

# ISIS ROV System

NMFD Deep Platforms Group

Dave Turner

# Vehicle Quick Spec

- Length: 2.7m Width: 1.5m  
Height: 2.0m Weight: ~3.4T
- Max. working depth: 6500m
- Propulsion: 6 x 5HP (3.7kW) Thrusters
- PMax electric power 18kW at 6500m
- Cable voltage: 2800V  
(10km of 3 fiber 3 core triple armoured x 17.3mm dia)
- Maximum forward and lateral speed: 0.75m.s-1 (1.5kt).
- Autopilot functions include:
  - Auto depth (to +/- 1m)
  - Auto altitude (to +/- 1m)
  - Auto heading (to <+/- 1°)Close loop control, using bottom lock or water lock with the Doppler.
- Hydraulic power unit 5HP (3.7kW) for manipulators, trays etc.
- Mineral Oil @ 3psi above ambient compensation system.
- Multi-channel serial, Ethernet and video communications over optical fibre. (8 x video ch available)
- 3 x 400W HMI Lights
- 2 x 250W Quartz Uplooking
- 2 x 250W Aft Facing
- 2 x Electric Pan & Tilt Units.
- 2 x 7 Function Manipulators
- USBL & LBL Navigation System
- Sampling Tools (Push Cores, Temp probes, Fluid Samplers, Suction Samplers)
- 100m range Altimeter.
- 1200khz Doppler (low alt navigation 100m).
- 300khz Doppler (high alt Navigation 250m).
- Octans for Pitch, Roll and Heading.
- MS1000 Avoidance Sonar (850khz)
- MS2000 Forward looking Sonar (high res swath tool)

# ISIS Vehicle

Syntactic foam for buoyancy, density  $500\text{kg}\cdot\text{m}^{-3}$ .

Reversible 3.7kW thrusters for propulsion. Two fore/aft, two vertical, two sideways.

Hydraulic power unit with control valves.

Oil-filled high voltage transformer.



*Framework made from welded hollow section and structural aluminium. Corrosion protected with anodes and ground-fault detectors. Most electronics housed in titanium pressure vessels.*

Oil-filled electrical junction boxes for cables.

Pressure balanced, oil-filled cable hoses connect most instruments to the junction boxes.

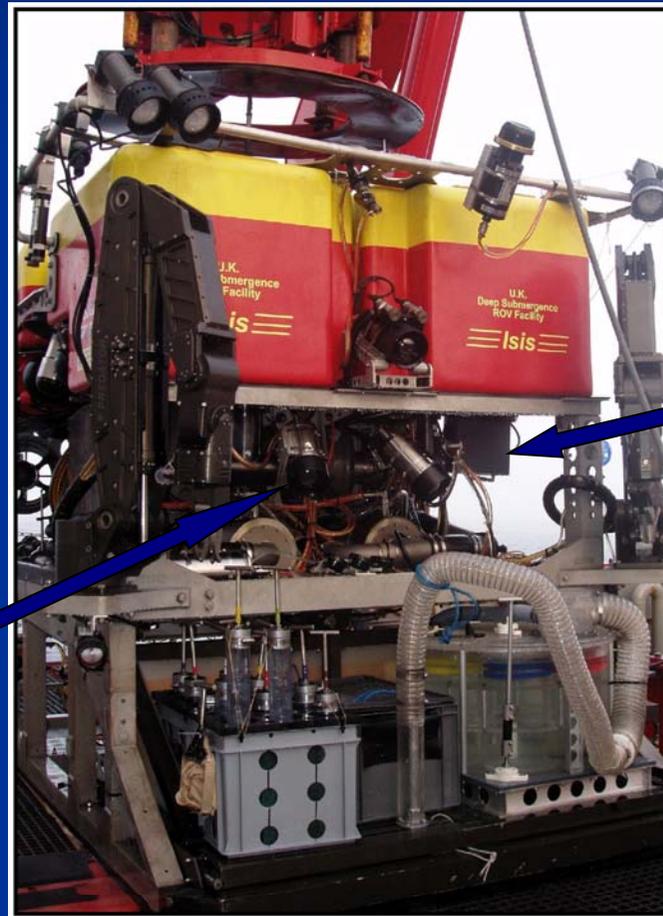
Forward tray and two side trays with hydraulic actuators.

# Cameras and Lights

*Three Metal halide lights of 400W each  
provide the main forward lighting*

An 3-chip 850 line  
colour camera with  
a 14x zoom  
provides broadcast  
quality video.  
*(not on board this  
dive)*

A 3.34Mpixel  
digital still camera  
with a 4x zoom  
gives publication-  
quality pictures.



Two standard  
resolution low light  
colour cameras with  
12x zoom provide the  
pilot and scientists with  
their own general  
coverage video.

Other video cameras  
monitor the tether and  
the rear of the vehicle.

# Navigation



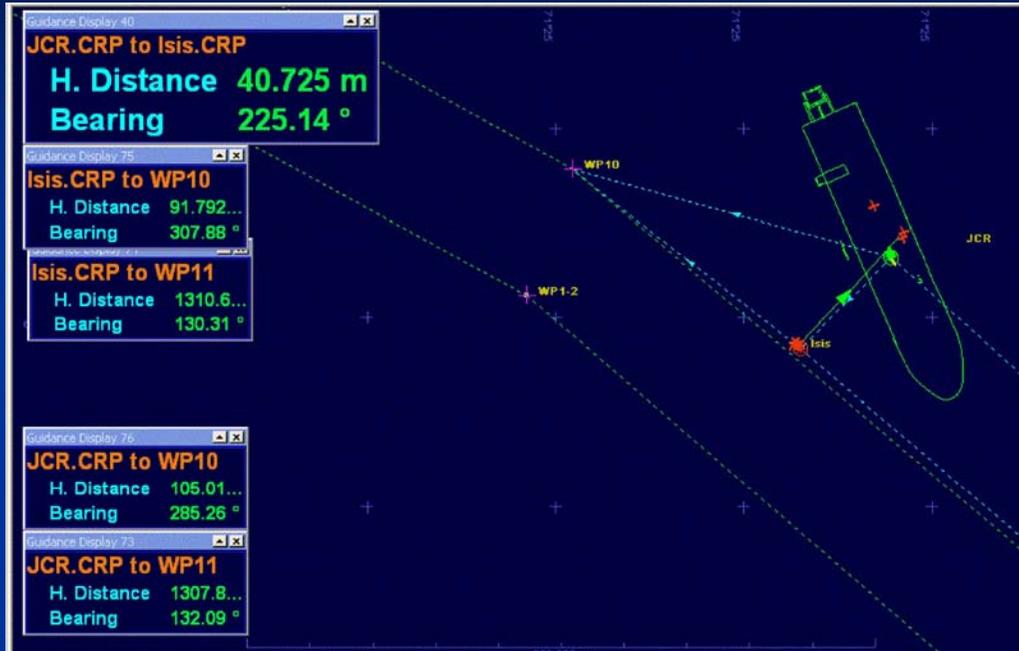
Compatt 5 USBL Responder



Doppler

We need to know the position of Isis relative to the ship. An acoustic transducer on the ship listens for signals from a responder on Isis (centre). By measuring the time and phase of the sound, and knowing the vehicle depth, Isis' position is calculated. We know the ship position by GPS, so we can work out the absolute position of Isis. When within 30m of the seabed, the Doppler velocity log (right) and a fibre-optic gyrocompass give a very smooth vehicle track, but one that drifts with time, and is corrected by the acoustic navigation.

# USBL Navigation



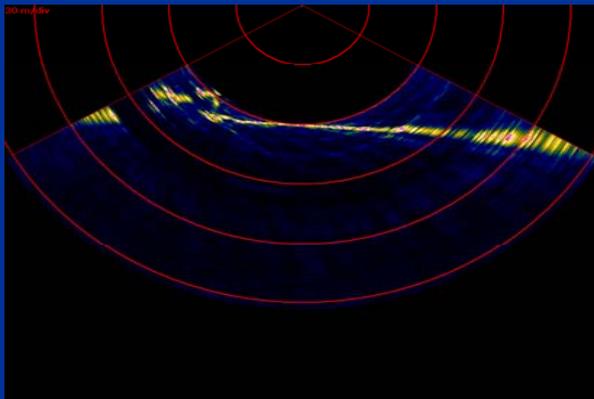
Above, a snapshot of Isis' navigator's display. The ship graphic is clear. Isis is the red dot below and to the left of the ship. The screen shows the numeric distance and bearing from the ship to Isis (top left), and, to help the pilot, gives range and bearing from Isis to the next waypoint; in this case, just over 91m at a bearing of 307°. At the slow speed of Isis, typically less than  $0.3\text{m}\cdot\text{s}^{-1}$  in deep water when moving, or when remaining at one position if sampling the sea bed, the ship must use its dynamic positioning system to perform slow maneuvers, or to keep stationary over a point on the sea bed.

# ISIS Sonars

SM2000 Swathing



Installing the SM2000 echosounder to the under-frame of Isis. It uses a curved transducer to achieve a swath coverage of 60° either side of centre. Multiple beams are formed by control of phase.

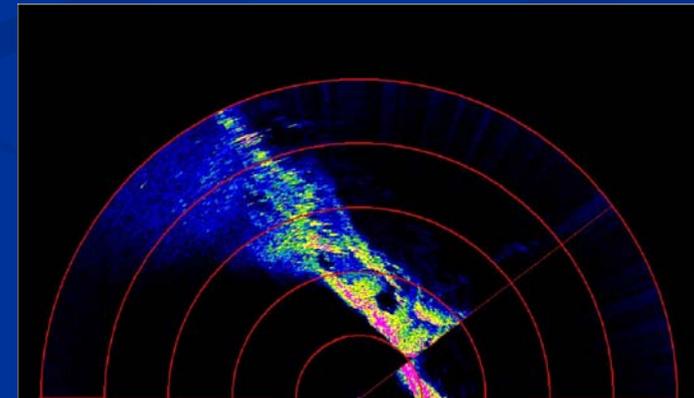


*A swath of Ship Wreck from an altitude of 100m, showing cargo hatch from P. side*

MS1000 Avoidance



The MS1000 echosounder is a pencil beam 875kHz single beam device that scans mechanically to generate an image



*A drumlin (in pink), across the ROV track, presents a hazard to the pilot and a site of interest for the scientist.*

# Manipulators



- 2 x Kraft Predator II.
- Hydraulically Operated.
- 7 Functions. (rotate, shoulder, elbow, wrist pitch, wrist yaw, wrist rotate, gripper)
- Force Feedback.
- approx 100kg lift at full extension.
- Aluminium Construction



The manipulators are operated from the control container, using the 'Mini Masters'

These units have replica joints of the vehicle arms and functions to allow:

- Variable grip force.
- Indexing, for comfortable control.
- Continuous Wrist rotate.
- Grip lock for securing the sample.

# The Control Systems



ISIS  
Control



Winch and cable drum with 10km cable. Three optical fibres for data and three conductors at 3kV for power.



20' Portable Workshop



HPU for Winch and Launch  
System

# Inside ISIS Control



**Left:** The engineer's seat, checking the vehicle's power use, faults, manipulators.

**Centre:** The pilot flies the vehicle in three dimensions, keeps on course and depth.

**Right:** The navigator works with the ship's officers to keep the ship and Isis on track.

**The science area:** Event logging, video and data recording to a 7TB data store, record keeping and working with the pilot to direct the sampling.

# ISIS Team Roles

- 8 x Engineers (min) per cruise.
- 2 x 12hr watches (4 engineers/watch).

## Launch and Recoveries

- Engineer
- Pilot
- Deck Co-ordinator
- Winch/handling system operator.

## Dive Operations

- Engineer
- Pilot
- Navigator
- Floating



ISIS control room and crew positions

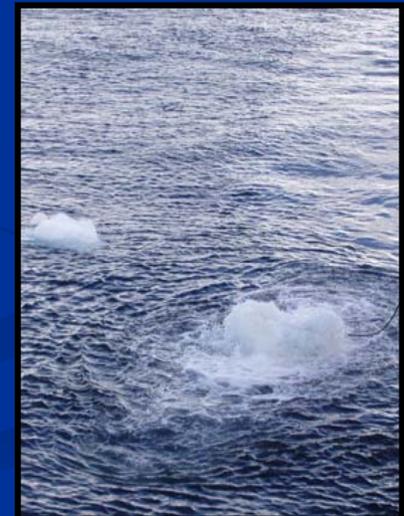


ISIS recovery aboard  
The RRS James Cook



ISIS recovery in  
Sea state 5

# Launching ISIS



Clockwise: Isis is lifted from the ship's deck; hangs over the side but latched to the gantry; lowered on its cable into the sea; floating free; attaching floats to the cable; diving using its thrusters!

# Recovering ISIS



Step 1: Vehicle surfaces, staying away from the side of the ship, stern to, while the buoyancy floats are removed one-by-one.



Step 2: Floats removed, Isis reverses towards the ship.



Step 3: Left: When Isis is underneath the gantry, the pilot turns parallel to the ship, and the winch lifts the vehicle out of the water. Good judgment is needed in rough seas to avoid the cable going slack, then snatching, as waves go by. Step 4: Right: Nearly home - Isis then latches firmly into the head of the gantry, to avoid swinging as it is brought on deck.



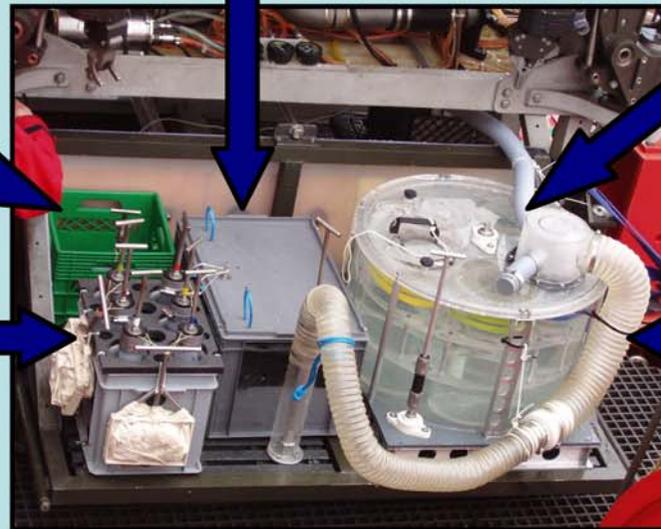
# Sampling Equipment

'Geo box' for stones or rock samples.

'Biobox' for containing animals collected by the manipulators

Five separate chambers for samples collected by the 'Slurp Gun'

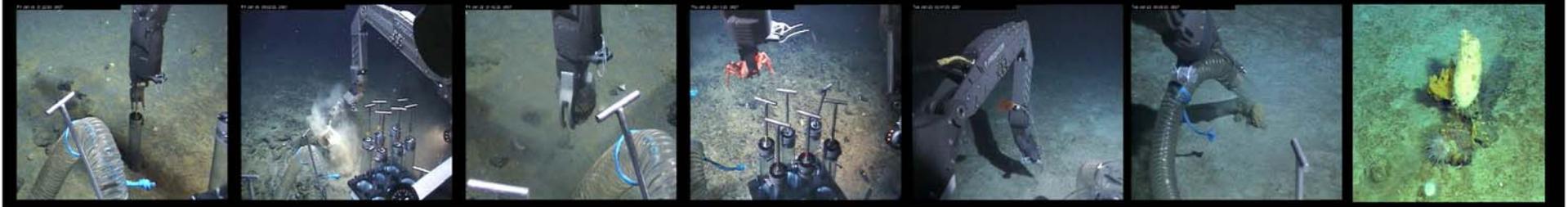
Six push corers, either 30cm or 50cm long, in storage box. The manipulators grab the 'T' handles. Gravel bags hang off the box.



'Slurp Gun' hose, in stowed position. Lifted by the manipulator when in action

*Isis has a large front retractable tray to contain the sampling equipment. Smaller trays at the sides can swivel to the front to carry additional samples.*

# Sampling Techniques



1.

2.

3.

4.

5.

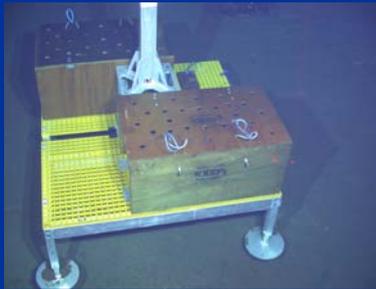
6.

7.

1. Manipulator pushing a 50cm sediment corer.
2. Coarse gravel grabbed in a bag.
3. A dropstone is collected.
4. Spider crab caught and placed in 'biobox'.
5. Removing Umbellula from the seabed.
6. Animals sucked into chamber by 'Slurp Gun'.
7. Video frame grabs record animals 'on the fly'.

# Typical Missions

- Bathymetric Survey using high resolution multi-beam sonar.
- Biological sampling using suction samplers and manipulators.
- Geophysical sampling, manipulators.
- Sub-sea structure work, manipulators and specialised tooling.



A sub-sea elevator



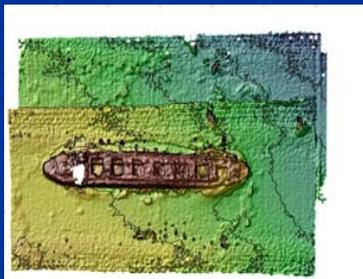
Multi-beam mapping sonar



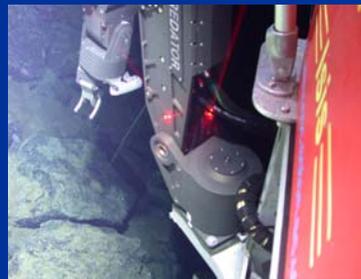
Pilot main camera



Tele-robotic manipulator sampling



Wreck survey



Ranging lasers

# Missions Accomplished

- **JCR 157 Marguerite Bay, Antarctica – Jan 2007**  
Biological and geophysical investigation in Antarctic peninsula. Was the deepest scientific ROV operation in Antarctic waters to date.  
**Mission spec : Swath, Bio and geophysical sampling and survey**
- **JC010 Gulf of Cadiz, Portuguese Canyons – June 2007**  
Major European scientific investigation of Eco-system Hot spots in European waters. (HERMES program)  
**Mission spec : Swath, bio and geophysical sampling and survey, sub-sea structure work on in situ experiments.**
- **JC021 Hess Deep – Jan 2008**  
Geophysical investigation in the Hess Deep plate spreading zone, Pacific.  
**Mission spec : Swath and geophysical sampling**
- **JC024 Axial Volcanic Ridges, Mid Atlantic – June 2008**  
Geophysical expedition to the Mid-Atlantic ridge axial volcanoes.  
**Mission spec : Swath, Bio and geophysical sampling and survey**



ISIS control shot showing piloting operations 'on buttons' during a swath survey



A bridge officer at the DP station, in constant communication with the ROV navigator

# Typical Cruise Achievements

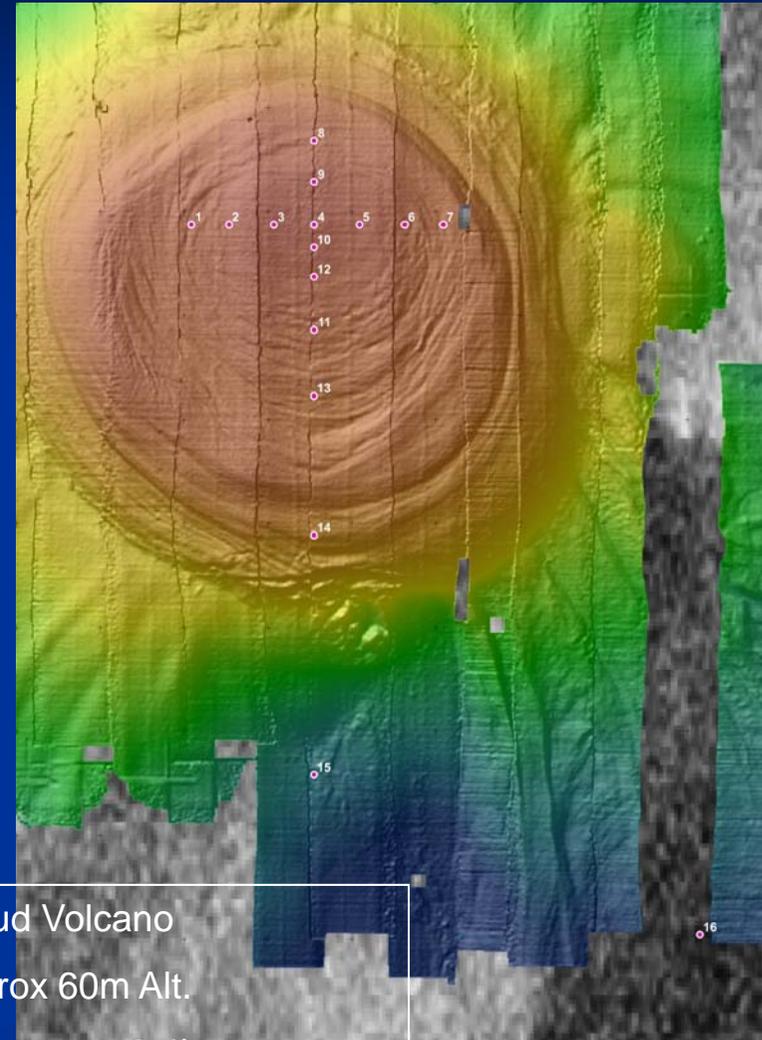
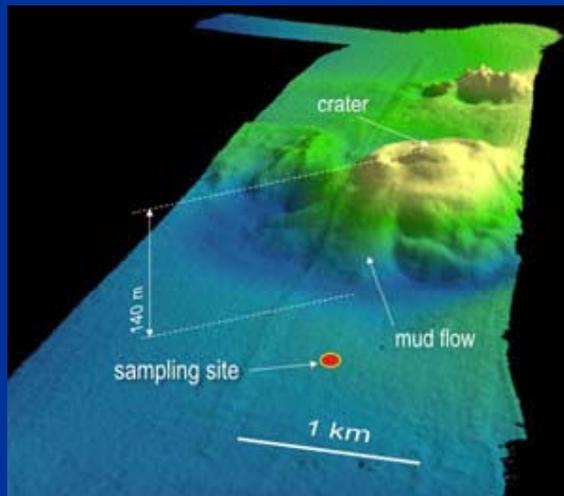
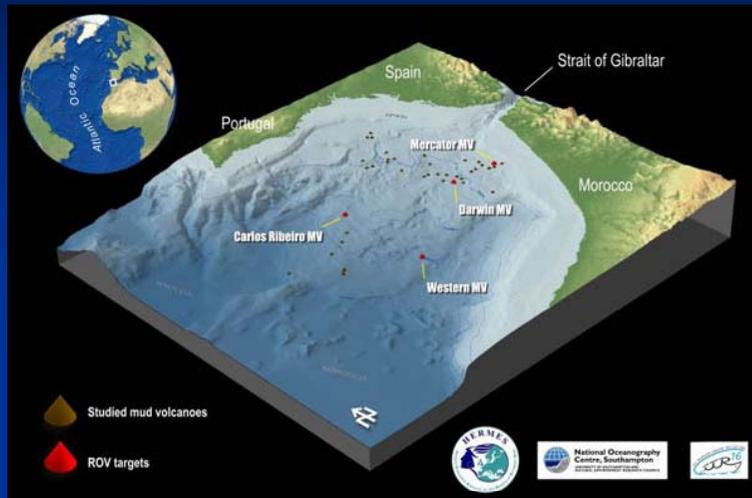
Based on our last 35 day cruise Isis can deliver:

- 16 to 20 Dives with an average of 36hrs /dive.
- Based on 3600m water depth approx 6hr turn around. (2hr ascent, 2hr reconfigure, and 2hr decent.)
- Max duration of dive at bottom approx 38hrs.
- Payload up to 60kg.

Science take home:

- Approx 160GB Swath Data. (received on My Book Tbyte Drive)
- Approx 25GB Techas Data. (ISIS sensors ) (received on My Book Tbyte Drive)
- Approx 900GB DVR Video.(4 ch, low frame rate)
- 360 DV Cam Tapes. (S Video) (180 of which are duplicates)
- 270 DVDs.

# SM2000 Swath



## Gulf of Cadiz Mud Volcano

- Survey at approx 60m Alt.
- Survey speed approx 0.4kt
- Post processing software (Caraibes)

# Shipping

The ISIS System Consists of:

■ 1 x ROV (shipped in 20' Container)	3.2T
■ 1 x Traction Winch	5.2T
■ 1 X Storage Drum (10,000m wire)	15.0T
■ 1 x Hydraulic Power Unit	5.0T
■ 1 x Launch and Recovery System	17.5T
■ 1 x 20' Workshop Container	7.0T
■ 1 x 20' Control Container	6.5T
■ 1 x 20' Data Container	5.5T
■ 1 x 20' Spares Container	7.0T

Total Shipping weight: 72.0T

Road Transportation:

2 x 40' Lorries

1 x 20' Lorry

2 x 40' Low Loader Lorries (one with wide load route clearance)