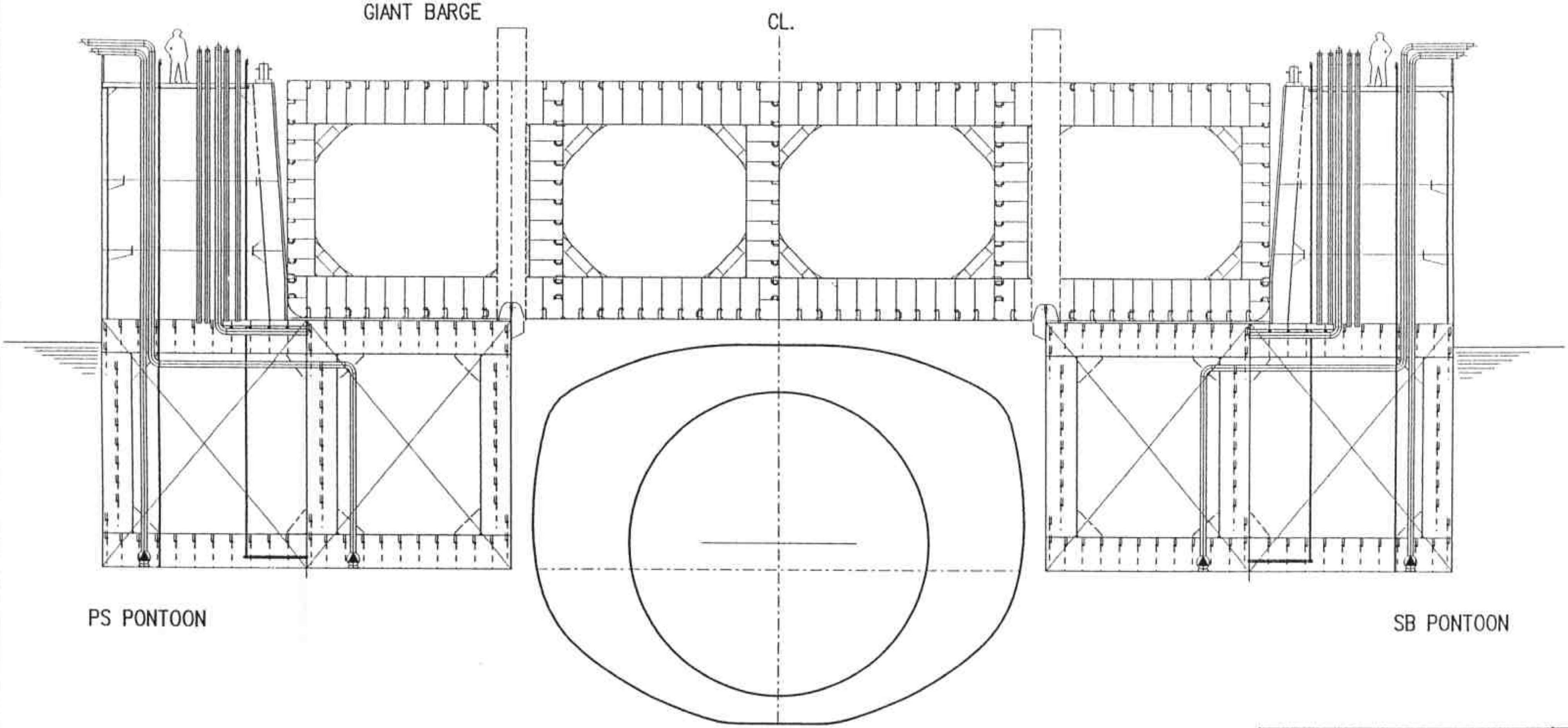
Orig. Size A0

Scale	Drawing No	Sheet	Rev
1:150	00.12.040-D-204	1 of 5	B2

APPENDIX G

GIANT-KURSK-PONTOONS

(1 page)



Rev	Date	Drawn	Description	Chkd	C.Appr	P.Appr	Client	Date
B	23-JUL-01	RHe	FOR CLIENT'S REVIEW	GVe	RHe	CVe		
A	23-JUL-01	RHe	FOR INTERNAL REVIEW	GVe	RHe	CVe		

Subject: SECTION GIANT WITH SIDE PONTOONS AND KURSK

Project: RECOVERY "KURSK"

Client: SMIT TAK

CAD-drwg not to be changed manually

Orig. Size: A3

Scale	Drawing No	Sheet	Rev
1:150	00.12.040-D-510	1 of 1	B

1/5