UNIVERSITY OF BRISTOL DEPARTMENT OF GEOLOGY CRUISE REPORT

RRS CHARLES DARWIN CRUISE 102

THE INTERACTION OF MICROBIAL ACTIVITY AND DIAGENESIS IN HYDROTHERMAL SEDIMENTS AT THE MID-ATLANTIC RIDGE AT 26°N

1996

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ITINERARY

The scientific personnel joined the ship by boat transfer from Ponta Delgada to a point ~500 m off the harbour entrance at 09:00 (all times in this report are GMT) on 11th September 1996.

OBJECTIVES

The were two objectives of this cruise. The first was to recover eight moorings that were deployed in August 1995 as part of the BRIDGE "FLUXES" programme. This programme sought to examine segment scale processes within the Broken Spur Vent Field segment of the Mid-Atlantic Ridge at 29°N, 43°W. Four days were allocated for the recovery operations, which allowed for their depth, complexity and possibilities of dragging for failed releases. The moorings all had single top-sided buoyancy followed by strings of various current meters, thermistors and thermistor chains and, on three of the eight, sediment traps. The longest mooring was 1500 m and the shortest was 200 m. The second object of the cruise was to recover sediments by coring in order to determine the relationship between microbial activity and diagenesis in metalliferous hydrothermal sediments using the following techniques:

1. To collect hydrothermal sediments from the MIR mounds in the TAG hydrothermal area using a variety of coring techniques (gravity corer, box corer, and multi corer).
2. To extract porewaters from these sediments for on board analysis of nutrients and trace element analysis on archived samples on return to the U.K.
3. To prepare core material for microbiological analysis on board (flux measurements) and on material returned to Bristol (incubation experiments, MPN, etc).
4. To preserve the solid phase in a form that would allow detailed geochemical and mineralogical analysis of the material on return to Bristol.

The research to be undertaken as a result of this cruise built on the results of previous BRIDGE cruises to the TAG area by members of CD102 and other U.K. and overseas scientists.

NARRATIVE

The ship sailed from the Azores at 15:30. The delay between embarkation of the scientific party and sailing was due to the need to replace a piston cylinder head following a water leak in the engines.

Station CD102/01

The ship arrived on station (29°23.90'N, 43°10.53'W) for recovery of mooring 'A' at 13:00 hours on 15/9/96 after an uneventful passage in fine weather. Conditions on station were ideal for recovery operations, with a gentle breeze, bright sunshine and only a slight swell on a near glassy sea surface.

The first activity was deployment of the PES fish. Unfortunately, there was a leak in one of the connections so the fish was recovered and the transducer deployed.

This required the ship to be moved closer to the mooring and the release was eventually triggered at 14:15 hours and reached the surface at 14:42. This was a simple, 500 m long mooring with several current meters and thermistors. The mooring was attached to a 10 kHz twin pyro-release of hybrid design; having "Marine Oceano Systems" (MORs) electronics and IOSDL hardware.

The release responded to commands from the surface, but the dunking transducer failed to receive data from the transponder. This was probably a result of there being too much 10 kHz noise in the water from the ship, and the dunking transducer having insufficient filters to discriminate signals coming from the release. However, this did not hinder the release of the mooring. Following the command to establish pinger mode, the transponder's pinger and bottom reflection was received by the PES recorder, from which it was easily determined that the mooring was upright. At 14:15 the release command was sent, once only, and the pinger trace and bottom reflection began to diverge, indicating a successful release. When the flotation was spotted on the surface, a second release command was sent to fire the remaining pyro-release in order to disarm the mechanism prior to recovery. Recovery proceeded smoothly and the only problem was that one of the current meters had a seized impeller.

Station CD102/02

Arrived on station (29°09.91'N, 43°10.34'W) and released mooring 'B' at 17:19. This mooring had one current meter, a thermistor and a sediment trap. Its release was a 12 kHz MORs mechanical release. Contact was established with the release and diagnostics verified, all using the dunking transducer. The mooring reached the surface at 17:48 and recovery proceeded smoothly. The bottle from the sediment trap on the mooring contained a good covering of reddish brown material.

Station CD102/03

Arrived on station (29°07.18'N, 43°11.31'W) and released mooring 'D' at 19:13. This mooring was similar in construction to mooring 'B'. The mooring reached the surface art 19:40. During recovery the sediment trap was streamed horizontally for several minutes, but otherwise proceeded smoothly. In addition to the small amount of reddish brown material, the sediment trap bottle contained a number of large invertebrates and there was no obvious smell of formalin, suggesting that the contents may have been turned over by bottom feeders.

Station CD102/04

Deployed 3.5 kHz and 10 kHz fishes at 20:30 following recovery of mooring 'D'. Arrived on station (29°23.5'N, 43°25.0'W) of proposed off-axis reference coring site at 22:30. Steamed a figure of X survey pattern over the site and identified a flat area with an apparent sediment cover of 5-10 m (from 3.5 kHz trace) for coring at 29°23.55'N, 43°25.00'W.

The box core was deployed at 23:50 in 3350 m of water (all water depths in this report are uncorrected for the local sound velocity profile) and reached 250 m above bottom at 00:50 (16/9/96). After waiting 5 minutes to stabilise the package the box core was lowered at 30 m/min and hit the sediment at 00:55 (as noted by a sharp drop in the load on the coring wire). The core was raised at 01:00 and a slight increase in wire load was noted. The core was recovered on deck at 02:25. During recovery it was obvious that the spade had not sealed the base of the box securely as a large amount of water poured out of the bottom. Examination of the corer showed that it had penetrated the sediment to a depth of at least 0.4 m and that the bottom consisted of carbonate ooze. There was no indication that the corer had not entered the sediment vertically or that there was insufficient sediment cover (there were no basalt chips in the small amount of sediment remaining in the box, nor was there any sign of fresh damage to the outside of the frame or corer consistent with hitting rocks). Weather conditions were excellent (light breeze, less than 1 m swell), hence, the failure of the box core to return with a sediment sample can most plausibly be ascribed to equipment failure.

CD 102/05

We arrived on station (29°00.38'N, 43°13.87'W) at approximately 05:00 and held position until day break. The release for mooring 'E' was triggered at 08:46 and the package reached the surface at 09:14. The mooring was relatively complex with a number of current meters, thermistors, a hybrid MORs/IOSDL twin pyro-release and a length of ~1500 m. Despite this recovery proceeded without incident and all the instruments were in good order.

CD 102/06

After a short steam we arrived at mooring 'F' (29°00.17'N, 43°11.81'W) and triggered the release at 11:24. This was another relatively complex mooring fitted with a MORS/IOSDL hybrid twin pyro-release. The package reached the surface at 11:47. Recovery proceeded without incident, but two of the current meters equipped with conductivity metres were flooded, although one had recorded about one week's data.

CD 102/07

Mooring 'G' (29°00.05'N, 43°09.72'W) was reached after a short steam and the release triggered at 14:23. This was another rig with several current meters and thermistors attached via a MORs/IOSDL hybrid twin pyro-release. The package was on the surface by 14:50 and was recovered without incident. All the instruments were in good order.

CD 102/08

Mooring 'H' (29°00.16'N, 43°07.92'N), the final mooring at the southern entrance to the Broken Spur segment, was released at 16:35 and reached the surface at 17:03. As before, this was a multiple current meter and thermistor rig with a MORs/IOSDL hybrid twin pyro-release. Recovery proceeded without incident, but one temperature recorder and one current meter were found to be flooded.

CD 102/09

The final mooring from Broken Spur, mooring 'C' (29°10.54'N, 43°10.29'N), was released at 19:28 and was on the surface by 19:49. This mooring was a simple twin current meter, thermistor and sediment trap rig with a MORs mechanical release. No problems were encountered during recovery and all the instruments were in good order. The sediment trap bottle contained a small amount of brown sediment and a few large invertebrates. No smell of formalin was apparent.

CD 102/10

We returned to 29°23.55'N, 43°25.00'W to carry out further coring operations. As a result of continuing problems with the box core and a shortage of seamen following their efforts at recovering all the moorings in record time, we ran a 3 m gravity core. The core was deployed at 23:13 (29°23.54'N, 43°24.91W) in 3350 m of water. The core was lowered at 60 m/min and reached 100 m off bottom at 00:15 (17/9/96) at 29°23.55'N, 43°24.95W. After waiting 5 minutes for the core to stabilise it was lowered at 50 m/min and hit the sediment at 00:20. A fall in load strain and subsequent increase on pull out gave indications that the core had been successful. The core was raised at 50 m/min and was retrieved on deck at 01:40.

The core contained 2.21 m of apparently homogeneous and relatively indurated carbonate ooze. The liner was cut into 5 cm lengths under N_2 and alternate sections taken for pore water extraction/solid phase geochemistry and microbiological analyses.

The sediment was clay-rich so only 7 cm^3 of pore water was extracted from each 5 cm section. This was not sufficient for the full range of onboard geochemical analyses, but preliminary indications indicated that ammonia levels were below detection limits.

By the time the core was retrieved all the relevant RVS personnel had worked their allotted hours through the day trying to get the box core in working order. Hence, it was not possible to carry out further operations and I took the decision to maintain the ship on station until 08:00 hours when operations would recommence.

Station CD102/11

A start was made preparing the multi-corer at 08:15 and, after several hours of adjustments it was deployed at 14:45 (29°23.44'N, 43°24.92W) in 3350 m of water. The package was lowered at 40 m/min and reached 100 m off bottom at 16:12 (29°23.65'N, 43°24.24'W). After waiting 5 minutes the multi-corer was lowered at 4 m/min and a decrease in load strain indicate that it reached bottom at 16:22. An additional 5 m of wire was paid out and the multi-corer was then raised at 4 m/min after 2 minutes on the bottom. After reaching 100 m above bottom the multi-corer was raised at 40 m/min.

The multi-corer was brought on deck at 18:20. Of the 10 cores fitted, 7 had worked perfectly and contained ~30 cm of carbonate ooze, with well preserved sediment-water interfaces. Two cores were broken at the base, probably by an

overtightened sealer, but they still contained ~25 cm of intact sediment with similarly well preserved upper surfaces. One core did not contain any sediment, apparently as a result of a failure of the upper seal to close. Of the 7 intact cores, one was taken for pore water analysis and the remainder used for microbiological incubation experiments. One of the two broken cores was archived for later microbiological/geochemical analysis in Bristol and the other archived for geochemical analysis of hydride generating elements at SOC.

Station CD102/12

Following modifications to the box corer to improve the seal of the spade against the box (which consisted largely of grinding the edges of the box and the upper block), it was decided to try and obtain a box core at the control site. The corer was deployed at 19:45 (29°23.28'N, 43°24.79'W) in 3350 m of water. The core lowered at 40 m/min and reached 100 m above the bottom at 20:54 (29°22.77'N, 43°24.21'W) and was left to stabilise for 5 minutes. The pinger trace was not strong, so the bottom was difficult to detect. The core was lowered at 30 m/min into the bottom and a sudden, but brief strain decrease was taken to indicate the corer had entered the sediments. The box core was immediately raised at 10 m/min and reached the surface at 22:20. Unfortunately, the corer had not tripped. The absence of any carbonate mud on the frame of the corer (in contrast to the previous deployment) suggested it had not hit the bottom. In view of the number of hours worked today by the RVS staff it was decided to suspend operations and resume at 08:00 the next day.

Station CD102/13

The box corer was triggered on board and found to be in good working order. It was reset and sent over the side at 09:35 (29°23.64'N, 43°24.92'W) in 3335 m (uncorrected depth) of water. The wire out was stopped at 3000 m for 5 minutes to allow the core to settle. The core was then sent in to the bottom (29°23.55'N, 43°24.94'W) at 30 m/min. Wire out recorded 3378 m on the bottom at 10:58. The strain gauge showed a sustained decrease to 3.75 tonnes followed by a well-defined increase to 4.5 tonnes during pull out at 10 m/min, before settling back to the background strain of 4 tonnes. The box corer was on deck at 12:20.

The box contained ~36 cm of homogeneous (apart from a few cm-sized grey redox spots), tan, carbonate ooze. The sediment water interface was well preserved and included a portion of a Paleodictyon trace. This feature was photographed and boxed for return to Bristol. Two 10 cm diameter subcores were taken; one for pore water extraction and to be split for logging. Four 5 cm subcores were taken; one for microbiological processing (sulphate reduction and bacterial enumeration), one for microbiological archive, one for geochemical archive, and one for analysis of hydride forming elements at SOC.

After the subcores had been removed the ship left the Broken Spur area at 13:10 to head south to the TAG hydrothermal site.

Station CD102/14

After arriving in the TAG area at 09:00 (19/9/96) the sound velocity profiler was deployed at 10:15 (26°09.44'N, 44°50.23'W) and recovered at 12:20. The data was downloaded for both the swath system and transponder net.

Station CD102/15

It was necessary to carry out a routine test of the swath bathymetry, so it was decided to take advantage of this to run an unlogged swath through the TAG area to compare with the published maps of the area. Accordingly, a transect was started at 13:50 from 26°11.0'N, 44°49.0'W running south to 26°07.5'N, 44°49.0'W and finishing at 15:00. This showed no significant difference between the published maps and that obtained using the GPS system on the Darwin.

Station CD102/16

On the basis of the swath and published maps, four transponder sites were chosen. Transponder 'A' (channel 12) was dropped at a nominal position of 26°07.9'N, 44°48.1'W in 3476 m of water. As with all the other moorings, the transponder was located 200 m above the bottom. The deployment started at 17:50 and was completed at 18:33.

Transponder 'B' (channel 9) was dropped at a nominal position of 26°08.85'N, 44°48.1'W in 3357 m of water. The deployment started at 19:05 and was completed at 19:41.

Transponder 'C' (channel 3) was dropped at a nominal position of 26°08.80'N, 44°50.25'W in 3660 m of water. The deployment started at 20:48 and was completed at 21:33.

Transponder 'D' (channel 8) was dropped at a nominal position of 26°07.85'N, 44°49.6'W in 3670 m of water. The deployment was started at 22:00 and was completed at 22:30.

During the course of the deployment it became apparent there was a transponder in the area that had been left by a previous (unknown) vessel. It was receiving and transmitting on the frequencies of one of our designated transponders. Hence, it was necessary to use a spare operating on a different frequency. This reduced our number of available transponders, but we were able to use the "foreign" transponder in our net.

Due to poor GPS fixes (tensions in the Gulf?) it took longer than anticipated to calibrate the transponder net. Hence, it was not possible to start coring operations until 03:45 (20/9/96).

Station CD102/17

The 1 m gravity core was deployed at 03:52 with the depth pinger 100 m up the wire and the transponder a further 50 m up the wire. The ship position at deployment

was 26°08.64'N, 44°48.40'W in 3428 m of water and the target (the centre of the Mir mound) was 26°08.65'N, 44°48.40'W. The core was lowered at 50 m/min and stopped at 3000 m wire out to stabilise at 05:12. At this point the ship position was 26°08.65'N, 44°48.41W and the package was approximately 50 m due east of the ship. The package was lowered at 50 m/min until the core was 100 m off the bottom at 05:12 (wire out 3400 m). At this point the ship position was 26°08.70'N, 44°48.38'W and the package was 20 m south of the target.

The corer was lowered at 30 m/min into the bottom, when it entered at 05:15. The strain meter recorded a significant drop in tension, indicating that the bottom had been reached, but there was only a slight increase in tension during pull out. This may have been because the core hit bare rock, or it may simply reflect the fact that the 1 m core does not penetrate so far into the sediments. At the point the core hit the bottom the ship position was 26°08.70'N, 44°48.38'W and the package appeared to be 10 m east of the target.

The corer was brought on board at 06:35 and was found to contain 77 cm of sediment, of which 65 cm were archived following removal of the core catcher and the overlying water. The sediment consisted of 25 cm of carbonate ooze, with iron staining, overlying coarser-grained and darker carbonate. There were dark patches of friable dark sulphide(?) at the base of the core and patches of darker iron staining throughout the core. Overall, the core contained predominantly background carbonate sediments, but with clear evidence of hydrothermal input throughout the core.

Station CD102/18

Following success of the 1 m gravity core it was decided to deploy the 3 m gravity core in the same spot. Unfortunately, problems were encountered with the acoustic navigation system that meant there was an offset of the positions of this station and CD102/19 with CD102/17.

The 3 m gravity core was deployed at 07:00 (26°08.65'N, 44°48.00'W) in 3416 m of water. The wire out was stopped at 3362 m at 08:18 to allow the package to settle at ~100 m above the bottom. At this point the acoustic navigation system crashed. The core was driven into the bottom at 54 m/min and reached bottom at 08:42 with 3460 m of wire out. The best estimate of the position of the core was 26°08.77'N, 44°48.28'W compared to a position of 26°08.65'N, 44°48.40'W for the centre of the mound.

When the core was recovered on deck it was found to contain 221 cm of sediment (reduced to 205 cm after the core catcher was removed). This graded from carbonate ooze in the upper 30 cm to 80 cm of clearly iron stained sediment and deep red ochre for the bottom 95 cm of the core. The smearing on the inside of the core barrel and the slight opacity of the core liner makes detailed core descriptions difficult.

Station CD102/19

After the success of the 3 m gravity core it was decided to try the box corer at the same site. The corer was deployed at 11:04 in 3420 m of water. At this time the ship GPS position was 26°08.83'N, 44°48.33'W. The package was held with wire out of 3000 m at 12:19 to settle. The acoustic navigation recorded the package as ~125 m southwest of the target at 26°08.65'N, 44°48.40'W. The navigation system then crashed so it was decided to take the corer straight into the bottom at 30 m/min. Pinger bottom trace was lost at 150 m above bottom, but a well-defined decrease in strain marked bottom contact and there was a slight increase in strain on pull out at 10 m/min.

The core was recovered on deck at 14:30, where it was found to contain ~35 cm of sediment. The sediment-water interface was well preserved, with small shells (up to 3 mm across) on the surface and clumps of ~5 mm long thin hair-like organisms anchored to the sediment surface. The spade was about 5 mm of the bed of the corer, possible due to chips preventing complete sealing of the spade. As a result, some slumping had occurred in the sediment and cracks opened up on the sediment surface to a depth of a few centimetres.

One 10 cm diameter subcore was taken for pore water extraction and several 5 cm diameter subcores were taken for microbiological and geochemical archiving. A further 10 cm diameter subcore was taken for core description after splitting.

The subcore was 33 cm long. The upper surface of the core contained a thin (few mm) layer of small shells and forams on top of tan carbonate ooze. This tan colour gradually faded to a paler colour over the upper 2-3 cm (redox boundary?). At 4 cm the core intersected a 5 mm diameter burrow. Several burrows of similar dimensions were observed in the sediment infilled with slightly darker sediment. At 8 cm there were several 10 mm diameter slightly darker irregular patches (organic-rich redox zones?) in the light carbonate ooze. At 10 cm there was a 3-4 cm thick dark tan layer within the carbonate ooze. The upper and lower surfaces of this layer were irregular (bioturbated?). The layer contained one isolated patch of light carbonate ooze approximately 15 cm across, together with widely spaced basalt fragments (~5% of the layer) up to 20 mm across. In some portions of the sediment within the box core this brown layer was immediately underlain by a layer of coarse (up to 3 mm) biogenic debris (shells and spicules). Between 14-22 cm the core consisted of light carbonate ooze with widely spaced darker tan patches (up to 5 mm in diameter). At 22 cm there was a 5 mm thick layer of widely spaced small (<3 mm diameter) basalt chips. Below 22 cm to the core bottom the core consisted of apparently homogeneous light tan carbonate ooze to the core base at 33 cm. The base of the core was marked by several large (up to 25 mm) basalt chips, but these may have been pushed into the bottom of the core by the spade passing through the overlying sediments. Because some compaction of the subcores occurred during sampling and this compaction varied with

the type of core used it is likely that the absolute position of the different zones in the subcores will vary, although the relative positions should be constant.

Overall, the core represents background sedimentation of carbonate ooze, with a minor hydrothermal component. The dark brown layer is most likely a small debris flow or turbidite, on the basis of the basalt chips and the underlying shell rich deposit.

Station CD102/20

The next target was set for 26°08.65'N, 44°48.60'N. This area is at the base of the steep slope to the west of the main mound and has been described as containing mixed hydrothermal material and may contain a variety of material slumped off the mound (Rona et al., 199X). A 1 m gravity core was deployed at 14:50 in 3442 m of water. At 16:05 the wire out was stopped at 3000 m to allow the package to settle. The acoustic navigation gave the package position at 50 m SSW of the target. The corer was then run out at 30 m/min and hit bottom at 16:12, with 3576 m of wire out. There was a drop in wire strain and a small increase in strain on pull out.

The corer was on deck at 17:40. The outside of the core barrel was stained with hydrothermal sediment, but the core catcher only contained a few small grains of altered basalt. It seems most likely that the core hit a small pond of sediment that was too thin to be cored.

Station CD102/21

Following the results of the last core attempt it was decided to try coring the mound slightly to the east of the last location at a new location of 26°08.65'N, 44°48.50'W. The corer was deployed at 17:50 in 3448 m of water. The ship position at deployment was 26°08.67'N, 44°48.58'W. The wire was stopped at 3000 m out for the package to stabilise. At this time the ship position was 26°08.61'N, 44°48.53'W and the package was ~100 m due south of the target. The core hit bottom at 19:11 with a wire out of 3507 m. At this time the ship position was 26°08.66'N, 44°48.57'W and the package remained at ~100 m S of the target. The strain trace showed a small decrease on entry and a very small increase on pull out.

The core was on board at 20:32 and was found to contain only a few fragments of 1 cm sized sulphide and oxidised sulphide fragments. The outside of the core barrel was stained with iron-rich sediments. This suggests that either the core hit very shallow sediments or the sediments were very coarse-grained and flowed out of the core barrel on recovery.

Station CD102/22

To complete the sampling suite at the first Mir mound site the multi-corer was deployed at a target site of 26°08.65'N, 44°48.40'N. The package was lowered over at 21:46 in 3417 m of water, when the ship position was 26°08.75'N, 44°48.47'W. The wire out was stopped at 3000 m with the ship position at 26°08.68'N, 44°48.41'W and the package ~80 m due south of the target. The multi-corer was run into the bottom at 5

m/min, where it hit at 23:33 with a wire out of 3458 m. A further 5 m of wire was run out and the multi-corer then lifted off the bottom at 23:35. At this point the package appeared to be 125 m SSW of the target.

The multi-corer was brought back on board at 00:30 (21/9/96). The corer had not fired and there was no sediment in the barrels or the feet. There were a few sediment stains on the bottom of the core barrels. A deck test showed that the corer was working, so we concluded that it had hit hard ground, which did not allow the central portion of the multi-corer to travel down enough to trigger the core sealer.

Station CD102/23

Following the recovery of only chips in the last two gravity cores we decided to use a plastic bag in the core catcher to enhance retention of rubble-like sediment in the barrel. The next target was to the north of the mound at 26°08.80'N, 44°48.45'W in 3480 m of water. The 1 m gravity corer was deployed at 02:10 slightly to the west of this target in 3435 m of water. The corer reached bottom at 03:27 with 3470 m of wire out and hit ~40 m SW of the target.

The corer was recovered on deck at 04:30 where it was found to contain ~17 cm of carbonate ooze with a slight iron coloration. The plastic bag had stopped core wash out, but the corer had been stopped by hard ground.

Station CD102/24

Continuing our exploration of the mound, the next target was slightly to the east of the main centre point at 26°08.65'N, 44°48.30'W. The 1 m gravity corer was deployed at 05:15 in 3440 m of water. The bottom was reached at 06:50 with 3464 m of wire out when the corer was ~50 m W of the target. The corer was recovered on deck at 08:30 and found to contain ~40 cm of strongly iron stained carbonate ooze.

Station CD102/25

We next decided to repeat our efforts with the multicorer at the initial site where we obtained the box core. The corer was deployed at 08:57 in 3440 m with a target of 26°08.65'N 44°48.40'W. The corer was stopped at 10:13 with 3000 m wire out to stabilise. At this point the package was ~50 m due south of the target. With wire out of 3468 m the multi-corer hit the bottom at 5 m/min at 10:32. An extra 5 m of wire was paid out and the corer was then pulled out at 10 m/min. At the time the multi-corer hit the bottom it was ~75 m SSW of the target.

The multi-corer was brought back on deck at 12:05. Eight of the tubes contained approximately 15 cm of sediment, of which 6 had overlying water and 2 had failed to seal completely, allowing the water to drain away. A 9th core had a plug of indurated iron oxide/silicate jammed in the bottom of the core which had smashed the end when the corer triggered. This plug was labelled as sample A of station CD102/25. All subcores showed the same basic sedimentary features, but the thickness of the different layers showed some heterogeneity over the area covered by the cores

(approximately $1m^2$). The surface layers contained a broken crust (2-4 mm thick) of largely black (manganese?) and lesser amounts of brown (iron?) oxides. The presence of anchored hair-like organisms on fragments of the oxide crust suggests that they were at the sediment-water interface. The crust overlies a 2-8 cm thick layer of iron stained carbonates. These were underlain by a layer of rubble-like iron-oxide/silicate sediments that varied in texture from friable to more indurated. This layer extended to the bottom of the subcores that varies in thickness from 8-17 cm. The two subcores without water were sectioned into 5 cm intervals and archived. One of the subcores with overlying water was used for pore water extraction and the remaining 5 were used for microbiological flux and enumeration studies.

Station CD102/26

A new target was chosen for gravity core prospecting at 26°08.55N, 44°48.30'W in 3440 m of water. This site is to the south of the areas considered before. The 1 m gravity corer was deployed at 13:33. It was decided to use an entry speed of 50 m/min to punch through any lithified sediments. The corer hit the bottom at 15:01 with a wire out of 3459 m, at which point the corer was ~70 m SSW of the target. There was a good fall off in strain when the package hit the bottom, but no obvious increase during pull out.

The core was brought on deck at 16:22. There was staining of carbonate ooze along the side of the core barrel and on the weights, but the corer was empty. This suggests that the corer hit a shallow patch of sediment and fell over.

Station CD102/27

The next target (26°08.55'N, 44°48.30W) was chosen to be ~200 m south of the centre of the mound. The 1 m gravity core was deployed at 16:57 in 3442 m of water. The corer hit the bottom at 18:17 with 3464 m of wire out at ~100 m WSW of the target. There was a good drop in strain and a significant increase in strain to 4.5 tonnes on core pull out.

The corer was brought on board at 19:38 and it was clear that the corer had been buried into the sediment up to the weights. When the locking collar was removed from the corer about 30 cm of iron stained carbonate ooze drop out of the barrel. The core liner was full (120 cm) of oxidised hydrothermal sediment. Smearing by fine-grained material along the margins of the core liner made it very difficult to accurately log the core. The bottom 4-5 cm was examined more closely when the core catcher was removed and was seen contain banded yellow, orange, red and black sediments and small (2-3 cm) sized fragments of what appeared to be chimney material. The core was archived for future examination.

Station CD102/28

Following the success of the last core we decided to go for a 3 m gravity corer at the same target (26°08.55'N, 44°48.30'W). The corer was deployed at 20:20 in

3422 m of water with the ship position at 26°08.56'N, 44°48.51'W. It hit bottom at 21:35 with a wire out of 3458 m. The position of the corer was ~100 m S of the target. There was a well defined drop in strain when the corer hit, but only an increase to 4 tonnes on pull out.

The corer was recovered on deck at 22:50 and was found to only contain a handful of chippings of indurated oxide and basalt(?) in the core catcher.

Station CD102/29

Although CD102/27 and CD102/28 had the same nominal targets, they hit bottom ~100 m apart. Hence, it was decided to make another effort at coring the exact bottom location of CD102/27 using the 3 m gravity corer again. It was deployed at 23:09 at a new target (26°08.51'N, 44°48.48'W) in 3434 m of water. The corer hit bottom at 00:44 (22/9/96) with 3480 m of wire out. The package hit ~10 m SE of the target. There was a well defined drop in strain, but no big increase during pull out.

The corer was brought back on deck at 02:01. The sides of the barrel were marked by sediments, but there was only a small amount of red hydrothermal oxides in the core catcher.

Station CD102/30

A further attempt was made to core target 9 (26°08.51'N, 44°48.48'W) using the 3 m gravity corer. It was deployed at 02:30 and hit bottom at 03:52 with 3521 m of wire out. At this point the package was ~140 m SW of the target. The core was brought back on deck at 05:20. It was found to contain about 15 cm of carbonate ooze.

In an effort to search for well defined sedimented areas the 3.5 kHz fish was switched on and an east-west survey was run over the area of target 9. This appeared to show basement outcropping at the top of the slope to the east of the target, with increased sediment cover downslope to the east. The thickness of sediment was over 10 m and it contained several horizontal reflectors, which suggests there may be some structure to the sediment column, possibly in the form of sulphide layers.

Station CD102/31

The 3.5 kHz profile definitely indicates the presence of deep sediment in the area of target 9, so a further attempt was made with the 3 m gravity core. It was deployed at 05:40 and hit the bottom at 06:55 with 3478 m of wire out. At this point the package was ~40 m due S of the target.

The corer was brought on deck at 08:10 and was found to contain about 20 cm of mixed sulphide/sulphate debris, including some material wedged in the top of the core barrel. Hence, there does not appear to be any problem in getting the corer to penetrate into the sediments, but rather with recovery. It may be that the sulphide material is too hard for the core catcher tines to close around and too dense to be retained in the core barrel during recovery.

Station CD102/32

Another attempt was made to core target with the 3 m gravity corer at 08:46. The corer hit the bottom at 10:20 with 3508 m of wire out and the package about 30 m SW of the target.

When the corer was brought back on deck at 11:40 it was found to contain 152 cm of red-brown oxidised hydrothermal sediments. The sediment-water interface was clearly missing and the upper portion of the core had been disturbed, hence it was decided to section the core into 10 cm intervals and archive it for future work.

Station CD102/33

Unfortunately the transponder was found to have a stripped thread on one of the bolts holding it to the wire so the location of this core was solely determined by the position of the ship in the net. In order to lower the amount of weight in the core barrel and possible lessen the chance of core washout, operations were switched to the 2 m gravity corer. This was deployed at 12:48 in 3462 m of water.

The corer reached bottom at 14:13 with a wire out of 3495 m. Based on the ship track and comparison with previous stations, it is estimated that the corer hit bottom ~70 m SSE of the target. Again there was no large pull out strain, so it was no surprise when the core was brought on deck (at 16:15) empty, except for a few chunks of silicified hydrothermal sediments in the core catcher.

Station CD102/34

To maximise the chances of core recovery the sealer at the top of the core barrel was greased. We decided to return to the site where we obtained the large amounts of sulphide. Accordingly, the 2 m gravity corer was deployed (with the newly fixed transponder) at 16:40 in 3447 m of water. The new target (10) has co-ordinates of 26°08.45'N, 44°48.46'W.

The corer hit bottom at 18:17 with 3502 m of wire out at ~25 m S of the target. There was no significant increase in strain and there was no sediment in the barrel when the corer was recovered at 19:46.

Station CD102/35

It was decided to make an attempt at recovering sediment from the site of the successful multi-corer site at new target 11 (26°08.60'N, 44°48'40W). The 3 m gravity corer was deployed at 20:26 in 3433 m of water. The corer hit bottom at 21:50 with 3457 m of wire out. At this point the corer was ~60 m SE of the target. There was no large pull out. The corer was recovered on deck at 23:20, and was found to contain a small amount of red oxidised hydrothermal sediment.

Station CD102/36

We determined to make another attempts at target 11. This time a serrated plastic bag was used over the core catcher to try and aid in recovery. The corer was deployed at 23:45 in 3478 m of water. It hit the bottom at 01:05 (23/9/96) with 3478 m

of wire out, at which time it was ~40 m ENE of the target. There was no significant increase in strain on pull out.

When the core was recovered on deck at 02:30 it was found to contain a small amount (~10 cm) of iron stained carbonate ooze and some weathered sulphides.

Station CD102/37

Another attempt at target 11. The corer was deployed at 03:00 in 3456 m of water and hit bottom at 04:28. At this time there was 3465 m of wire out and the package was ~40 m SW of the target. There was a promising 5 tonne strain on pull out. When the core was recovered on deck it was found to contain about 120 cm of sediment. The upper portion was ~30 cm well consolidated carbonate ooze and below this was a little under 1 m of rubble-like red-brown oxidised hydrothermal sediment. The core was sectioned and processed for microbiological and geochemical studies.

Station CD102/38

A new target (12) was specified at 26°08.56'N, 44°48.37'W. The 3 m gravity corer was put over the side at 06:31 in 3450 m of water. Bottom was reached at 07:40 with wire out of 3457. There was no obvious pull out and only a small amount of red hydrothermal oxide rubble was recovered in the core catcher.

Station CD102/39

In filling in our coverage of the Mir mound we designated a new target (13) at 26°08.55'N, 44°48.45'W. The 3 m gravity corer was deployed at 09:10 and reached bottom at 10:44 with 3470 m of wire out. At this point the package was within 10 m of the target. No obvious strain increase was observed on pull out and on recovery at 12:12 there was only a handful of red-brown hydrothermal oxide and fragments of black oxide crust.

Station CD102/40

After running a 3.5 kHz profile it was decided to head back to target 3 and try and core the area mapped as containing mixed hydrothermal material. The 3 m gravity corer was deployed at 14:05 in 3492 m of water. It hit bottom at 15:34 with 3486 m of wire out, at which point it was 75 m S of the target. The pull out was only 4.25 tonnes, and when the core reached the deck at 16:53 it was found to only contain a handful of weathered chimney material.

Station CD102/41

Another 3.5 kHz survey was run on a northerly track between 26°09.00'N and 26°10.00'N along 44°49.00'W. This is on the edge of the Alvin zone in an area cored successfully by previous cruises by the Russian research ship Mistislav Keldysh. Following this survey a target (14) was chosen at 26°09.25'N, 44°48.90'W. The 3 m gravity corer was deployed at 18:42 in 3540 m of water. It hit the bottom at 19:58 with 3611 m of wire out. The position was less sure because we were outside the

transponder net, but the corer hit bottom ~100 m SSW of the target. There was only a pull of 4.25 tonnes, so it did not seem likely that the core would contain any material.

When the core was recovered on deck at 21:21 it was found to contain 139 cm of sediment. The upper 30 cm consisted of iron stained carbonate ooze that graded into red hydrothermal oxides over a distance of 20 cm. The lower portion of the core consisted entirely of red-brown hydrothermal oxides.

Station CD102/42

At 21:34 the 3 m gravity corer was sent over at the same target in 3508 m of water. The corer reached bottom at 22.47 with 3600 m of wire out. At this point the package was about 30 m SW of the target. There was a good pull out of 4.75 tonnes and when the corer was recovered on deck at 00:08 (24/9/96) it was found to contain 182 cm of sediment. The upper 40 cm consisted of carbonate ooze that became progressively more iron stained as it went deeper. Below this the core appeared to contain layers of more yellow material intercalated in the generally red-brown hydrothermal sediment. These may be sulphide layers, although the smearing on the inside of the core barrel made it difficult to distinguish the sediment structure clearly. The core was cut into 30 cm sections and archived.

Station CD102/43

From the previous core and Russian expeditions to the area, it was apparent that we were in an area where there are abundant sulphides, so we sent in an other 3 m gravity corer on the same target at 00:26. The corer hit bottom at 01:41 with 3594 m of wire out, at which point the package was 30 m NE of the target. There was a 5 tonne strain during pull out, and when the core was recovered it was found to contain 228 cm of sediment. The upper 40 cm was carbonate ooze that became more iron stained towards the bottom of this section. At 40-50 cm deep the sediment appeared to be dominated by red-brown hydrothermal oxides. Between 50-90 cm there was a layer of fine grained (~1 mm, or less) sulphides. This layer was underlain by even finer grained green sediment that continued to the bottom of the core. When a portion of the green sediment was exposed to atmosphere it turned red within a few minutes, suggesting that it contained very reduced iron. The core was cut into 5 cm sections and processed for geochemical and microbiological studies. It is important to note, therefore, that during centrifuging of the sediment for pore water extraction, this sediment remained green, preserving the redox state of the samples.

Station CD102/44

In order to examine the variability of sediments in the area, a 3 m gravity core was put over the side at 03:36 on a new site (15) 200 m to the north of site 14 in a water depth of 3537 m. The core reached bottom at 04:59 with 3579 m of wire out. At this point the package was 70 m SW of the target. There was a 4.5 tonne strain on pull

out. When the corer was brought on deck it only contained loose chippings of sulphide chimney fragments in the core catcher.

Station CD102/45

The next 3 m gravity corer was targeted (16) at a site half way between the 14 and 15. It was put over the side at 06:57 in 3457 m of water. The corer hit bottom at 09:25 with 3586 m of wire out ~70 m E of the target. There was a good pull out strain of 4.75 tonnes. The core was recovered on deck at 10:52, when it was found to contain 119 cm of sediment. The upper portion consisted of iron stained carbonate ooze, which gradually darkened to the base of the core. The core catcher was filled with a lithified plug of rust coloured sediment. This material was hard to remove from the catcher and may have prevented further entry of the corer into the sediment.

Station CD102/46

A number of problems were encountered with the acoustic navigation at this northerly site as we were operating outside the transponder net. Hence, it was decided to deploy an additional transponder at a nominal position of 26°10'N, 44°49'W in a water depth of 3450 m. This operation was started at 11:30 and the new position was accurately plotted within the network by 14:00.

Station CD102/47

Following the success of the gravity core programme at target 14 it was decided to box core this area. Accordingly, the box corer was deployed at 14:28 in 3532 m of water. It reached bottom at 16:05 with 3607 m of wire out at ~75 m W of the target. There was a strong pull out strain of 5 tonnes.

The corer was recovered on board at 17:42 and was full of sediment, although the spade had not sealed perfectly. This resulted in some slumping of the sediment, causing cracks to open up on part of the sediment-water interface. One large subcore was taken for pore water analysis and 4 small subcores were taken for geochemical and microbiological analysis. An additional large core was taken and split to provide a core description. The subcores were 30-35 cm long, with the depth varying according to the position of the subcores in the box and the degree of compaction they sustained during sampling. All the subcores exhibited the following sedimentological features, although the exact position of the boundaries varied by a few cm between the subcores. The top 4 cm consisted of tan carbonate ooze that was slightly iron stained and more strongly consolidated than might normally be expected for surface carbonate-rich sediments. Between 3-5 cm there was a discontinuous layer (through ~30% of the layer) of darker iron stained carbonate. Below this the carbonate ooze became lighter to a depth of 22 cm. Within this portion there were several ~5 mm diameter darker spots and at 16-19 cm there was a slightly darker layer that was continuous through ~80% of the core. Between 22-33 cm there was an irregular transition zone between the lightly iron stained carbonate in the upper portion and the light red-brown, predominantly,

hydrothermal sediments of the lower portion. These, in turn, graded into dark brown hydrothermal sediments at the base of the core at 40 cm. Within this latter zone there were a few sparkling grains of sulphide.

Station CD102/48

A further box core was deployed at this site at 18:20 to provide a measure of the lateral heterogeneity of the surface sediments. The corer reached bottom at 20:10 with 3605 m of wire out and was within 30 m of the target. There was not a large pull out strain (4.5 tonnes) and when the corer was recovered on deck at 21:54 it was found not to have triggered. There was sediment on the frame and tests on deck suggested that there was a bolt sticking close to the upper shackle that had prevented firing.

Station CD102/49

In order to provide additional archive material a further 3 m gravity core was put over the side at 22:29 in 3540 m of water. The corer reached the bottom at 23:49 with 3605 m of wire out at ~40 m E of the target. There was only a small pull out strain of <4.5 tonnes and when recovered on deck at 01:10 (25/9/96) the corer was found to only contain about 10 cm of carbonate ooze.

Station CD102/50

Another 3 m gravity corer was deployed at 01:35 at the same site. It hit the bottom at 02:52 with 3594 m of wire out, within 30 m of the target. Again, there was only a small 4.5 tonnes strain on pull out, and when the corer was recovered on deck it was found to only contain 52 cm of iron stained carbonate ooze.

Station CD102/51

The next 3 m gravity corer at this site was deployed at 04:50. It reached the bottom at 06:17 with 3597 m of wire out within 20 m of the target. There was a small strain of 4.5 tonnes on pull out and the core was found to be empty, apart from a small amount of carbonate ooze in the core catcher.

Station CD102/52

The 3 m gravity core was once more deployed at target 14. This time it was decided to aim for the position of the successful box corer to the west of the target as it was thought that the addition of the fifth transponder to the net may have altered the navigation slightly. The corer was deployed at 07:55 and reached bottom at 09:03. The wire out was 3606 and the corer was ~70 m NW of the target. There was a good strain of 5 tonnes on pull out.

The core was recovered on deck at 10:15 and was found to contain 2.57 m of sediment. The upper 25-30 cm was iron-stained carbonate ooze that graded quickly into progressively more red hydrothermal oxides. The core was cut into three sections, consisting of the lower 80 cm, middle 80 cm and upper 90 cm.

Station CD102/53

The multi-corer was deployed at target 14 at 11:26 in 3550 m of water. The package hit the bottom at 13:08 with 3601 m of wire out. At this point the corer was ~60 m NW of the target.

When the core was recovered on deck at 14:48 it was found to contain 10 tubes of sediment. All the subcores showed the same basic features, although the thickness and continuity of the green layer varied between subcores, as did the extent of the red hydrothermal rubble at the base of the subcores. In subcore A the upper 12 cm were composed of iron stained, light tan, carbonate ooze. Between 12-14 cm there was a semi-continuous layer of green sediment and from 14-23 cm there was red-brown hydrothermal rubble. Subcore B was similar to A, except that the lower portion of the core consisted predominantly of iron-stained carbonate ooze, with only minor amounts of red-brown hydrothermal sediment. Subcores C and D were like B. Subcore E was similar to B, except for the presence of a 2 cm fragment of red-brown hydrothermal oxide embedded in the carbonate sediment at 20 cm. Subcore F was the same as subcore E, except that the green layer was less continuous. Subcores G and H were similar to subcore F. Subcore I was similar to subcore F, except that the green colour was more developed and continuous. Subcore J was similar to subcore I.

Station CD102/54

A 3 m gravity core was deployed at target 9 at 15:47 in 3443 m of water. The objective was to try and recover sulphide sediments that were found in the base of core CD102/31. The corer reached bottom at 16:48 with 3508 m of wire out ~30 m WSW of the target. There was only a 4.5 tonne pull out, and when the corer was recovered on deck at 18:10 it was found to contain only a handful of oxidised rubble.

Station CD102/55

The 3 m gravity corer was deployed at target 9 at 18:35, with same objectives as the previous core. The corer reached bottom at 19:52 with 3485 m of wire out at about ~50 m S of the target. The pull out was ambiguous, increasing momentarily to 5 tonnes and then falling back to 4.25 tonnes. This may indicate that the corer did initially have a lot of sediment, but that it fell out during extraction of the corer from the sea bed. When the core was brought back on deck at 21:14 it was found to contain 79 cm of coarse-grained red hydrothermal sediment.

Station CD102/56

It was decided to retrieve a box core from the same spot where the multi-core at CD102/25 had been taken. Accordingly, the box corer was deployed at 21:40 at target 11. The corer reached bottom at 23:07 with 3455 m of wire out. At this point it was 25 m SW of the target. The pull out strain was 4.75 tonnes.

When the corer was recovered on deck at 00:48 (26/9/96) it was found to be nearly full of hydrothermal sediment. The sediment water interface was covered with what appeared to be weathered chimney fragments up to 10 cm across. They were

colonised by a large number of small organisms. The upper few centimetres consisted of iron stained carbonate ooze which gave way to coarse grained hydrothermal sediments. The colours varied from yellow through to bright red and brown. At a depth of about 20 cm in the core there were discontinuous vughs of atacamite. One large subcore was taken for pore water extraction, one small subcore was taken for microbiological analysis, two were taken for archive in Bristol and one was taken for analysis of hydride forming elements at SOC.

Station CD102/57

To complete the operations at target 11 a 3 m gravity core was deployed at 01:38. It reached bottom at 02:54 with 3459 m of wire out ~100 m SSW of the target. There was a pull out of 4.75 tonnes. When the core was recovered it was found to contain 140 cm of sediment, consisting of carbonate ooze grading into red and then green altered sediments.

Station CD102/58

A 3 m gravity core was deployed at target 14 at 04:47 in 3541 m of water. The corer reached bottom at 06:15 with 3605 m of wire out. There was a 5 tonnes pull out. When the corer was recovered it was found to contain 2 m of sediment, consisting of carbonate ooze overlying altered hydrothermal material that graded form green to red to brown.

Station CD102/59

Another attempt was made for the sulphides at site nine with the 3 m gravity corer. It was deployed at 08:16 and reached bottom at 10:09 with 3465 m of wire out. The navigation system was erratic during this operation so the package may have been either 30 m NE or almost on the target. The pull out strain was less than 4.5 tonnes and only 24 cm of oxide rubble was recovered in the core.

Station CD102/60

Another target (sulphide) was designated at 26°08.47'N, 44°48.47'W and the 3 m gravity corer was deployed at 10:40. Further navigation problems meant that we had to leave the corer hanging at 750 m wire out until reasonable fixes were once more obtained. The corer reached bottom at 13:38 with 3509 m of wire out ~50 m W of the target. Pull out strain was 4.5 tonnes. The core was found to contain 112 cm of sediment. The upper 25 cm consisted of heavily iron-stained carbonate sediment grading into green and red, altered, hydrothermal sediment. The whole core was archived.

Station CD102/61

A 3 m gravity core was deployed at 13:38 at the sulphide target. The corer reached the bottom at 16:56 with 3500 m of wire out. The package was 30 m SW of the target. There was a 4.5 tonne pull out and when recovered the corer was found to contain 30 cm of carbonate ooze and hydrothermal fragments.

Station CD102/62

To check on the nutrient analyses an unacidified surface sea water sample was collected from the z-boat approximately 500 m upwind of the Darwin.

Station CD102/63

A box corer was deployed on the sulphide site at 18:52 in 3430 m of water. The corer hit the bottom at 20:33 with 3470 m of wire out. The package was 20 m NE of the target and the pull out load was 4.5 tonnes. When the box corer was brought on deck it had not tripped, possibly as a result of the sliding bolt near the shackle sticking.

Station CD102/64

The box corer was deployed at the same site at 22:20. The package reached the bottom at 23:47 with 3486 m of wire out at 40 m S of the target. There was a 4.5 tonne strain on pull out. Unfortunately the wire had caught round the arm of the box corer during pull out preventing the spade from sealing properly. Hence, there was only ~4 cm of sediment in the bottom of the box when it was recovered. This consisted of a thick oxide crust overlying oxidised hydrothermal rubble, including some atacamite.

Station CD102/65

The box corer was redeployed at the same site at 01:50 (27/9/96). The corer reached bottom at 03:22 with 3485 m of wire out. The package was 25 m S of the target. When it was recovered it was found that a fist-sized chunk of basalt had jammed in the box of the corer, preventing it from sealing.

Station CD102/66

The multi-corer was deployed at 06:14 at the sulphide site. At 07:29 the package reached the bottom, 40 m S of the target with 3501 m of wire out. Only 4 of the multi-corer tubes had sealed and they only contained 4 cm of sediment. This consisted of dark red hydrothermal sediment with light coloured sandy flecks. Portions were taken for microbiological and geochemical analysis.

Station CD102/67

Recovery of the transponders commenced at 08:20 and proceeded without incident and all five were recovered by 15:50.

Station CD102/68

Our next operation was to core the active TAG mound using the 3 m gravity corer. As the transponders had been recovered all navigation was by GPS, hence it was decided to simply aim for the centre of the TAG mound at 26°08.20'N, 44°49.65'W. The 3 m gravity corer was deployed at 16:15 and reached bottom at 17:23 with 3666 m of wire out. At this point the ship position was 26°08.20'N, 44°49.64'W. There was a 4.75 tonnes strain on pull out and when the corer was recovered it was found to contain 47 cm of coarse grained hydrothermal oxide, together with some silica. The whole core was archived.

Station CD102/69

The 3 m gravity corer was deployed at the same site at 19:01. The corer reached the bottom at 20:19 with 3693 m of wire out. At this point the ship position was 26°08.20'N, 44°49.61'W. The pull out strain was only 4.5 tonnes and when the corer was recovered at 21:39 it was found to only contain about 15 cm of carbonate ooze, together with a few chips of basalt.

Station CD102/70

The 3 m gravity corer was again targeted at the TAG mound at 21:49. The corer reached the bottom at 22:57, with 3678 m of wore out and the position of the ship was at 26°08.19'N, 44°49.64'W. There was only a 4.5 tonne pull out strain and when the corer was recovered it was found to only contain about 10 cm of carbonate ooze.

Operations were completed at 00:25 (28/9/96) and, after securing gear, the ship headed for Ponta Delgada.

The ship made good time during the passage and arrived off Ponta Delgada early in the morning of the 3rd October. The scientific party were disembarked by boat transfer onto a tug boat inside the harbour. The flat water ensured that there were no problems during this transfer. However, it was fortunate that no equipment was required to be transferred between the boats. The tug boat had no craning facilities and the gang plank onto the dockside was narrow and uneven, so that it would have been very difficult to transfer any bulky gear.

A summary of the station operations are presented in Appendix 1.

SCIENTIFIC REPORTS

Mooring Recovery

The recovery of the moorings proceeded exceptionally well. All the rigs released on command, were immediately spotted when they reached the surface and were recovered on deck without problems. The smooth running of this operation was a reflection of the very good weather (light winds and good visibility) and the professionalism of the deck crew.

The only problems were encountered after the rigs were recovered on deck. These problems were all related to high-pressure flooding of the pressure cases. One Aandera RCM exploded on the after deck immediately after recovery. Another RCM was found to be under pressure during attempts to open it in the main laboratory and was dismantled on deck. Two other instruments had flooded, but there was no significant pressure build-up.

Coring

The gravity corer was deployed a total of 40 times; of which 32 deployments were with the 3 m barrel, 2 were with the 2 m barrel and 6 were with the 1 m barrel. There were no equipment failures and substantial amounts of sediment were recovered on 17 deployments (15 with the 3 m corer and 2 with the 1 m corer). This represents an overall success rate of 42.5%.

The box corer was deployed a total of 10 times. Of these, 4 deployments were successful in retrieving substantial amounts of sediment that could be subsampled and analysed. Two deployments were unsuccessful as a result of normal operational difficulties. In one case the spade was jammed by a chunk of rock and in the other case the corer had not fully hit the bottom before it was recovered. In four cases the deployments were unsuccessful due to equipment failure. In two cases the spade failed to seal the bottom of the corer and the sediment was flushed out during recovery, in one case the trigger bar (just below the top shackle) jammed and in the other case the coring warp got caught round the spade. The problems with the box corer are discussed in more detail in the recommendations section.

The multi-corer was deployed a total of 5 times. Of these 4 deployments were successful in recovering sufficient sediment for experimental work and one failed, probably due to the corer hitting hard ground.

Copies of the cruise track in the TAG coring area and the positions of the corers are given in Appendix 2. The screen dumps used for positioning the corers within the acoustic navigation network are presented in Appendix 3.

RECOMMENDATIONS

The boat transfer to embark the scientific party at Ponta Delgada was carried out under near perfect conditions of lights winds, no rain, good visibility and a low swell. Despite this, the transfer was potentially hazardous with individuals having to step across a 0.5-1.0 m gap between the Charles Darwin and the tug and negotiate a vertical variation of up to 2 m between the two sides of the transfer point (next to the starboard winch on the Darwin). None of the tug's crew spoke English, so that the possibilities of confusion during the transfer were increased. A slight loss of footing could have resulted in someone falling between the two ships, with potentially dangerous consequences. In addition, gear had to be passed by hand between the two vessels, with the potential for loss over the side. If the weather had been any less clement the transfer would have been too hazardous to have even been attempted.

I would recommend that boat transfers do not take place outside the harbour at Ponta Delgada and that future embarkation of personnel takes place with the ship tied alongside or, at the very least, within the sheltered confines of the harbour where the swell is minimal.

The recovery of the moorings was exceptionally rapid, with all eight being brought on board in only two days of daylight operations. It should be emphasised that the speed of the operation was due to the exceptionally fine weather conditions and the 100% first-time success rate of the release triggers. Hence, the rapid recovery of moorings at Broken Spur should not be taken as a guideline to reduce the time allotted to future mooring recovery operations.

The flooding of several of the instruments on the moorings caused some problems. The high-pressure flooded instrument that was dismantled on deck required a device to be made *ad hoc* to allow a gradual release of the pressure case end cap. This comprised two long threaded rods with plates bolted to each end. The nuts were backed off slowly to allow a controlled release of the internal pressure. During this operation the O-ring ruptured catastrophically on being exposed. This released a high-pressure jet of water and battery acid into the face of the operator. Fortunately, this incident did not result in any injuries, but a better solution for dismantling high-pressure flooded instruments needs to be considered and implemented.

It became apparent early in the cruise that a number of items that were vital to operations had not been fully checked and tested before being loaded on the ship.

The fish used to trigger the acoustic releases on the moorings worked fine on deck, but a leak in one of the couplings meant that it failed immediately it was deployed.

The conducting cable to the fish used in operating the transponder net was found to have a short in the final section. Apparently this fault had been identified on a previous cruise and the cable had been sent for repair and returned to RVS in a supposedly working state. Clearly, this piece of equipment had not been adequately tested prior to CD 102.

Serious problems were encountered with the box corer. My understanding is that the corer had been damaged during a previous cruise and repaired prior to loading on CD 102. However, it quickly became apparent that the corer was not in working order, in particular there were major difficulties in getting the spade to provide an adequate and reliable seal to the box. RVS technicians and deck hands spent considerable time with welding and grinding equipment trying to rectify the problem. For the RVS personnel this meant that it was very difficult for them to take their required rest periods and maintain the level of service that had been promised for CD 102.

It is clear that there had not been adequate time for checking and testing of equipment vital to the scientific success of CD 102. This cruise formed the essential core of a >£200,000 grant made to the PSO by the BRIDGE/NERC programme. The failure to provide the level of support that had been promised at the cruise planning meeting is serious. If further time was required for preparation of equipment this should have been brought to the PSO's attention at the cruise planning meeting so that CD 102 could have been rescheduled or alternative ship time to purchased.

ACKNOWLEDGEMENTS

As usual, the officers and crew of the RRS Charles Darwin provided efficient and skilful support of all operations. The coring targets were very small and in all

cases the officers on the bridge were able to deliver the package to with 100 m of the target, and in most cases within 50 m (including several direct hits within 10 m!).

Dave Dunster and Derrick Rees did a first class job in getting the box corer into working shape despite the fact that they had been given a poorly prepared piece of equipment to start with. They were ably assisted by Simon Mitchell during deployment of the corers. Dave Boothe, Rod Pearce and Phil Taylor provided a very efficient service in running the acoustic navigation and in deploying and recovering the various moorings.

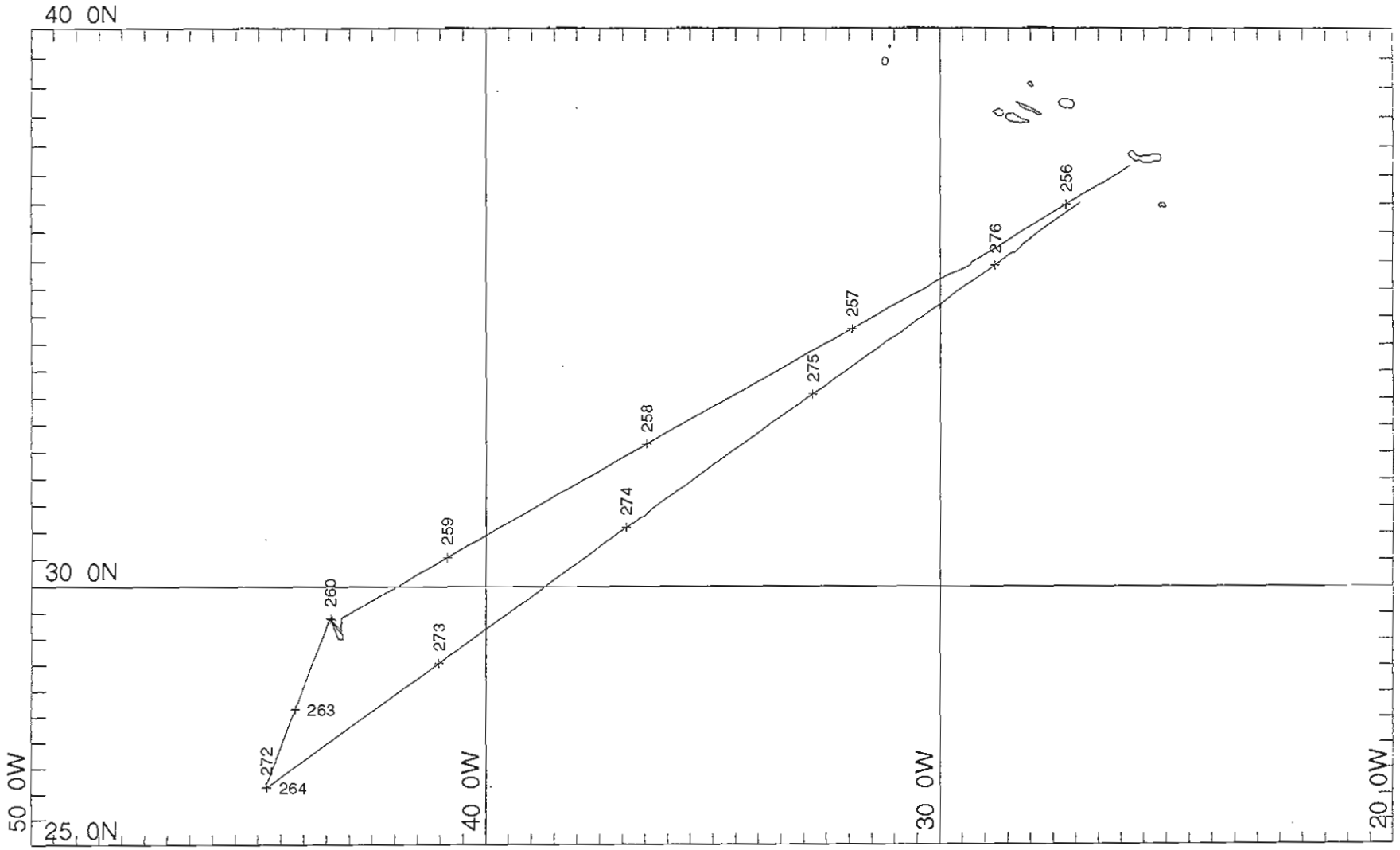
The funding for the coring part of this cruise was a NERC/BRIDGE research grant awarded to M.R. Palmer, R.J. Parkes and R.A. Mills. The recovery of the moorings was funded by a NERC/BRIDGE research grant awarded to C.R. German and B.J. Murton.

APPENDIX 1: STATION SUMMARY

Station	Date	Time	Latitude	Longitude	Activity	Comments
CD102/01	15/09	14:10	29°23.90'N	43°10.53'W	Mooring recovery	successful
CD102/02	15/09	17:20	29°09.97'N	43°10.44'W	Mooring recovery	successful
CD102/03	15/09	19:15	29°07.18'N	43°11.31'W	Mooring revovery	succesful
CD102/04	15/09	23:30	29°23.00'N	43°25.00'W	Box core	returned empty due to equipment failure
CD102/05	16/09	08:46	29°00.08'N	43°14.32'W	Mooring recovery	successful
CD102/06	16/09	11:24	29°00.17'N	43°11.81'W	Mooring recovery	successful
CD102/07	16/09	14:23	29°00.05'N	43°09.72'W	Mooring recovery	successful
CD102/08	16/09	16:35	29°00.16'N	43°07.92'W	Mooring recovery	successful
CD102/09	16/09	19:28	29°10.54'N	43°10.29'W	Mooring recovery	successful
CD102/10	16/09	23:13	29°23.54'N	43°24.91'W	3 m Gravity core	2.21 m of sediment
CD102/11	17/09	14:45	29°23.44'N	43°24.92'W	Multi-corer	30 cm of carbonate sediment
CD102/12	17/09	19:45	29°23.28'N	43°24.79'W	Box corer	failed to trigger (did not hit bottom?)
CD102/13	18/09	09:35	29°23.64'N	43°24.92'W	Box corer	36 cm of carbonate sediment
CD102/14	19/09	10:15	26°09.44'N	44°50.23'W	Sound velocity	successful
CD102/15	19/09	13:50	26°11.00'N	44°49.00'W	Swath bathymetry	successful
CD102/16	19/09	17:50	26°07.90'N	44°48.10'W	Transponder net	successful
CD102/17	20/09	03:52	26°08.64'N	44°48.40'W	1 m Gravity core	77 cm of sediment
CD102/18	20/09	07:00	26°08.65'N	44°48.40'W	3 m Gravity core	2.21 m of sediment
CD102/19	20/09	11:04	26°08.60'N	44°48.22'W	Box corer	33 cm of sediment
CD102/20	20/09	14:50	26°08.65'N	44°48.68'W	1 m Gravity core	only a few basalt chips recovered
CD102/21	20/09	17:50	26°08.65'N	44°48.50'W	1 m Gravity core	only a few sulphide chips recovered
CD102/22	20/09	21:46	26°08.65'N	44°48.40'W	Multi-corer	failed to trigger (hard ground?)
CD102/23	21/09	02:10	26°08.80'N	44°48.45'W	1 m Gravity core	17 cm of sediment
CD102/24	21/09	05:30	26°08.65'N	44°48.30'W	1 m Gravity core	40 cm of sediment
CD102/25	21/09	08:57	26°08.65'N	44°48.40'W	Multi-corer	up to 15 cm of sediment
CD102/26	21/09	13:33	26°08.55'N	44°48.30'W	1 m Gravity core	some sediment stains, but core barrel empty
CD102/27	21/09	16:57	26°08.55'N	44°48.40'W	3 m Gravity core	1.20 m of sediment
CD102/28	21/09	20:20	26°08.55'N	44°48.40'W	3 m Gravity core	only a few oxide and rock chips recovered
CD102/29	21/09	21:09	26°08.55'N	44°48.40'W	3 m Gravity core	only a small amount of red oxides recovered
CD102/30	22/09	02:30	26°08.55'N	44°48.40'W	3 m Gravity core	15 cm of carbonate ooze
CD102/31	22/09	05:40	26°08.55'N	44°48.40'W	3 m Gravity core	20 cm of grey sulphides/sulphates
CD102/32	22/09	08:46	26°08.55'N	44°48.40'W	3 m Gravity core	1.52 m of sediment
CD102/33	22/09	12:48	26°08.55'N	44°48.40'W	2 m Gravity core	only a few fragments of silicified sediment
CD102/34	22/09	16:46	26°08.45'N	44°48.46'W	2 m Gravity core	unsuccessful

Station	Date	Time	Latitude	Longitude	Activity	Comments
CD102/35	22/09	20:26	26°08.60'N	44°48.40'W	3 m Gravity core	small amount of red oxides
CD102/36	23/09	00:10	26°08.60'N	44°48.40'W	3 m Gravity core	10 cm of carbonate and red oxides
CD102/37	23/09	04:20	26°08.60'N	44°48.40'W	3 m Gravity core	30 cm of carbonate overlying 1 m of red rubble
CD102/38	23/09	06:31	26°08.56'N	44°48.37'W	3 m Gravity core	oxide rubble in core catcher
CD102/39	23/09	09:10	26°08.55'N	44°48.45'W	3 m Gravity core	10 cm of red oxide rubble and black oxide crust
CD102/40	23/09	14:05	26°08.65'N	44°48.50'W	3 m Gravity core	handful of weathered chimney material
CD102/41	23/09	18:42	26°09.25'N	44°48.90'W	3 m Gravity core	1.41 m of sediment
CD102/42	23/09	21:34	26°09.25'N	44°48.90'W	3 m Gravity core	1.82 m of sediment
CD102/43	24/09	00:26	26°09.25'N	44°48.90'W	3 m Gravity core	2.21 m of sediment
CD102/44	24/09	03:36	26°09.25'N	44°48.90'W	3 m Gravity core	a few fragments of sulphides
CD102/45	24/09	06:57	26°09.25'N	44°48.90'W	3 m Gravity core	1.19 m of sediment
CD102/46	24/09	11:30	26°10.00'N	44°49.00'W	transponder	successful
CD102/47	24/09	14:28	26°09.25'N	44°48.90'W	Box core	40 cm of sediment
CD102/48	24/09	18:20	26°09.25'N	44°48.90'W	Box core	unsuccessful due to equipment failure
CD102/49	24/09	22:29	26°09.25'N	44°48.90'W	3 m Gravity core	handful of carbonate ooze
CD102/50	25/09	01:35	26°09.25'N	44°48.90'W	3 m Gravity core	52 cm of sediment
CD102/51	25/09	04:50	26°09.25'N	44°48.90'W	3 m Gravity core	handful of carbonate ooze
CD102/52	25/09	07:55	26°09.25'N	44°48.90'W	3 m Gravity core	2.57 m of sediment
CD102/53	25/09	11:26	26°09.25'N	44°48.90'W	Multi-corer	25 cm of sediment
CD102/54	25/09	15:47	26°08.55'N	44°48.40'W	3 m Gravity core	handful of oxidised rubble
CD102/55	25/09	18:35	26°08.55'N	44°48.40'W	3 m Gravity core	79 cm of coarse grained red sediment
CD102/56	25/09	21:40	26°08.60'N	44°48.40'W	Box corer	40 cm sediment
CD102/57	26/09	01:38	26°08.55'N	44°48.40'W	3 m Gravity core	1.40 m of sediment
CD102/58	26/09	04:47	26°09.25'N	44°48.90'W	3 m Gravity core	2.00 m of sediment
CD102/59	26/09	08:16	26°08.55'N	44°48.40'W	3 m Gravity core	24 cm of sediment
CD102/60	26/09	13:38	26°08.45'N	44°48.45'W	3 m Gravity core	1.12 m of sediment
CD102/61	26/09	15:29	26°08.45'N	44°48.45'W	3 m Gravity core	30 cm of sediment
CD102/62	26/09	16:00	26°09.00'N	44°49.00'W	Surface water sample	successful
CD102/63	26/09	18:52	26°08.55'N	44°48.40'W	Box corer	unsuccessful due to equipment failure
CD102/64	26/09	22:20	26°08.55'N	44°48.40'W	Box corer	unsuccessful due to equipment failure
CD102/65	27/09	01:50	26°08.55'N	44°48.40'W	Box corer	rock wedged in jaws
CD102/66	27/09	06:14	26°08.55'N	44°48.40'W	Multi-corer	4 tubes containing 4 cm of sediment
CD102/67	27/09	08:20	26°07.90'N	44°48.10'W	Transponder recovery	successful
CD102/68	27/09	16:15	26°08.20'N	44°49.65'W	3 m Gravity core	47 cm of sediment
CD102/69	27/09	19:01	26°08.20'N	44°49.65'W	3 m Gravity core	15 cm of sediment
CD102/70	27/09	21:49	26°08.20'N	44°49.65'W	3 m Gravity core	10 cm of sediment

Station	Date	Time	Latitude	Longitude	Activity	Comments
CD102/35	22/09	20:26	26°08.60'N	44°48.40'W	3 m Gravity core	small amount of red oxides
CD102/36	23/09	00:10	26°08.60'N	44°48.40'W	3 m Gravity core	10 cm of carbonate and red oxides
CD102/37	23/09	04:20	26°08.60'N	44°48.40'W	3 m Gravity core	30 cm of carbonate overlying 1 m of red rubble
CD102/38	23/09	06:31	26°08.56'N	44°48.37'W	3 m Gravity core	oxide rubble in core catcher
CD102/39	23/09	09:10	26°08.55'N	44°48.45'W	3 m Gravity core	10 cm of red oxide rubble and black oxide crust
CD102/40	23/09	14:05	26°08.65'N	44°48.50'W	3 m Gravity core	handful of weathered chimney material
CD102/41	23/09	18:42	26°09.25'N	44°48.90'W	3 m Gravity core	1.41 m of sediment
CD102/42	23/09	21:34	26°09.25'N	44°48.90'W	3 m Gravity core	1.82 m of sediment
CD102/43	24/09	00:26	26°09.25'N	44°48.90'W	3 m Gravity core	2.21 m of sediment
CD102/44	24/09	03:36	26°09.25'N	44°48.90'W	3 m Gravity core	a few fragments of sulphides
CD102/45	24/09	06:57	26°09.25'N	44°48.90'W	3 m Gravity core	1.19 m of sediment
CD102/46	24/09	11:30	26°10.00'N	44°49.00'W	transponder	successful
CD102/47	24/09	14:28	26°09.25'N	44°48.90'W	Box core	40 cm of sediment
CD102/48	24/09	18:20	26°09.25'N	44°48.90'W	Box core	unsuccessful due to equipment failure
CD102/49	24/09	22:29	26°09.25'N	44°48.90'W	3 m Gravity core	handful of carbonate ooze
CD102/50	25/09	01:35	26°09.25'N	44°48.90'W	3 m Gravity core	52 cm of sediment
CD102/51	25/09	04:50	26°09.25'N	44°48.90'W	3 m Gravity core	handful of carbonate ooze
CD102/52	25/09	07:55	26°09.25'N	44°48.90'W	3 m Gravity core	2.57 m of sediment
CD102/53	25/09	11:26	26°09.25'N	44°48.90'W	Multi-corer	25 cm of sediment
CD102/54	25/09	15:47	26°08.55'N	44°48.40'W	3 m Gravity core	handful of oxidised rubble
CD102/55	25/09	18:35	26°08.55'N	44°48.40'W	3 m Gravity core	79 cm of coarse grained red sediment
CD102/56	25/09	21:40	26°08.60'N	44°48.40'W	Box corer	40 cm sediment
CD102/57	26/09	01:38	26°08.55'N	44°48.40'W	3 m Gravity core	1.40 m of sediment
CD102/58	26/09	04:47	26°09.25'N	44°48.90'W	3 m Gravity core	2.00 m of sediment
CD102/59	26/09	08:16	26°08.55'N	44°48.40'W	3 m Gravity core	24 cm of sediment
CD102/60	26/09	13:38	26°08.45'N	44°48.45'W	3 m Gravity core	1.12 m of sediment
CD102/61	26/09	15:29	26°08.45'N	44°48.45'W	3 m Gravity core	30 cm of sediment
CD102/62	26/09	16:00	26°09.00'N	44°49.00'W	Surface water sample	successful
CD102/63	26/09	18:52	26°08.55'N	44°48.40'W	Box corer	unsuccessful due to equipment failure
CD102/64	26/09	22:20	26°08.55'N	44°48.40'W	Box corer	unsuccessful due to equipment failure
CD102/65	27/09	01:50	26°08.55'N	44°48.40'W	Box corer	rock wedged in jaws
CD102/66	27/09	06:14	26°08.55'N	44°48.40'W	Multi-corer	4 tubes containing 4 cm of sediment
CD102/67	27/09	08:20	26°07.90'N	44°48.10'W	Transponder recovery	successful
CD102/68	27/09	16:15	26°08.20'N	44°49.65'W	3 m Gravity core	47 cm of sediment
CD102/69	27/09	19:01	26°08.20'N	44°49.65'W	3 m Gravity core	15 cm of sediment
CD102/70	27/09	21:49	26°08.20'N	44°49.65'W	3 m Gravity core	10 cm of sediment



RVS MERCATOR PROJECTION

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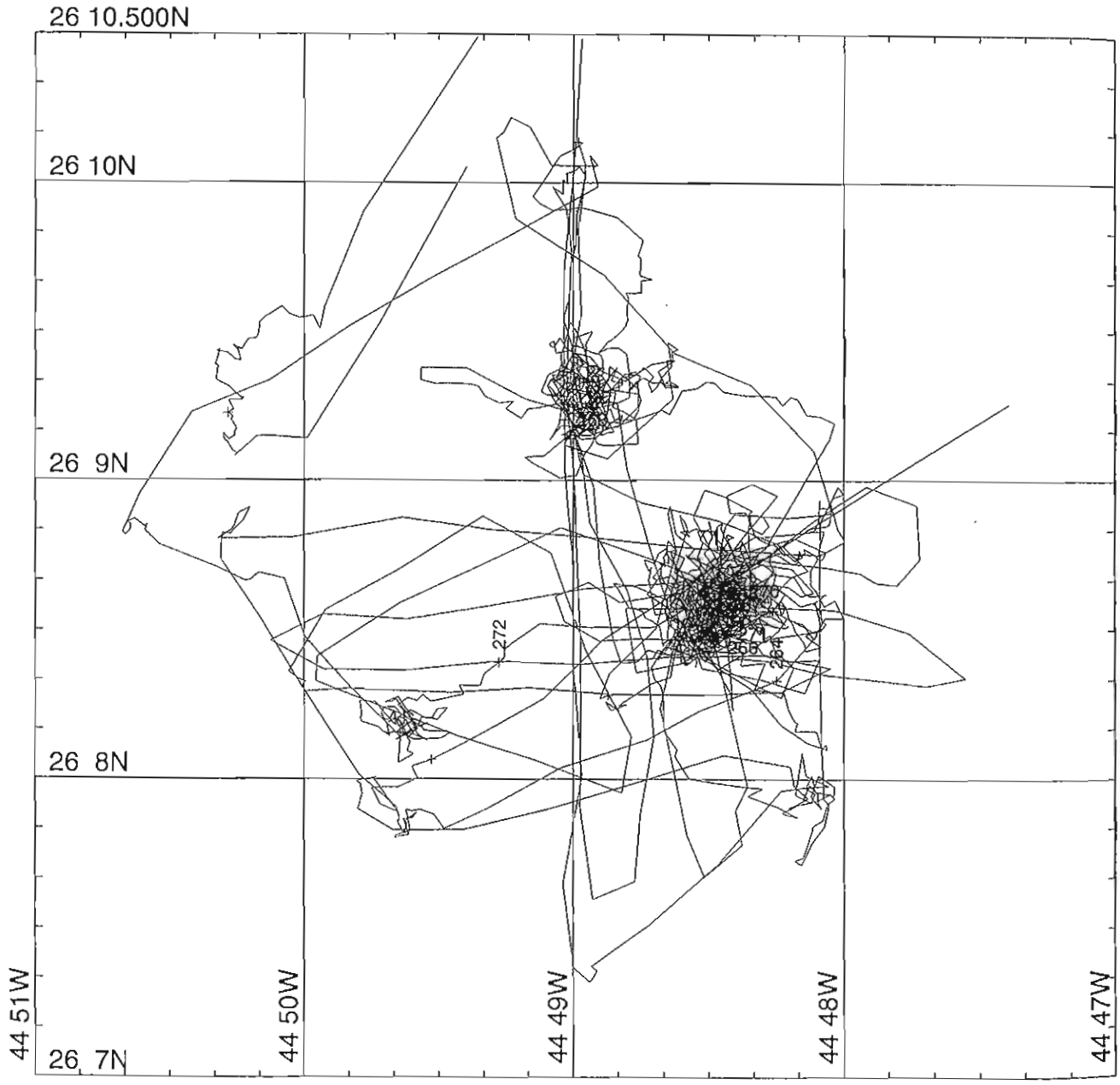
INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

RRS Charles Darwin Cruise 102 September 1996



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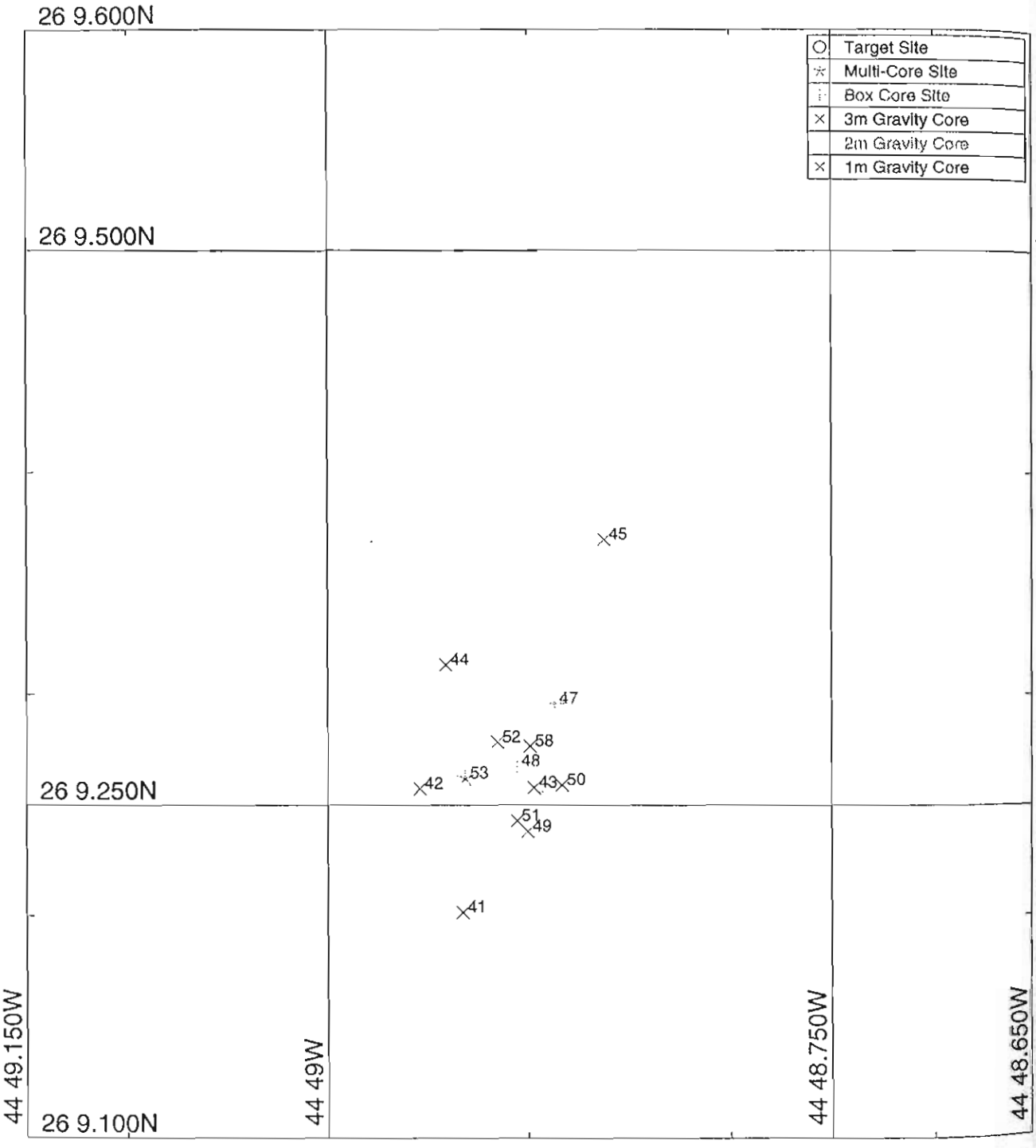
RRS Charles Darwin Cruise 102 Main Survey Area



MERCATOR PROJECTION

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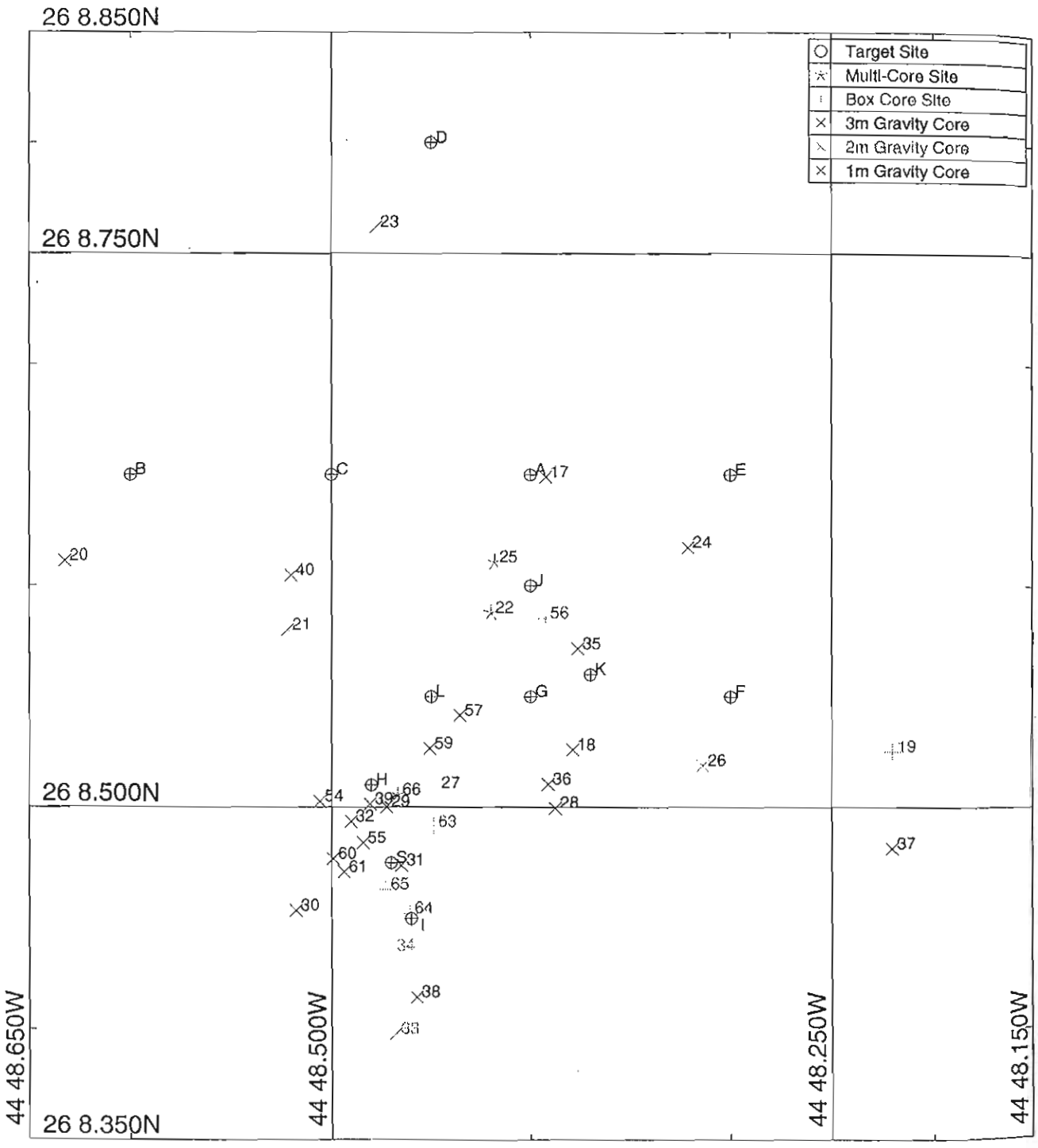
CD102 Acoustic Positions of Core Stations (North)



MERCATOR PROJECTION

GRID NO. 1

SCALE 1 TO 5000 (NATURAL SCALE AT LAT. 26)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

CD102 Acoustic Positions of Core Stations (South)

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Logging:ON Space:121M
Devices:OK Cyc:1011
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

Surf Nav Fix at
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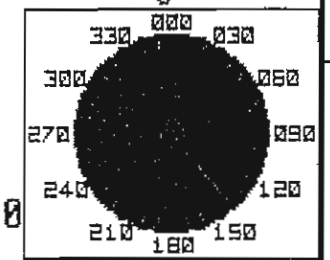
Rms: 0.00 Antenna: 1
Ship Acous Fix at SRO
X: 519339 Y: 2891772
Rms: 1.57 Z: -65.34
Using:1234 Rm: 1

Gyro:139.8 Cmg: 0.0
Set:
Drift:
Sp: 0.0



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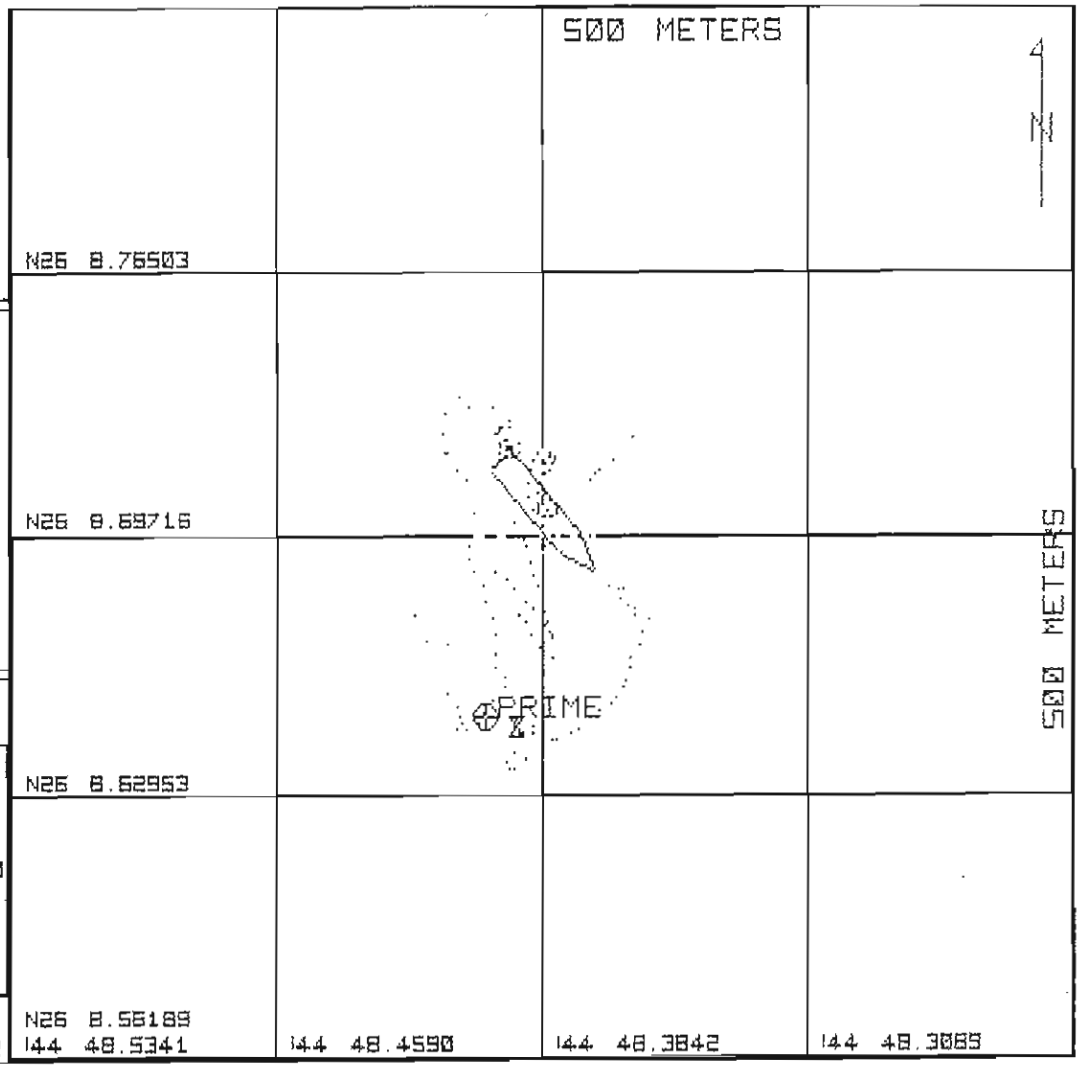

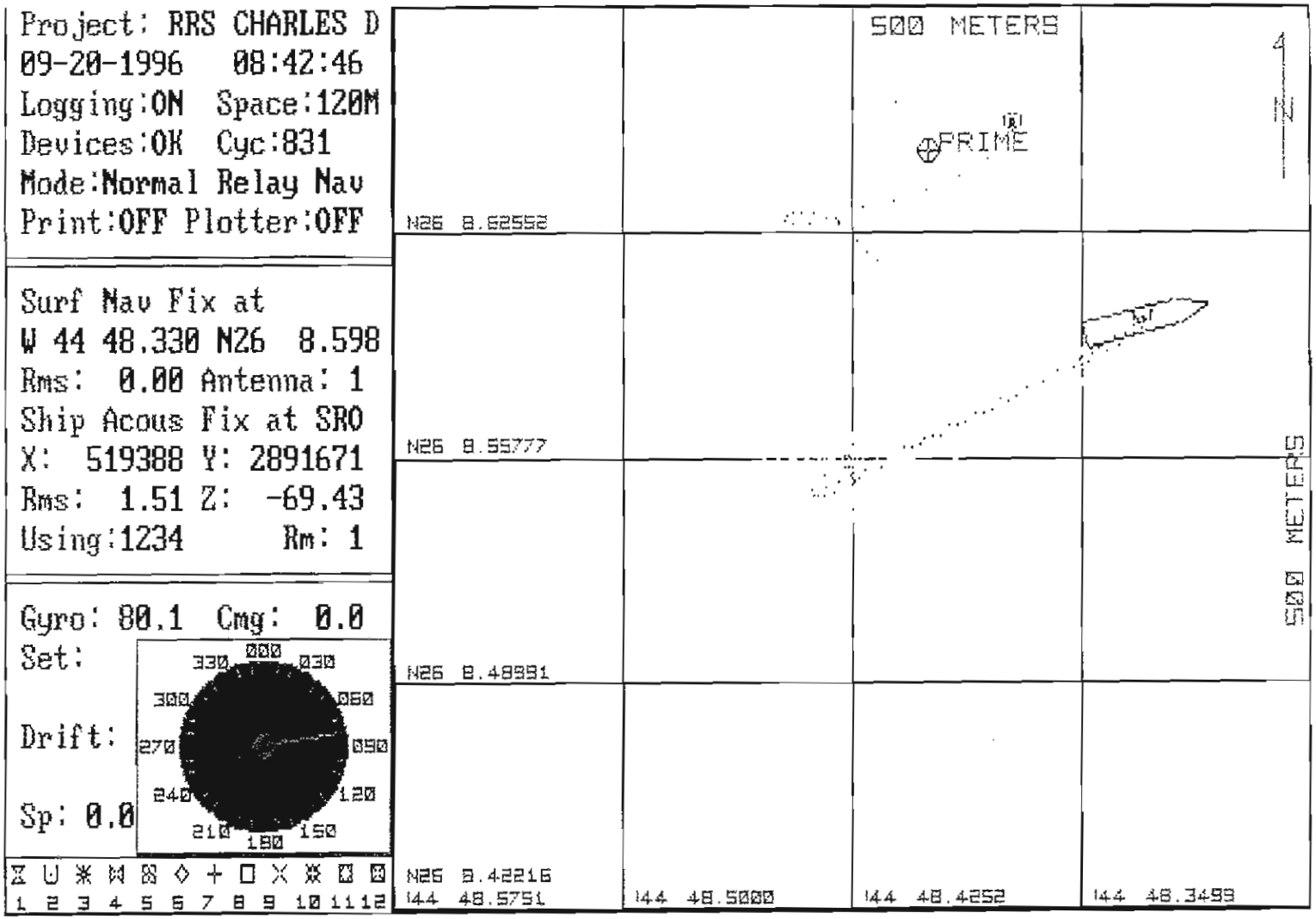
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Devices:OK Cyc:831
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Print:OFF Plotter:OFF
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Ship Acous Fix at SRO
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Rms: 1.51 Z: -69.43
Using:1234 Rm: 1
Gyro: 80.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
PRIME
N26 8.62552
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N26 8.48891
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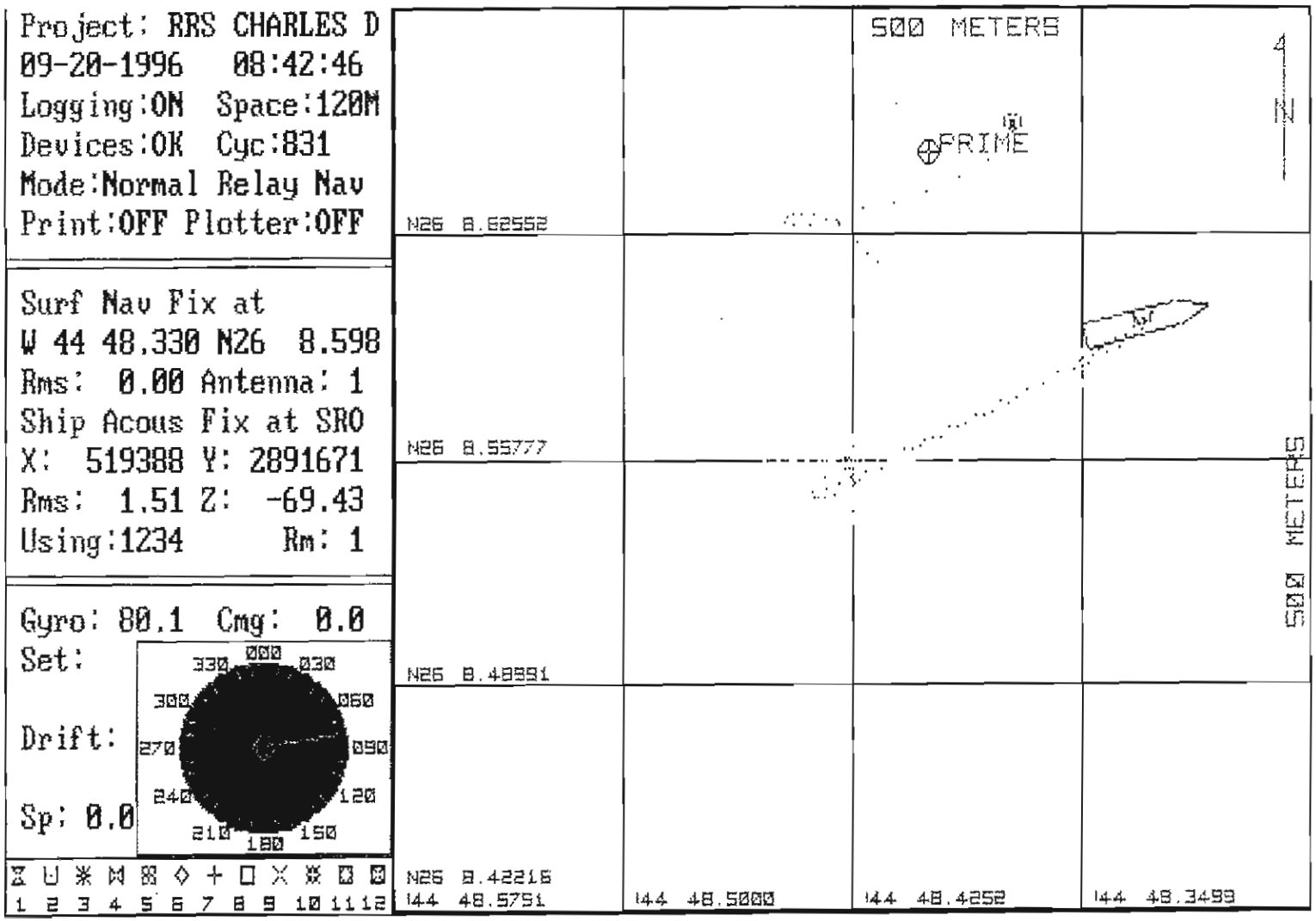
144 48.4252
144 48.3499
500 METERS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Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.330 N26 8.598
Rms: 0.00 Antenna: 1
Ship Acous Fix at SRO
X: 519388 Y: 2891671
Rms: 1.51 Z: -69.43
Using:1234 Rm: 1
Gyro: 80.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
PRIME
N
SRS 13M 005
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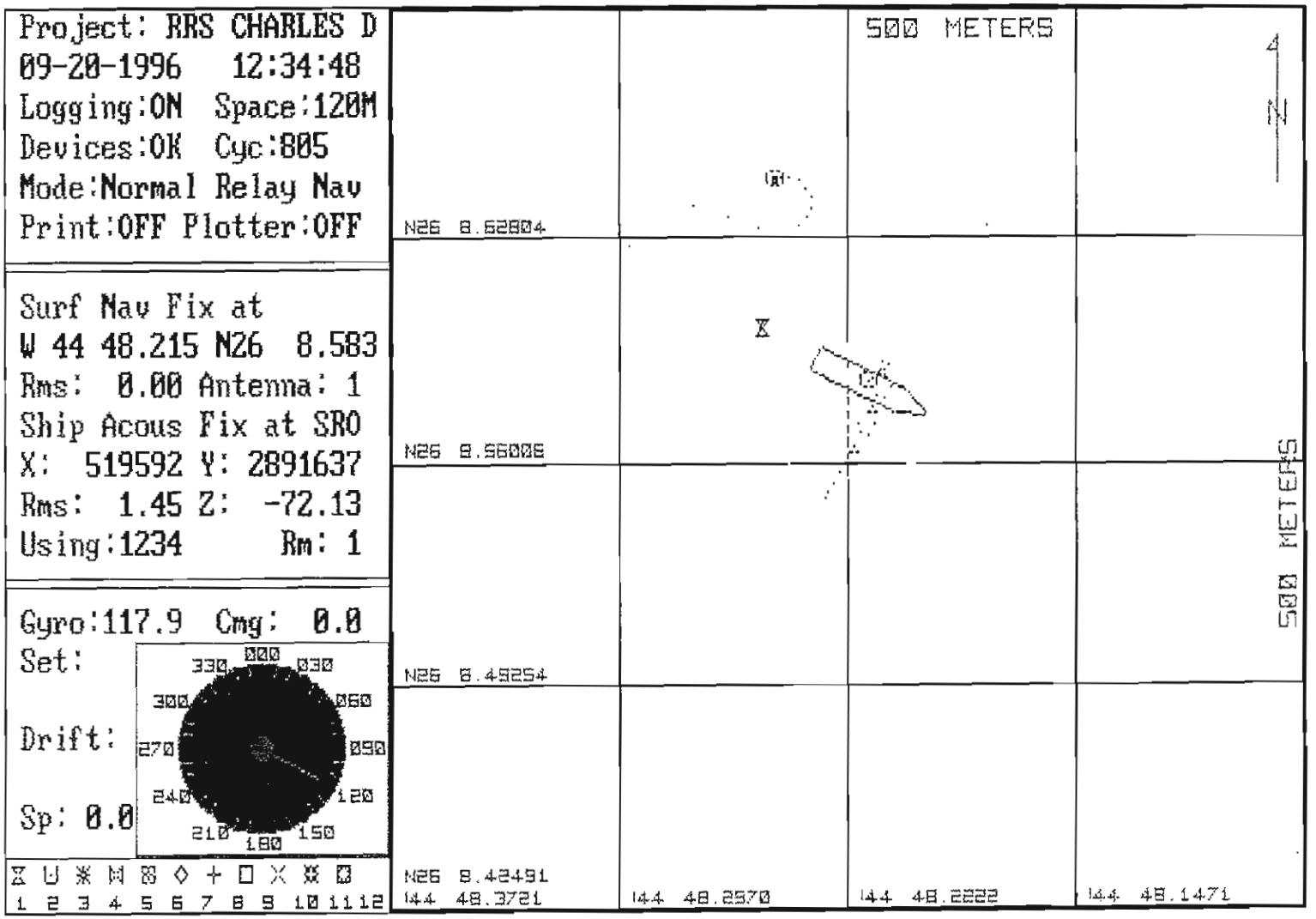
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Print:OFF Plotter:OFF
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Ship Acous Fix at SRO
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Using:1234 Rm: 1
Gyro:117.9 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
N
500 METERS
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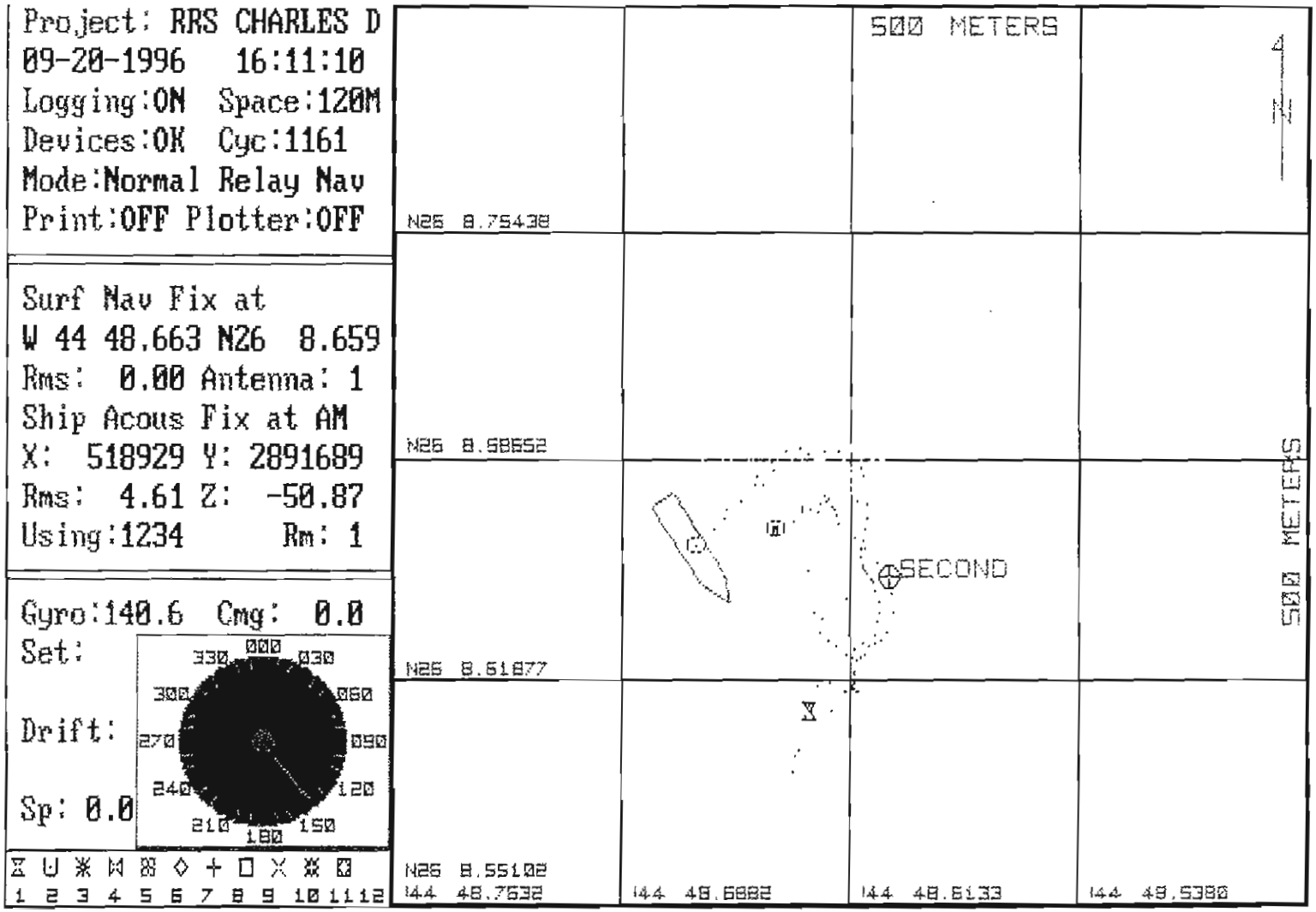
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Rms: 4.61 Z: -50.87
Using:1234 Rm: 1
Gyro:140.6 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
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SECOND
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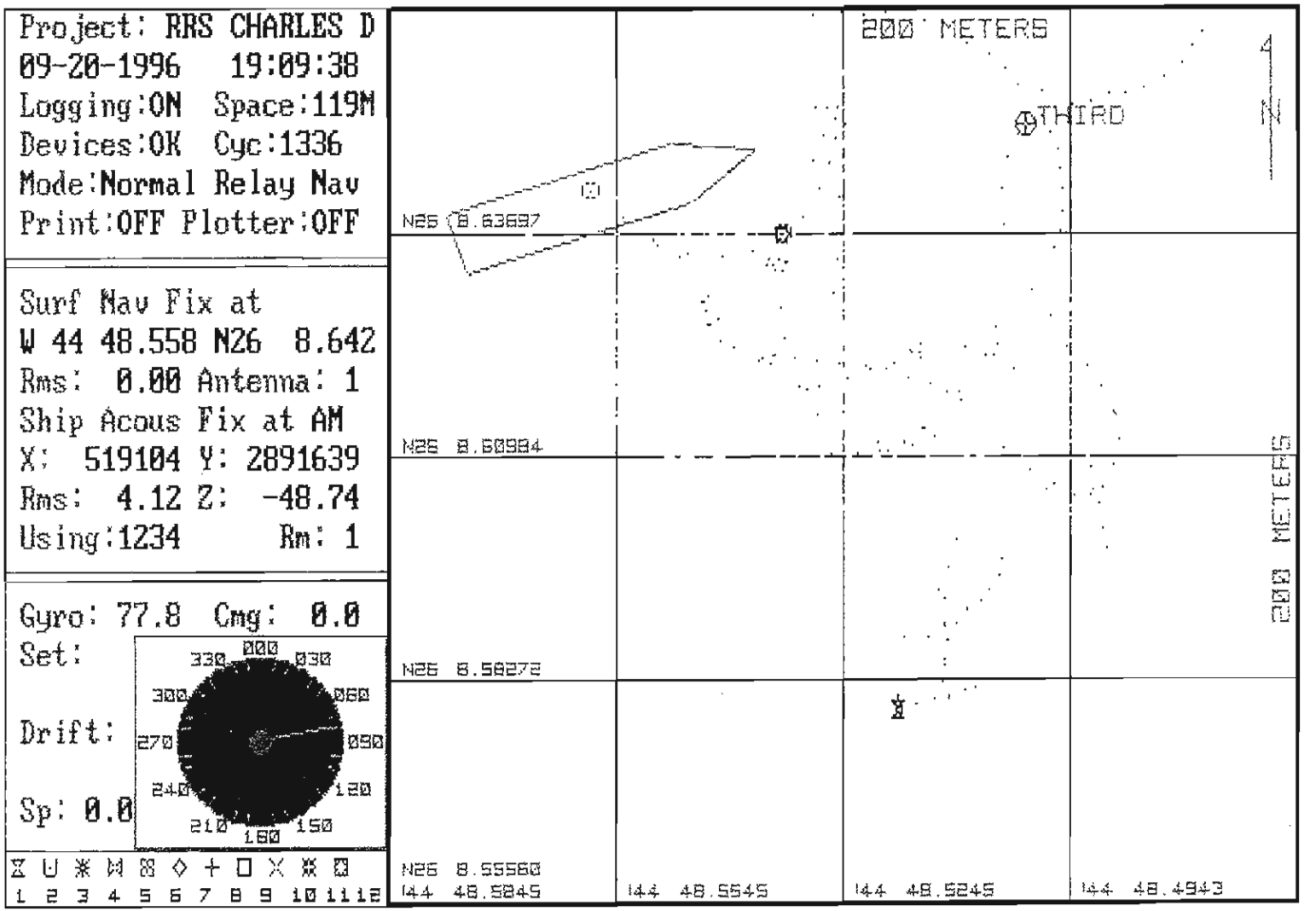
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Print:OFF Plotter:OFF
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Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
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THIRD
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N25 8.60984
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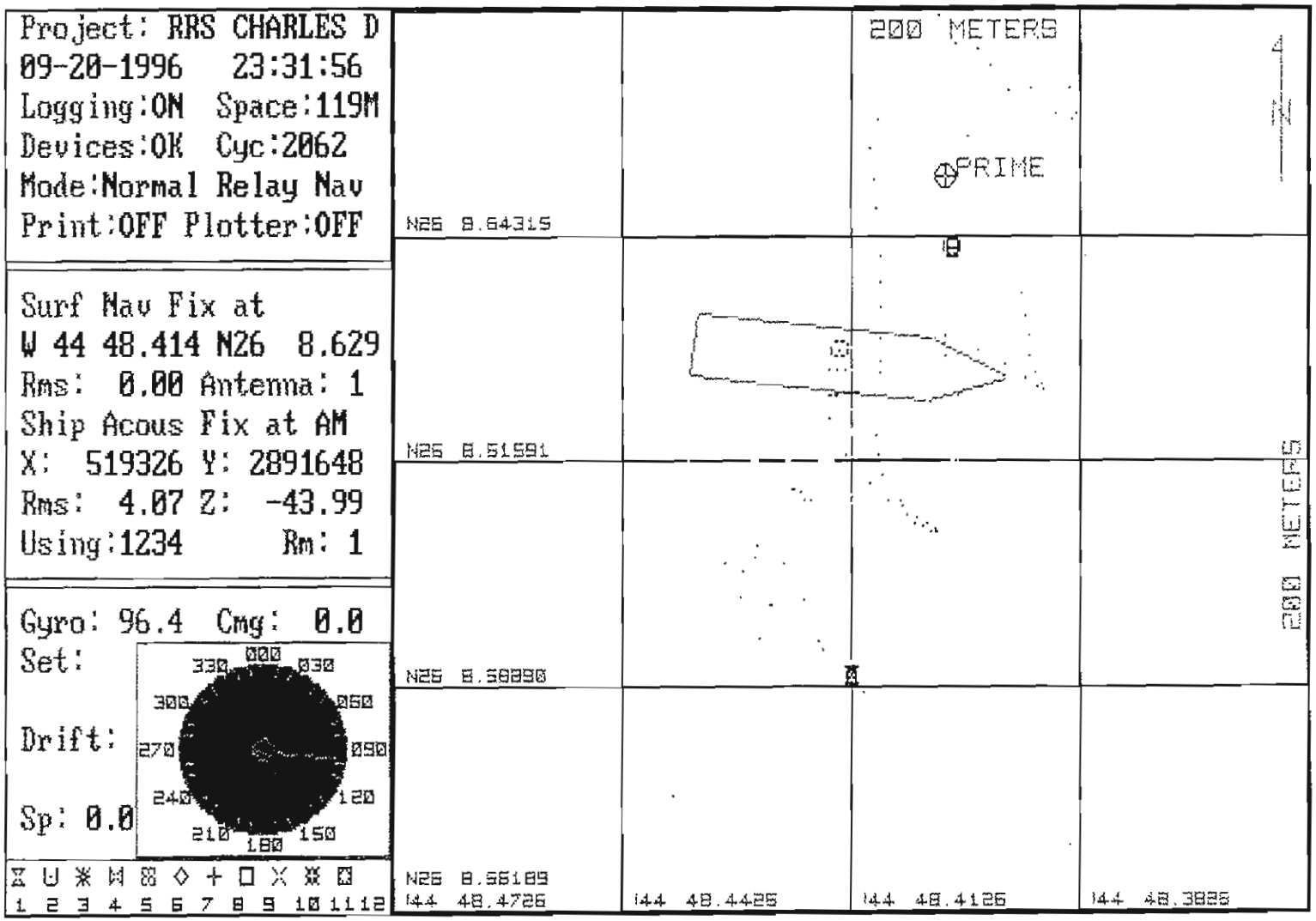
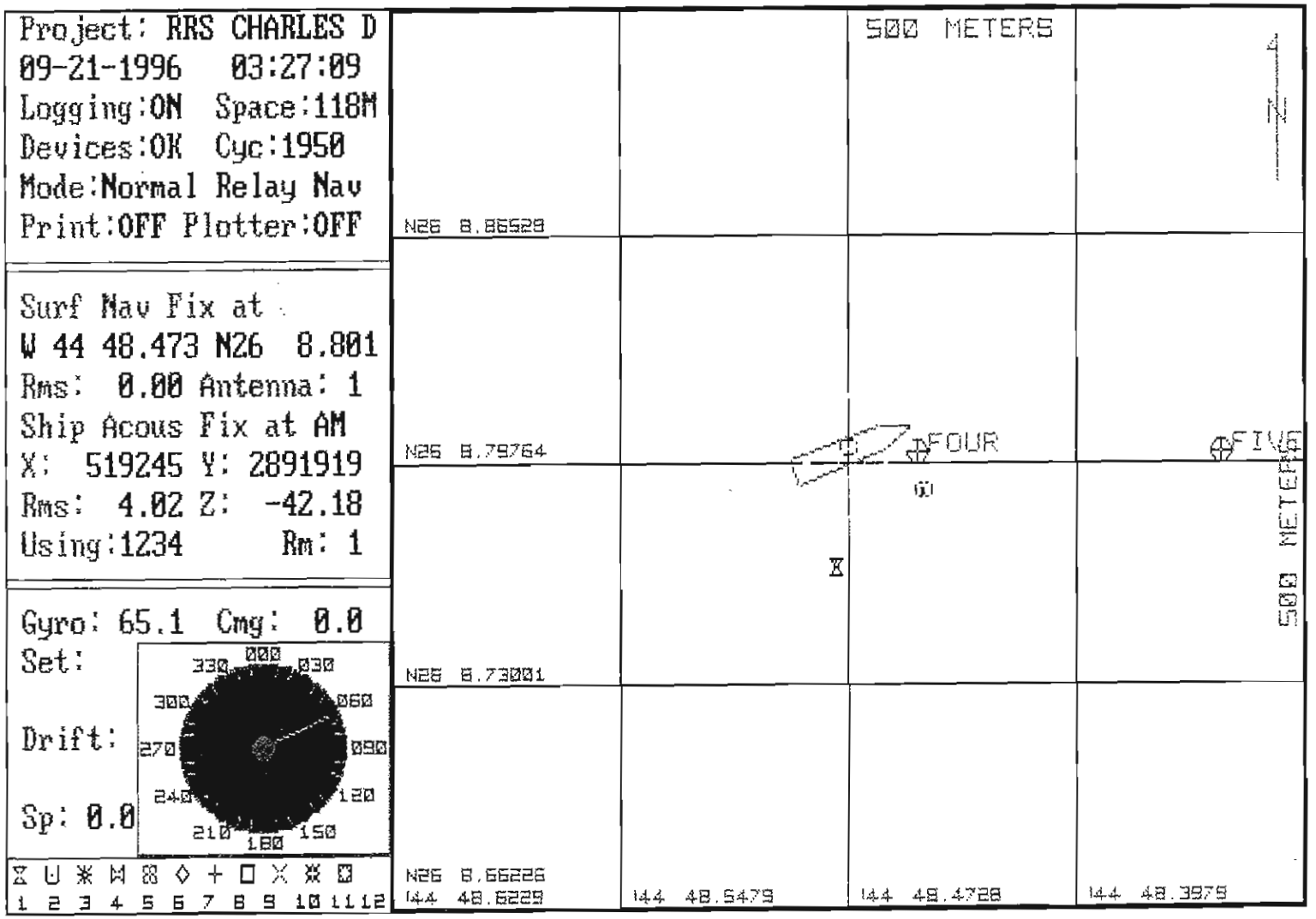
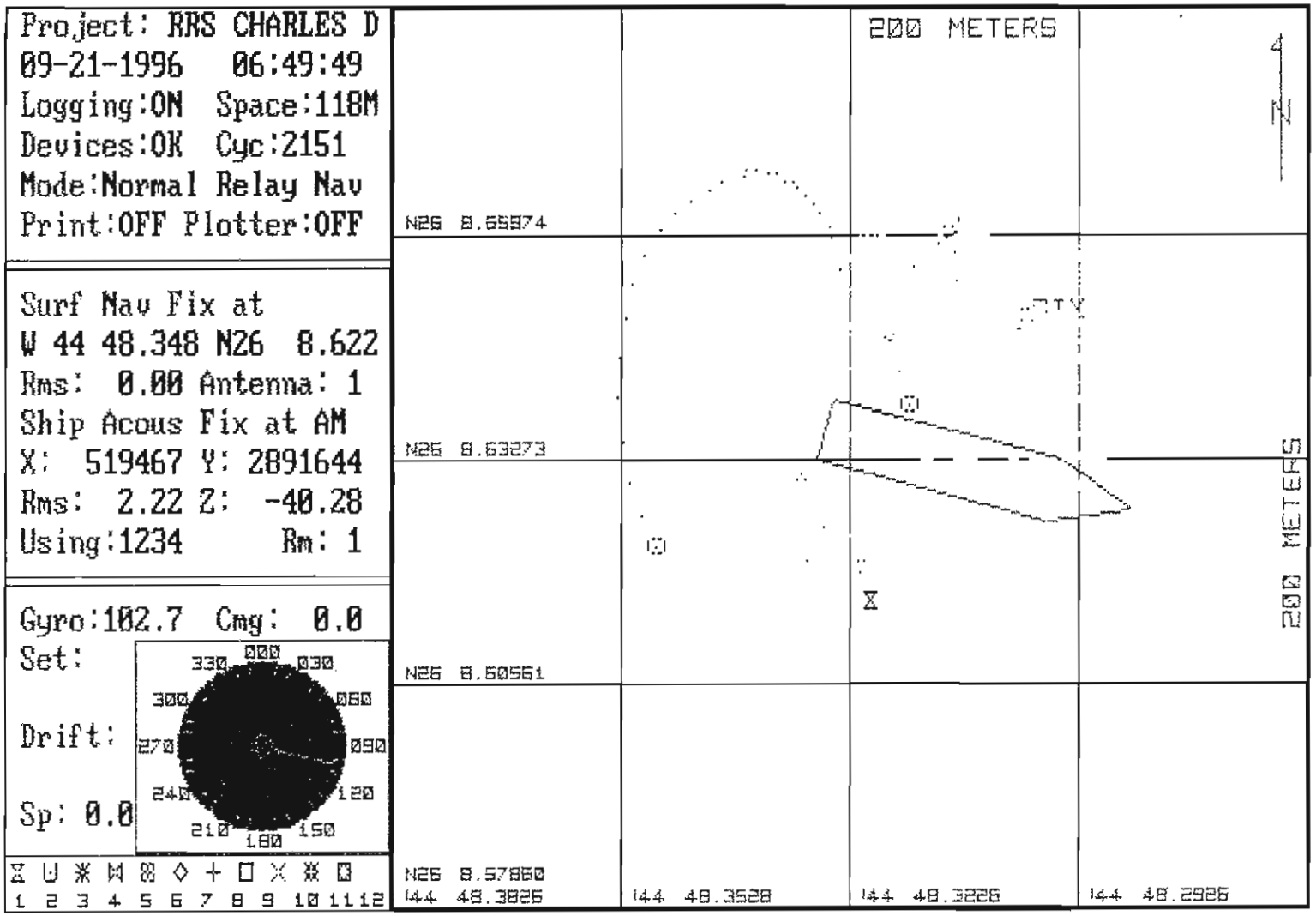
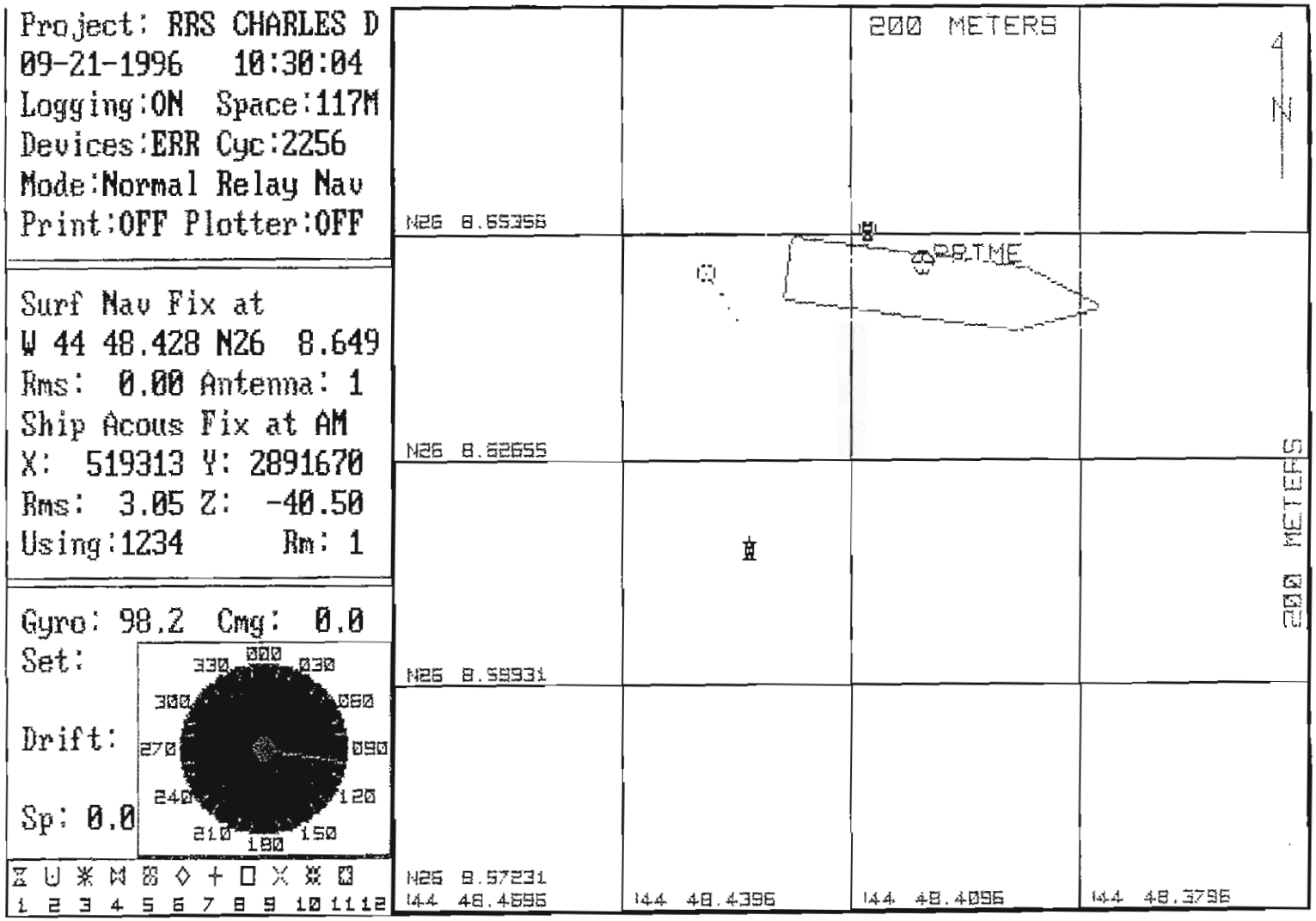

Project: RRS CHARLES D
09-20-1996 23:31:56
Logging:ON Space:119M
Devices:OK Cyc:2062
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.414 N26 8.629
Rms: 0.00 Antenma: 1
Ship Acous Fix at AM
X: 519326 Y: 2891648
Rms: 4.07 Z: -43.99
Using:1234 Rm: 1
Gyro: 96.4 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
PRIME
N
N26 8.64315
N26 8.51591
N26 8.39890
N26 8.26189
W44 48.4726
W44 48.4425
W44 48.4126
W44 48.3825
200 METERS


Project: RRS CHARLES D
09-21-1996 03:27:09
Logging:ON Space:118M
Devices:OK Cyc:1950
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.473 N26 8.801
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519245 Y: 2891919
Rms: 4.02 Z: -42.18
Using:1234 Rm: 1
Gyro: 65.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
N26 8.86529
N26 8.79764
N26 8.73001
N26 8.66226
144 48.6229
144 48.5479
144 48.4728
144 48.3979
FOUR
FIVE
500 METERS

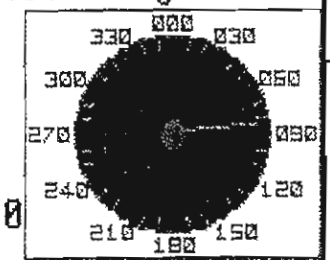

Project: RRS CHARLES D
09-21-1996 06:49:49
Logging:ON Space:118M
Devices:OK Cyc:2151
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.348 N26 8.622
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519467 Y: 2891644
Rms: 2.22 Z: -40.28
Using:1234 Rm: 1
Gyro:102.7 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
N
N26 8.65874
N26 8.63273
N26 8.60561
N26 8.57850
44 48.3825
44 48.3528
44 48.3228
44 48.2926
200 METERS


Project: RRS CHARLES D
09-21-1996 10:30:04
Logging:ON Space:117M
Devices:ERR Cyc:2256
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.428 N26 8.649
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519313 Y: 2891670
Rms: 3.05 Z: -40.50
Using:1234 Rm: 1
Gyro: 98.2 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
N
N26 8.65356
N26 8.62655
N26 8.59931
N25 8.57231
44 48.4696
44 48.4396
44 48.4096
44 48.3796
200 METERS

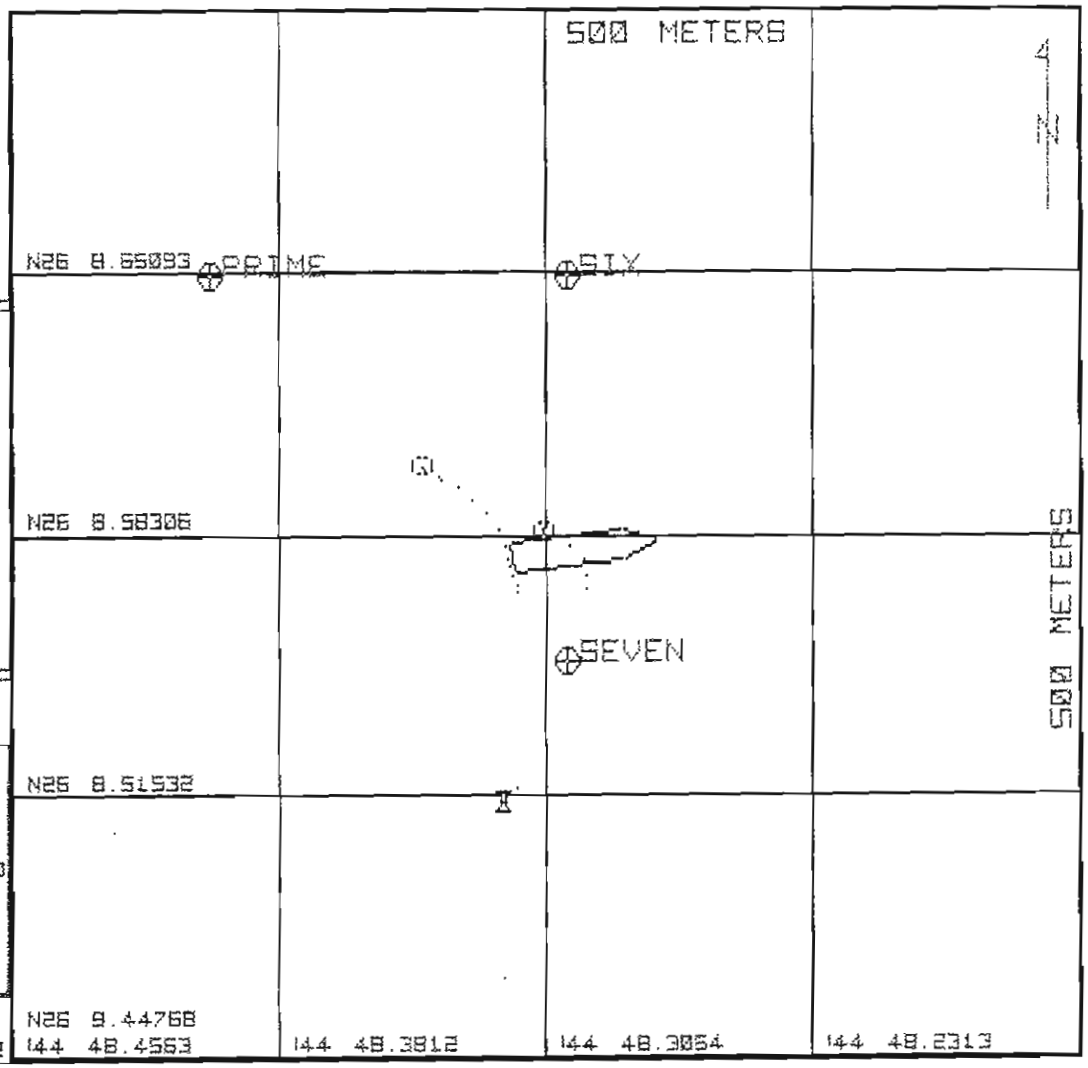
Project: RRS CHARLES D
09-21-1996 15:00:11
Logging:ON Space:117M
Devices:OK Cyc:2582
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

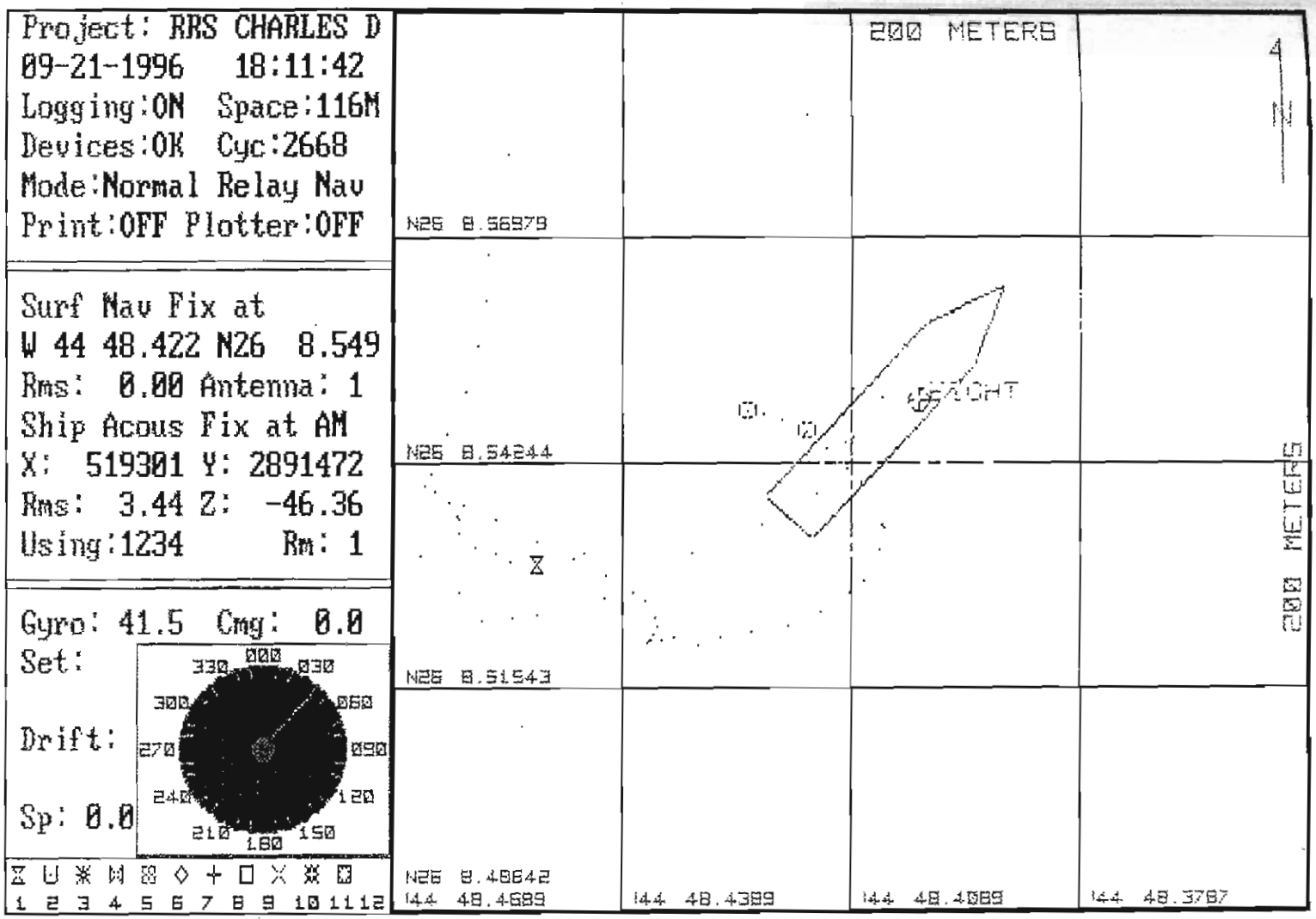
Surf Nav Fix at
W 44 48.340 N26 8.600
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519481 Y: 2891540
Rms: 3.06 Z: -41.66
Using:1234 Rm: 1

Gyro: 82.9 Cmg: 0.0
Set:
Drift:
Sp: 0.0



1 2 3 4 5 6 7 8 9 10 11 12

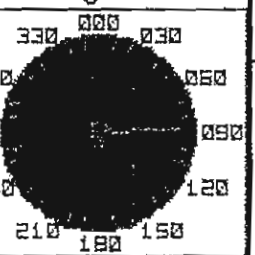



Project: RRS CHARLES D
09-21-1996 18:11:42
Logging:ON Space:116M
Devices:OK Cyc:2668
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.422 N26 8.549
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519301 Y: 2891472
Rms: 3.44 Z: -46.36
Using:1234 Rm: 1
Gyro: 41.5 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
200 METERS
N26 8.56879
N26 8.54244
N26 8.51543
N26 8.48642
W44 48.4689
W44 48.4389
W44 48.4089
W44 48.3787
1.
2.
YACHT

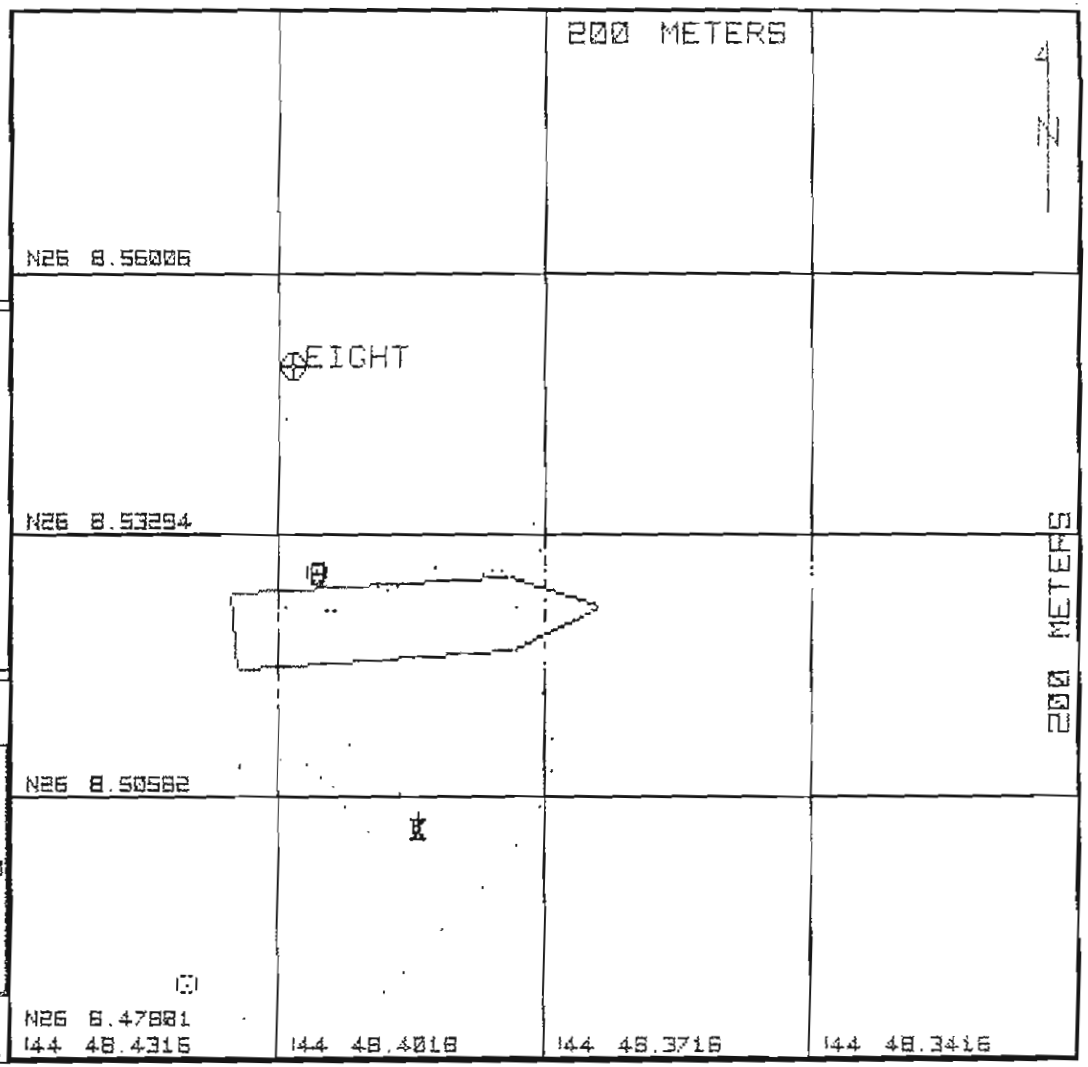
Project: RRS CHARLES D
09-21-1996 21:35:31
Logging:ON Space:116M
Devices:OK Cyc:2637
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

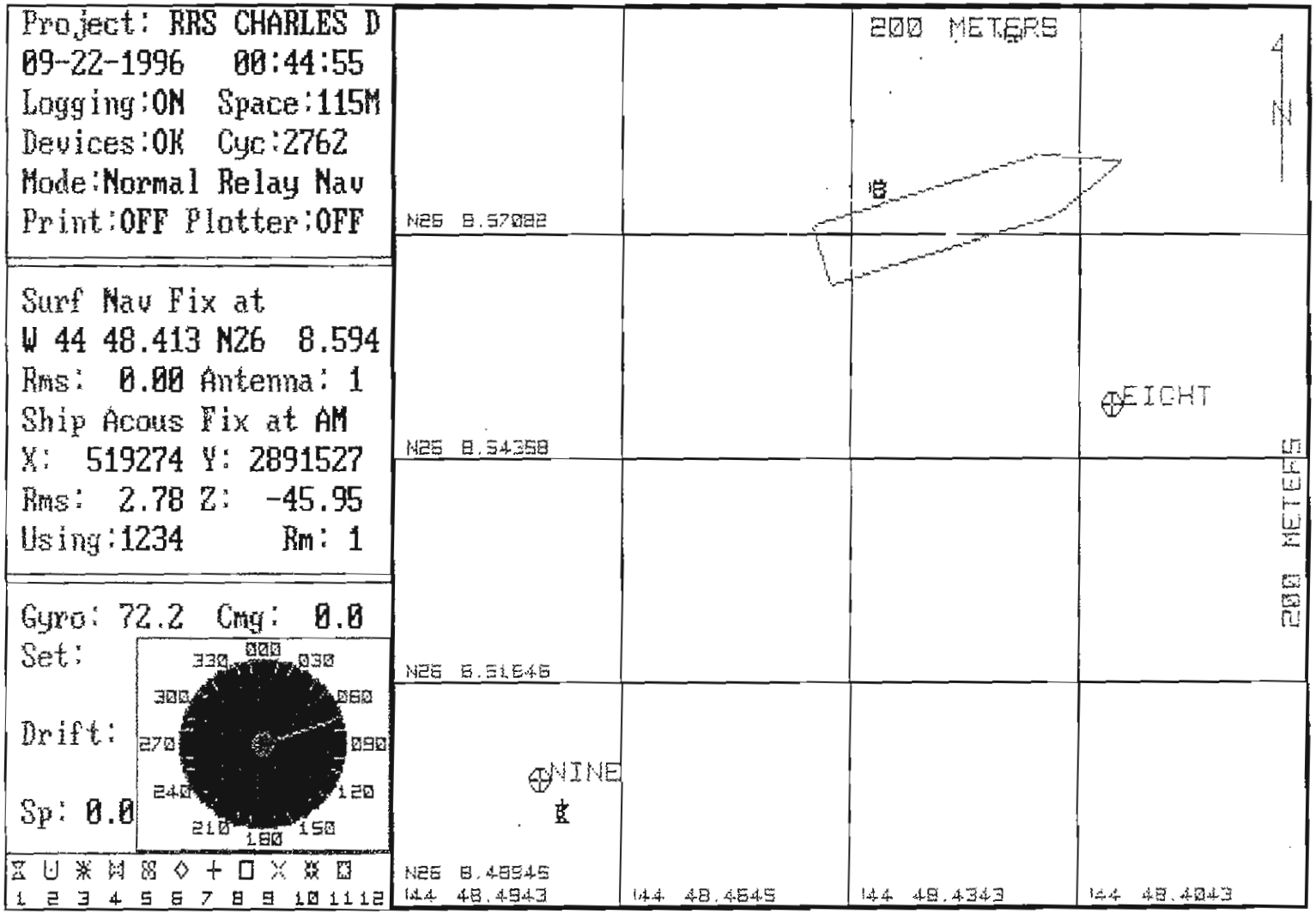
Surf Nav Fix at
W 44 48.412 N26 8.486
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519330 Y: 2891441
Rms: 2.49 Z: -45.41
Using:1234 Rm: 1

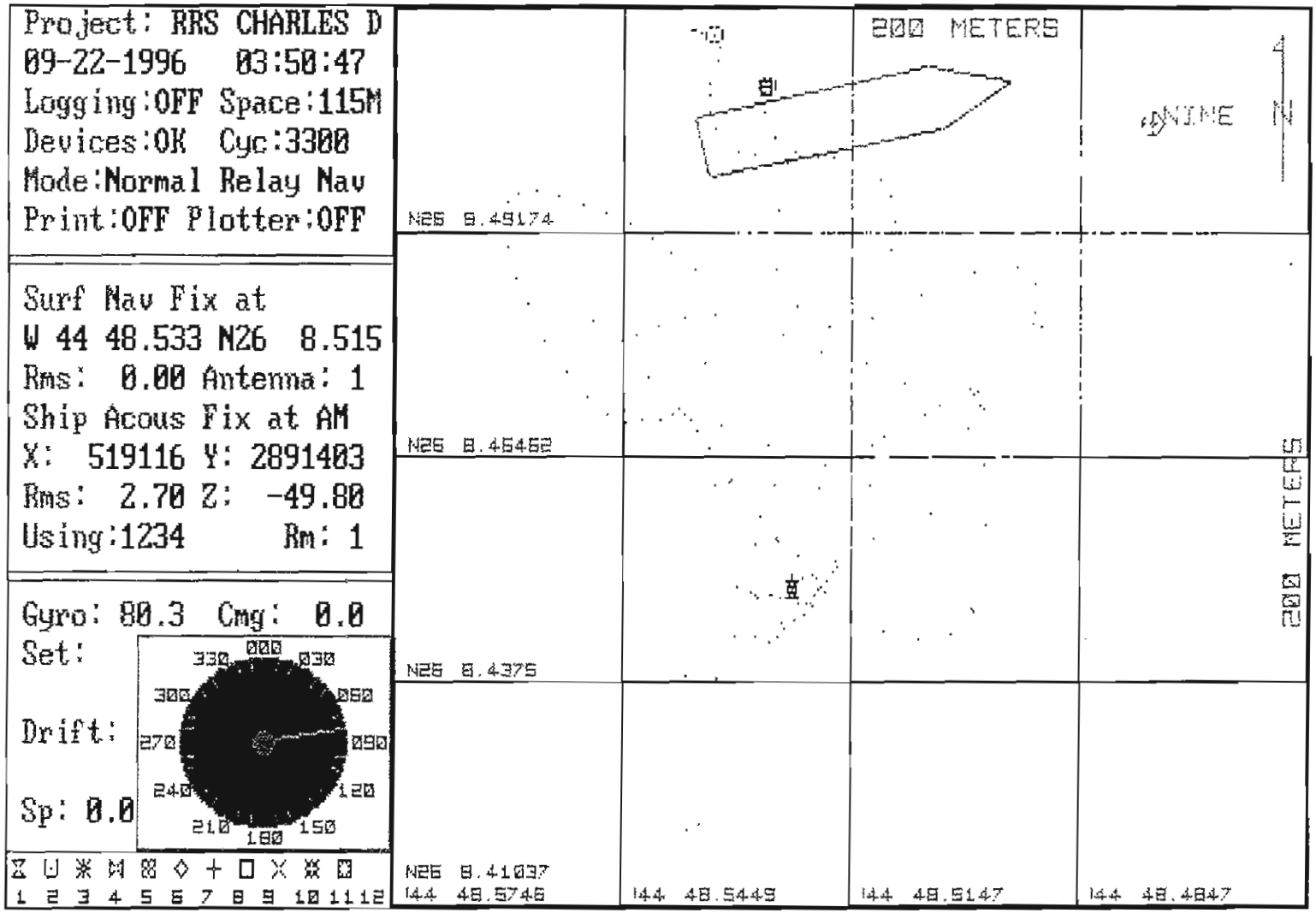
Gyro: 87.8 Cmg: 0.0
Set:
Drift:
Sp: 0.0



1 2 3 4 5 6 7 8 9 10 11 12



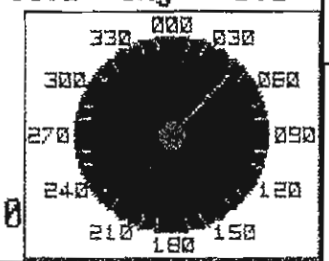

Project: RRS CHARLES D
09-22-1996 00:44:55
Logging:ON Space:115M
Devices:OK Cyc:2762
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.413 N26 8.594
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519274 Y: 2891527
Rms: 2.78 Z: -45.95
Using:1234 Rm: 1
Gyro: 72.2 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
N
B
EIGHT
NINE
200 METERS
N26 8.57082
N26 8.54358
N26 8.51646
N26 8.48945
W44 48.4943
W44 48.4643
W44 48.4343
W44 48.4043


Project: RRS CHARLES D
09-22-1996 03:50:47
Logging:OFF Space:115M
Devices:OK Cyc:3300
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.533 N26 8.515
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519116 Y: 2891403
Rms: 2.70 Z: -49.80
Using:1234 Rm: 1
Gyro: 80.3 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
NINE
N
N26 8.49174
N26 8.45452
N26 8.4375
N26 8.41037
W44 48.5746
W44 48.5445
W44 48.5147
W44 48.4847
200 METERS

Project: RRS CHARLES D
09-22-1996 06:55:30
Logging:ON Space:115M
Devices:OK Cyc:2894
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

Surf Nav Fix at
W 44 48.489 N26 8.504
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519209 Y: 2891395
Rms: 3.31 Z: -47.38
Using:1234 Rm: 1

Gyro: 44.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0



1 2 3 4 5 6 7 8 9 10 11 12

500 METERS

N26 8.56006

EIGHT

N25 8.45231

500 METERS

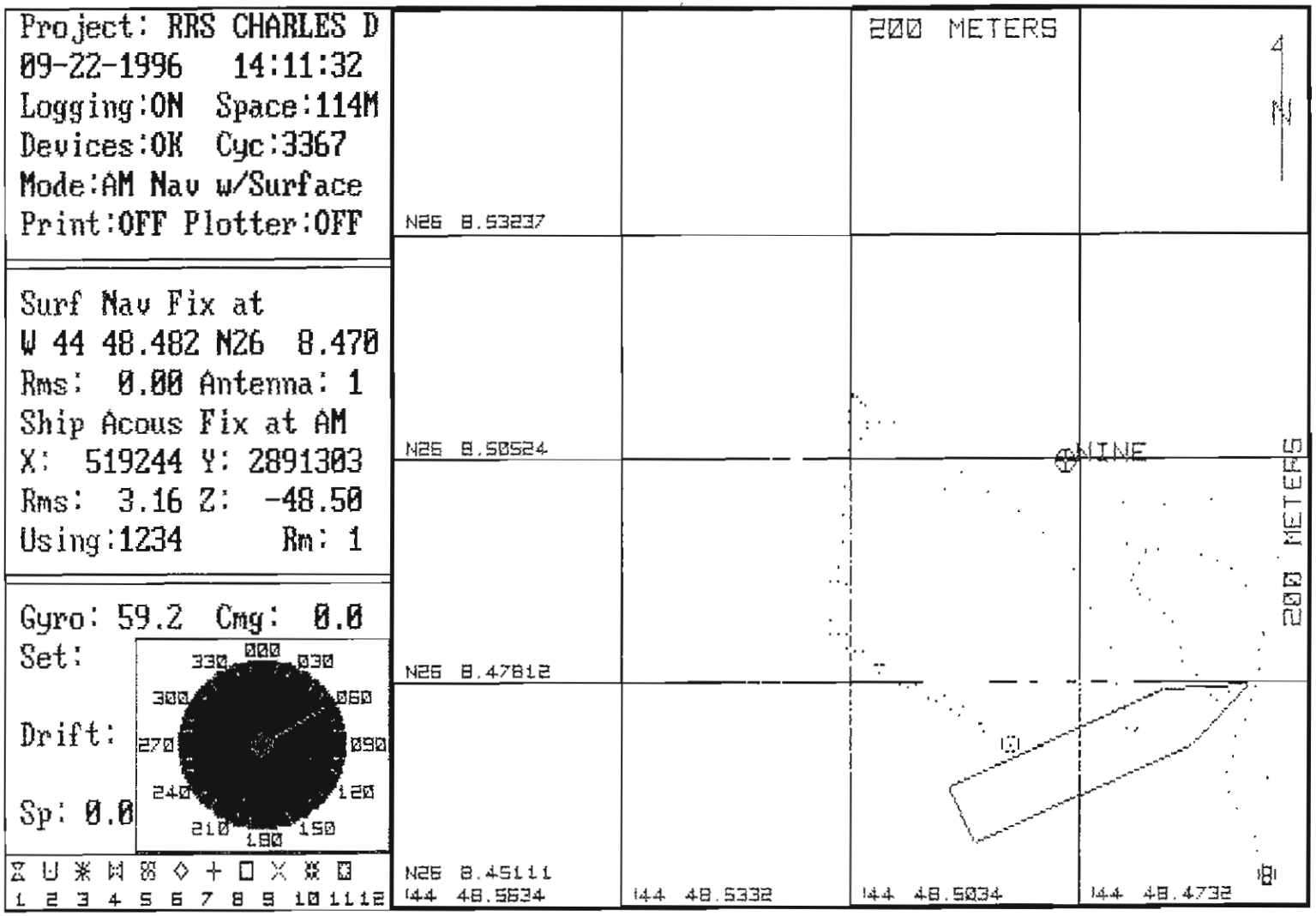
N26 8.42445

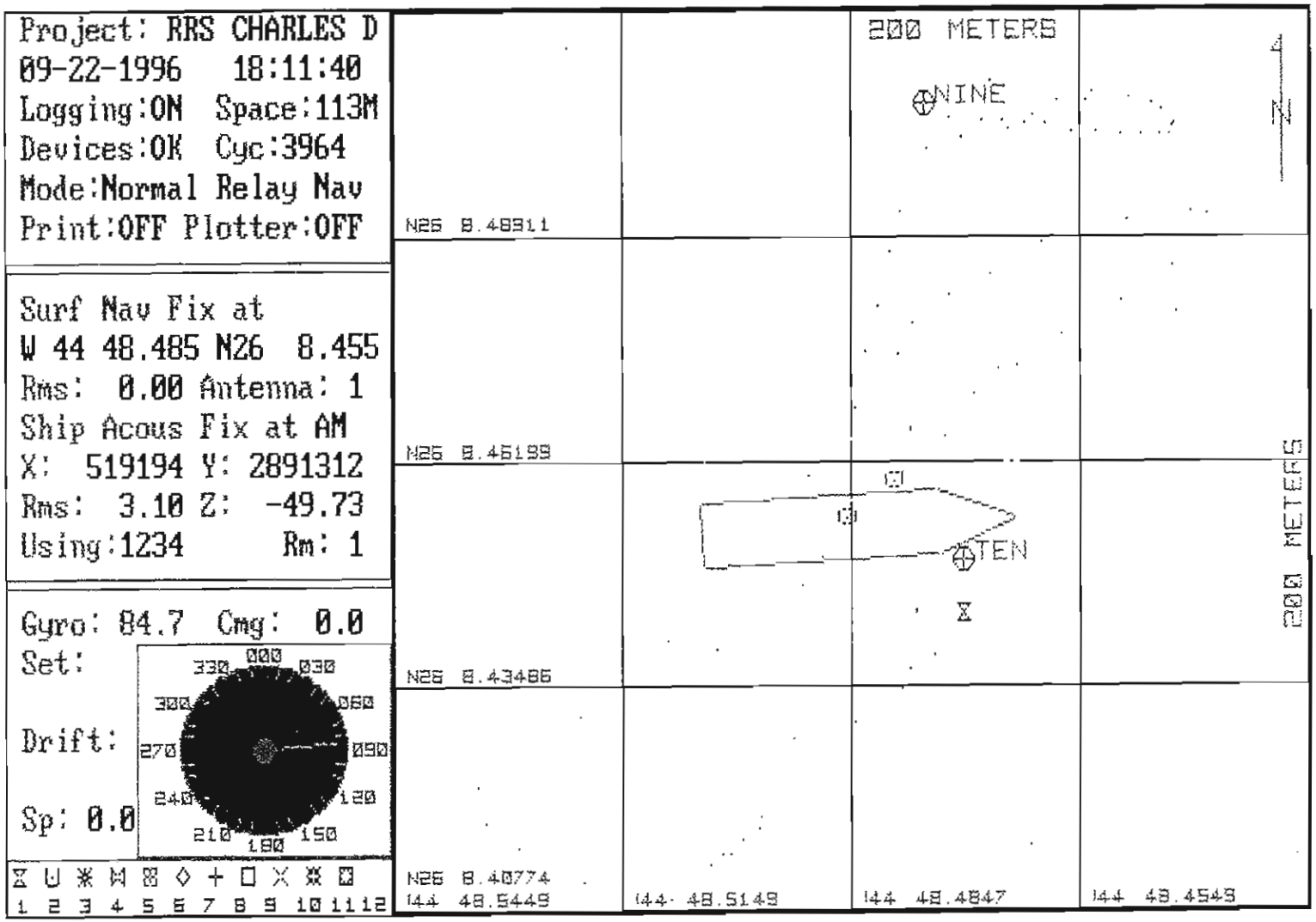
N26 8.35681
W44 48.5408

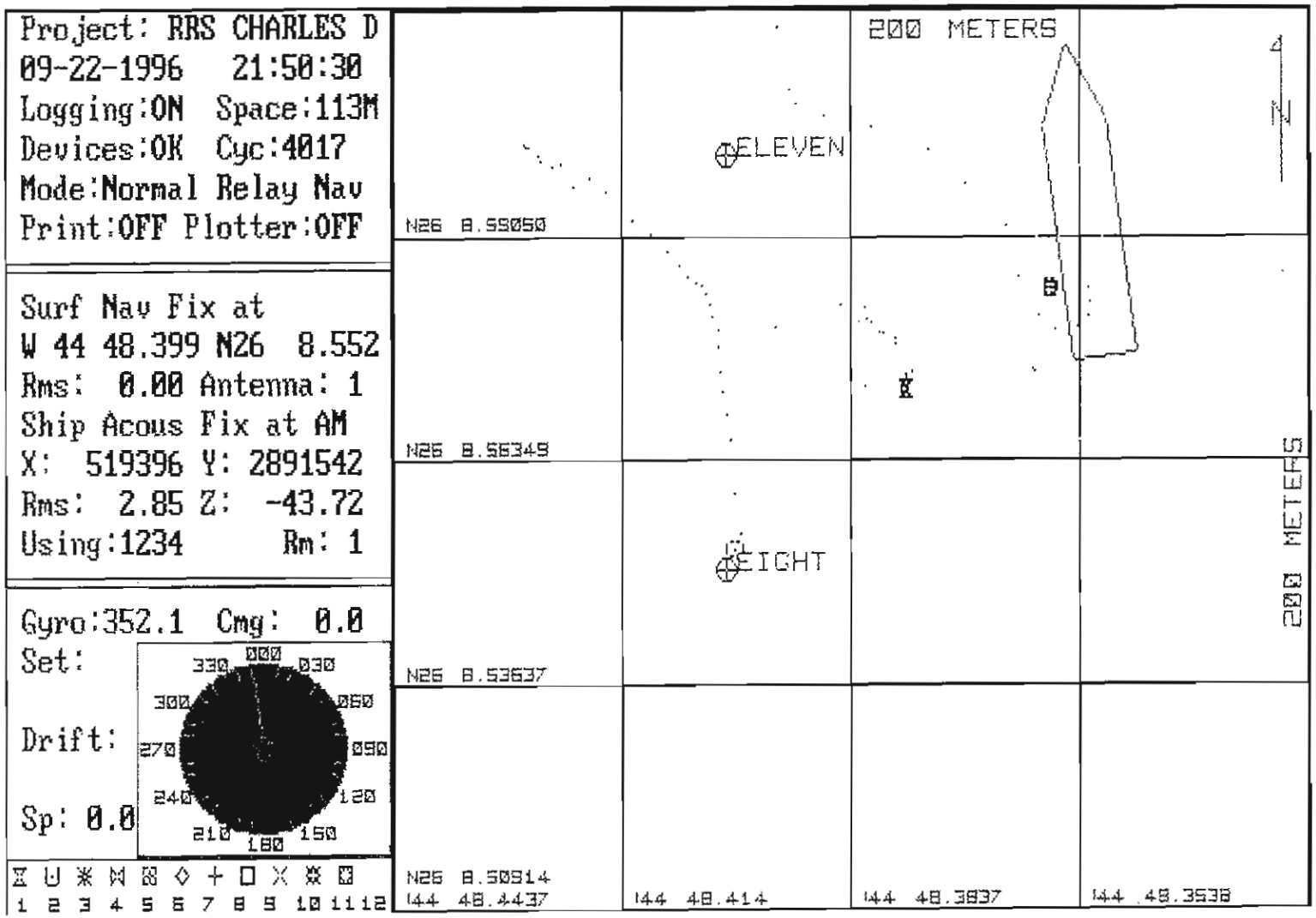
W44 48.5857

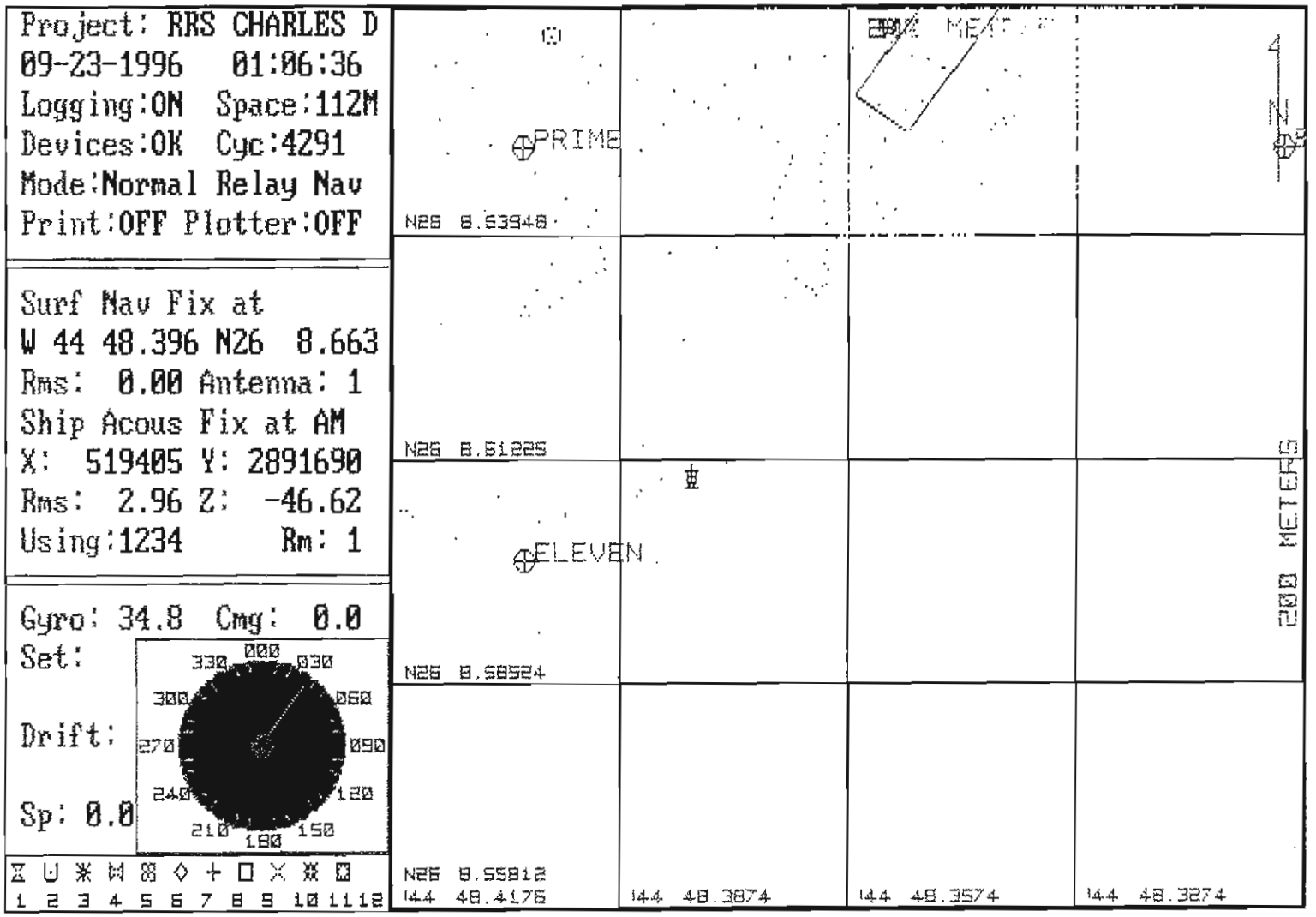
W44 48.4906

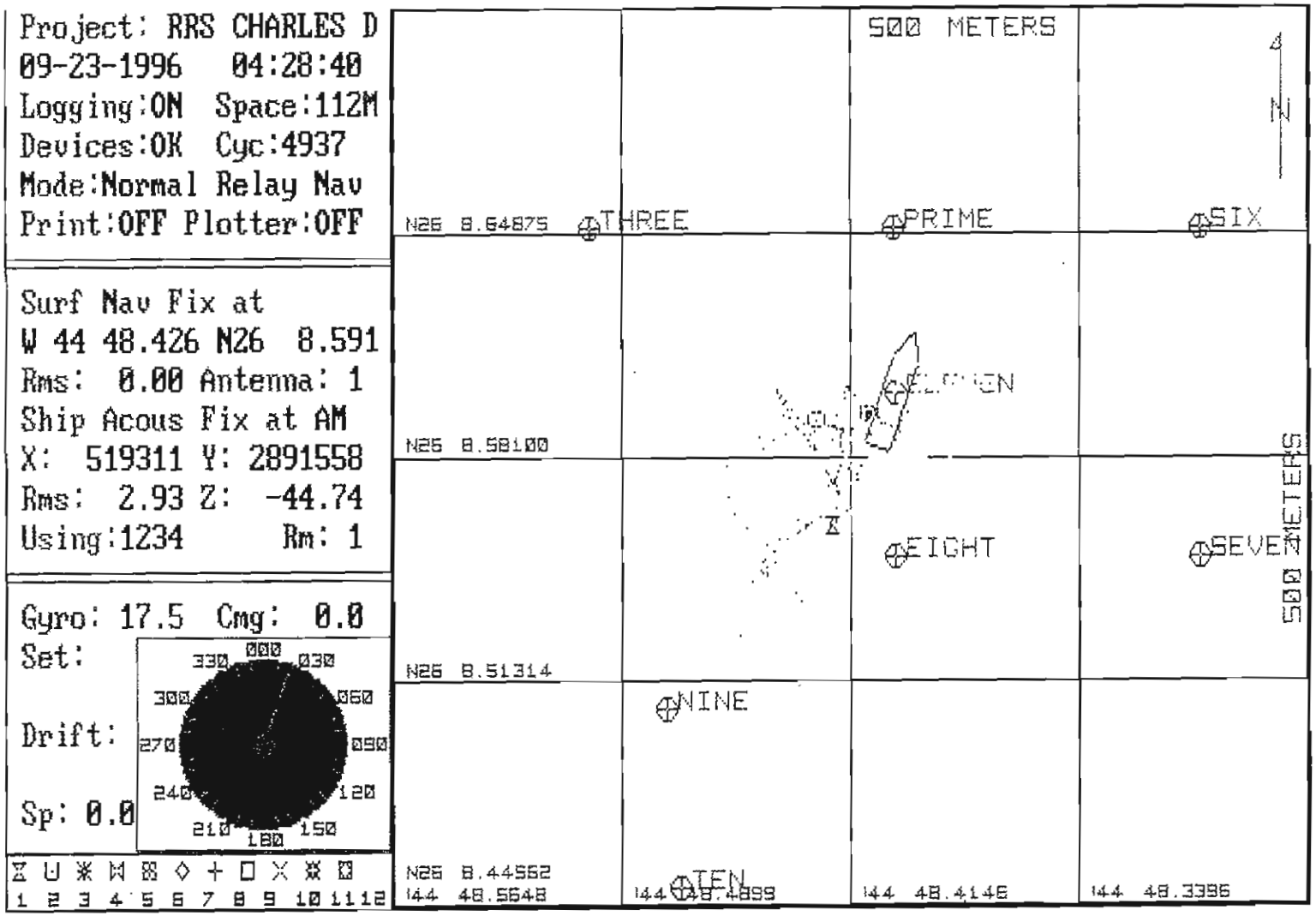
W44 48.4158

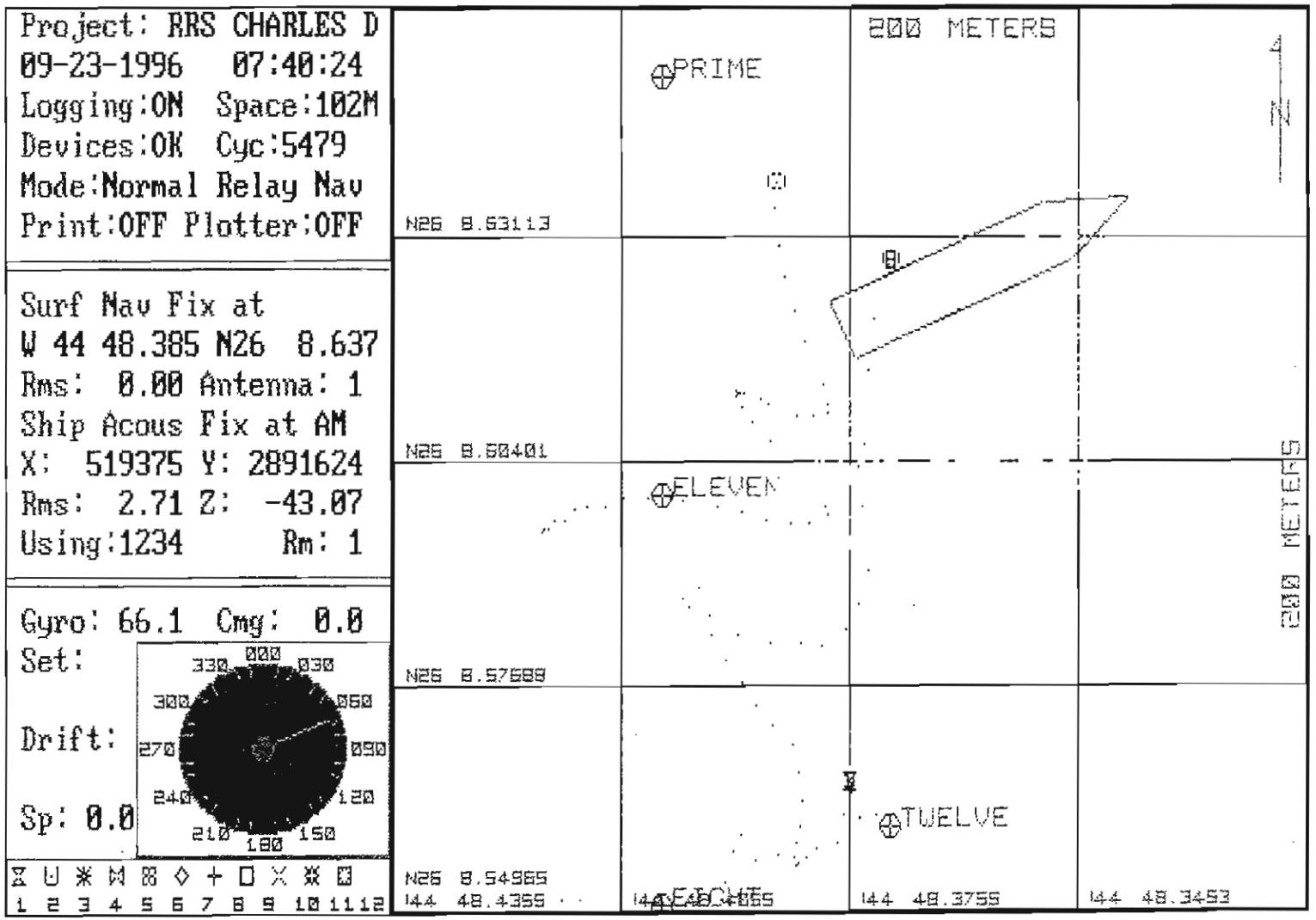

Project: RRS CHARLES D
09-22-1996 14:11:32
Logging:ON Space:114M
Devices:OK Cyc:3367
Mode:AM Nav w/Surface
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.482 N26 8.470
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519244 Y: 2891303
Rms: 3.16 Z: -48.50
Using:1234 Rm: 1
Gyro: 59.2 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
N26 8.53237
N26 8.50524
N26 8.47812
N26 8.45111
44 48.5634
44 48.5332
44 48.5034
44 48.4732
200 METERS

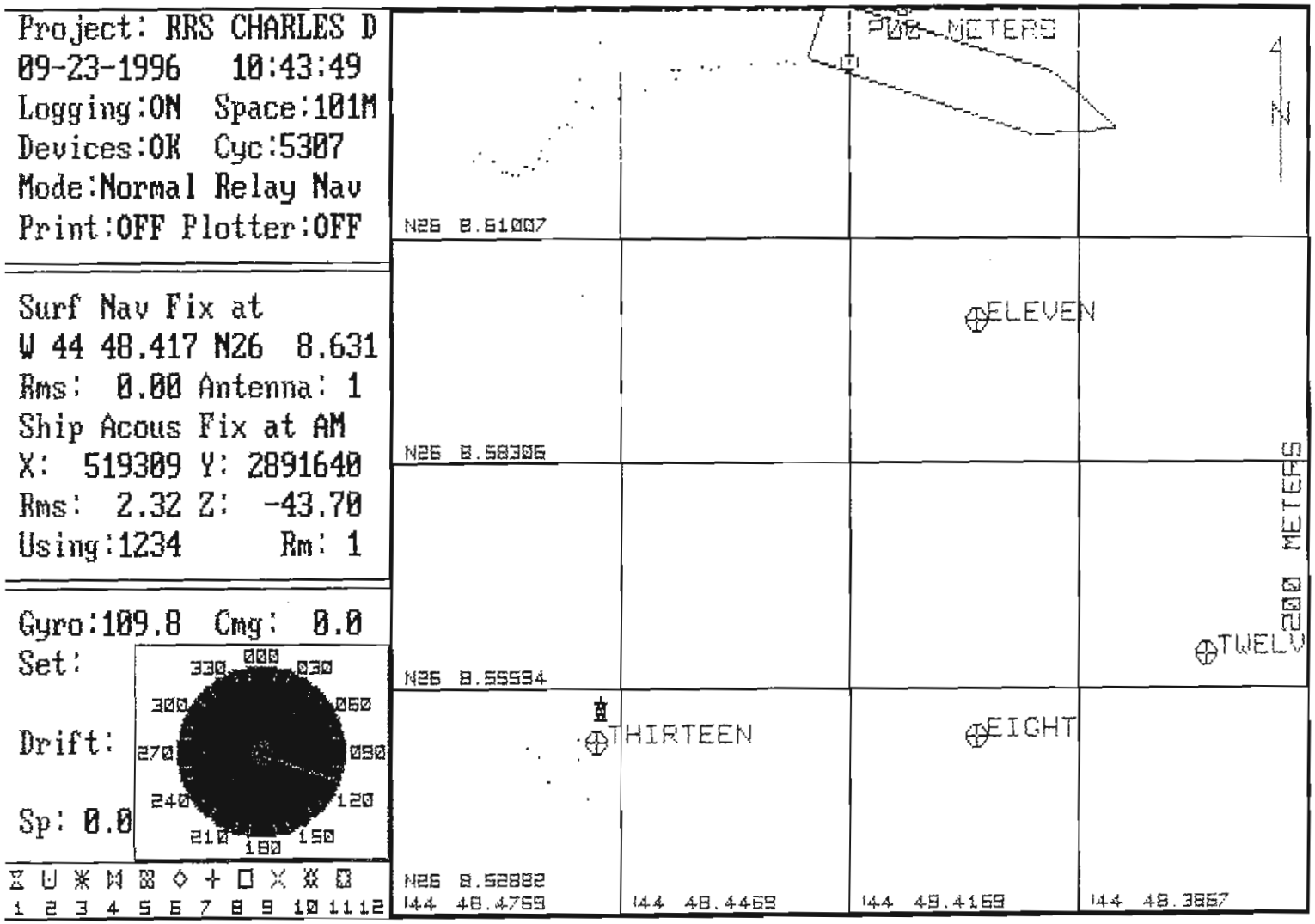

Project: RRS CHARLES D
09-22-1996 18:11:40
Logging:ON Space:113M
Devices:OK Cyc:3964
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.485 N26 8.455
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519194 Y: 2891312
Rms: 3.10 Z: -49.73
Using:1234 Rm: 1
Gyro: 84.7 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
NINE
TEN
200 METERS
N26 8.48911
N26 8.45199
N26 8.43486
N26 8.40774
W44 48.5449
W44 48.5149
W44 48.4847
W44 48.4548

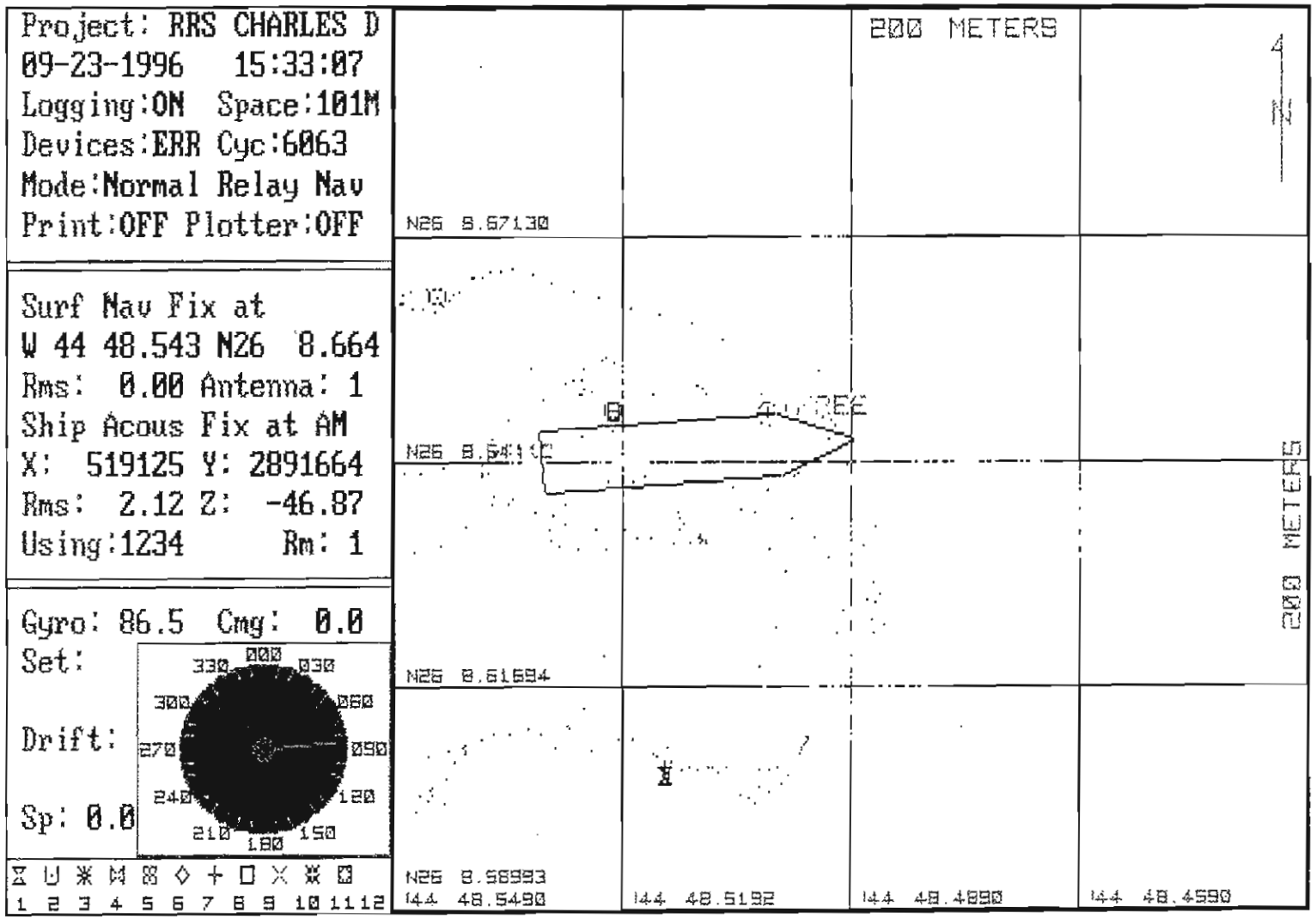

Project: RRS CHARLES D
09-22-1996 21:50:30
Logging:ON Space:113M
Devices:OK Cyc:4017
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.399 N26 8.552
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519396 Y: 2891542
Rms: 2.85 Z: -43.72
Using:1234 Rm: 1
Gyro:352.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
ELEVEN
EIGHT
200 METERS
N26 8.55050
N26 8.56349
N26 8.53637
N26 8.50914
144 48.4437
144 48.414
144 48.3837
144 48.3538


Project: RRS CHARLES D
09-23-1996 01:06:36
Logging:ON Space:112M
Devices:OK Cyc:4291
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.396 N26 8.663
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519405 Y: 2891690
Rms: 2.96 Z: -46.62
Using:1234 Rm: 1
Gyro: 34.8 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
PRIME
ELEVEN
N26 8.63948
N26 8.61225
N26 8.58524
N26 8.55812
44 48.4178
44 48.3874
44 48.3574
44 48.3274
200 METERS
N


Project: RRS CHARLES D
09-23-1996 04:28:40
Logging:ON Space:112M
Devices:OK Cyc:4937
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.426 N26 8.591
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519311 Y: 2891558
Rms: 2.93 Z: -44.74
Using:1234 Rm: 1
Gyro: 17.5 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
N
THREE
PRIME
SIX
N26 8.64875
N26 8.58100
N26 8.51314
N26 8.44562
EIGHT
SEVEN
NINE
TEN
500 METERS


Project: RRS CHARLES D
09-23-1996 07:40:24
Logging:ON Space:102M
Devices:OK Cyc:5479
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.385 N26 8.637
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519375 Y: 2891624
Rms: 2.71 Z: -43.07
Using:1234 Rm: 1
Gyro: 66.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
PRIME
ELEVEN
TWELVE
N26 8.63113
N25 8.60401
N26 8.57688
N26 8.54965
44 48.4355
44 48.3755
44 48.3453
200 METERS

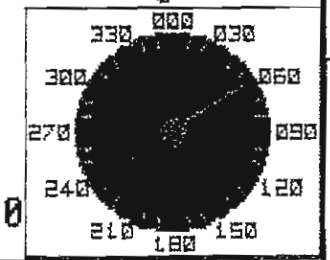

Project: RRS CHARLES D
09-23-1996 10:43:49
Logging:ON Space:101M
Devices:OK Cyc:5307
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.417 N26 8.631
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519309 Y: 2891640
Rms: 2.32 Z: -43.70
Using:1234 Rm: 1
Gyro:109.8 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
2000 METERS
N
ELEVEN
TWELV
THIRTEEN
EIGHT
N26 8.61007
N26 8.58306
N26 8.55594
N26 8.52882
W44 48.4769
W44 48.4469
W44 48.4169
W44 48.3867


Project: RRS CHARLES D
09-23-1996 15:33:07
Logging:ON Space:101M
Devices:ERR Cyc:6063
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.543 N26 8.664
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519125 Y: 2891664
Rms: 2.12 Z: -46.87
Using:1234 Rm: 1
Gyro: 86.5 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
N26 8.67130
N26 8.64112
N26 8.61694
N26 8.58993
44 48.5490
44 48.5192
44 48.4890
44 48.4590
200 METERS

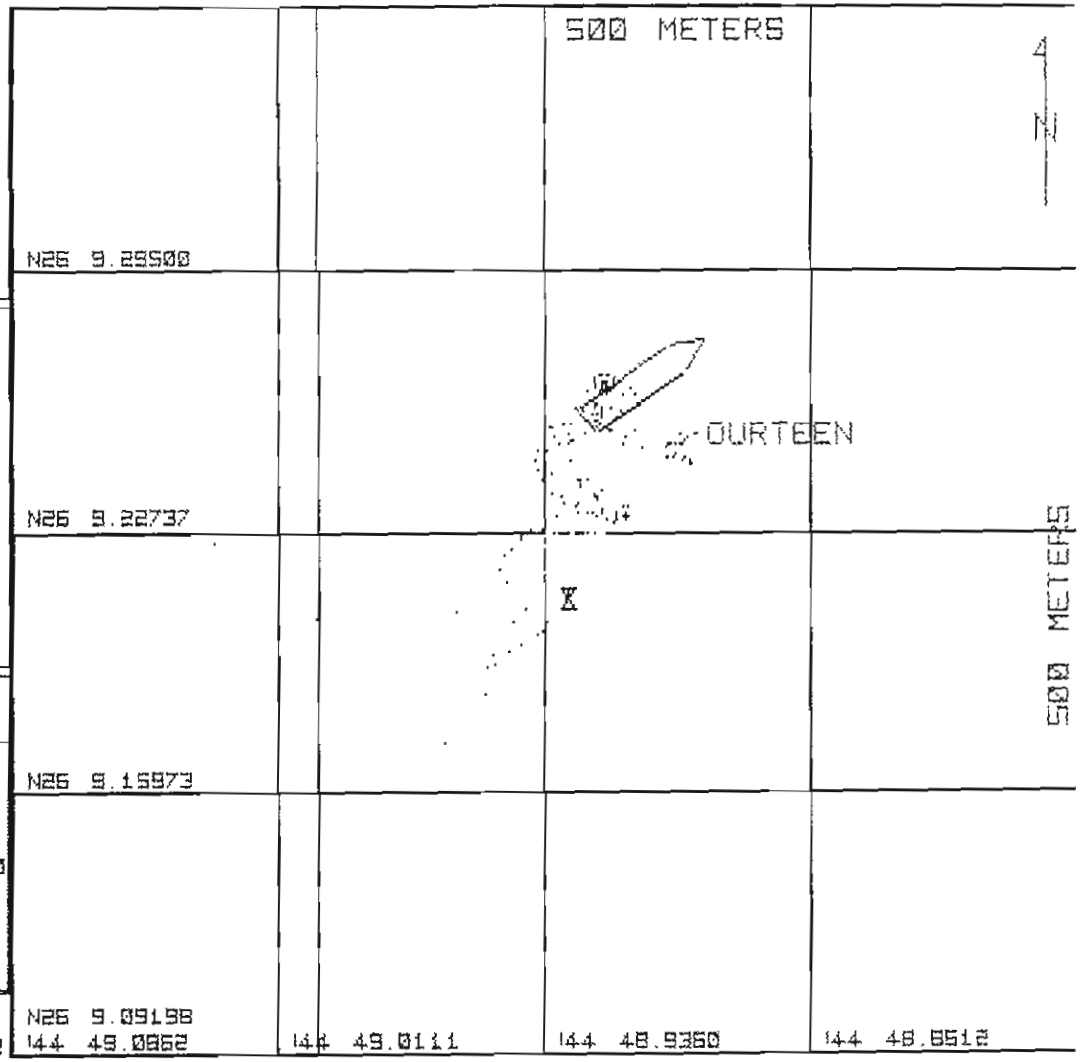
Project: RRS CHARLES D
09-23-1996 19:55:47
Logging:ON Space:100M
Devices:OK Cyc:5664
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

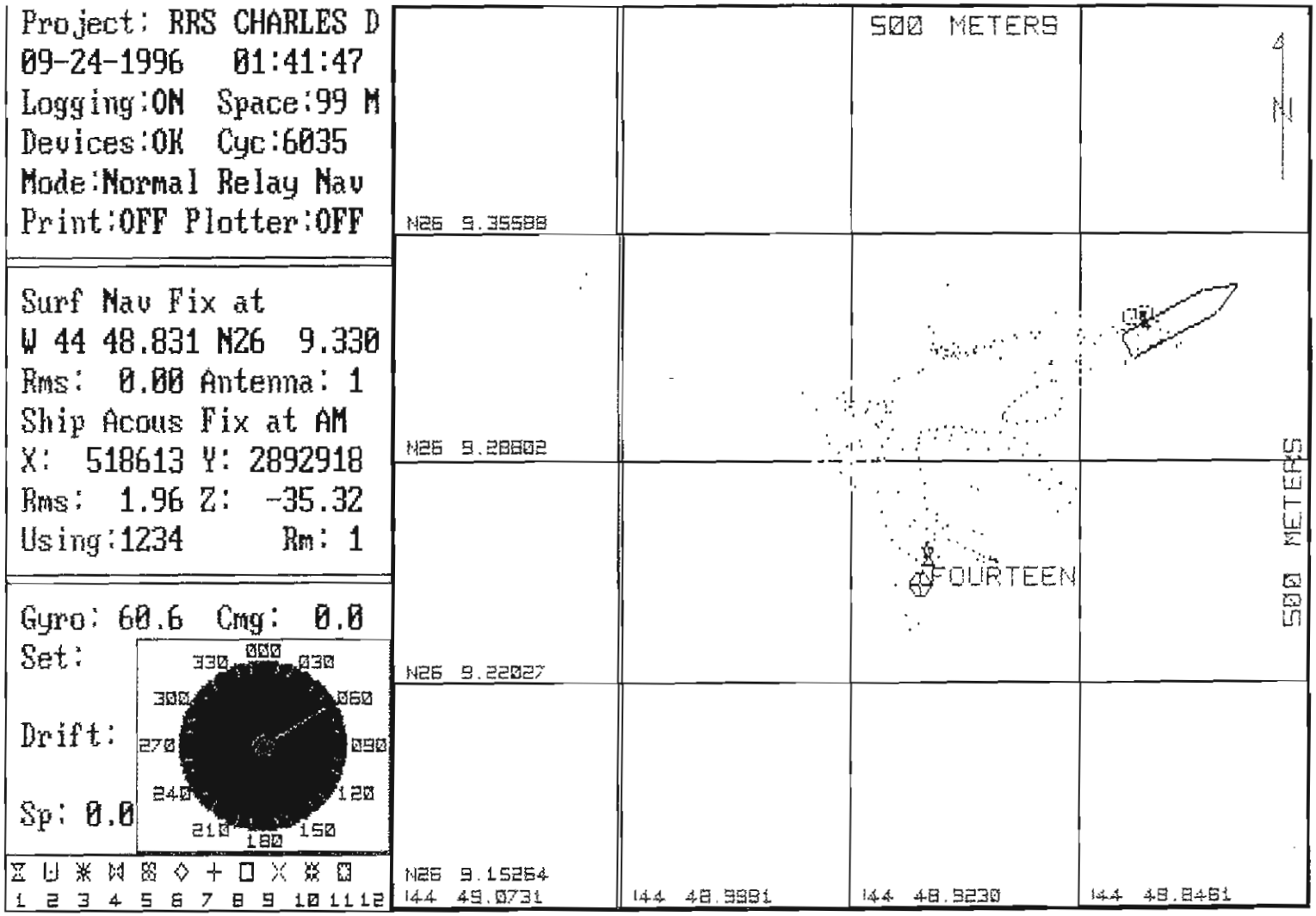
Surf Nav Fix at
W 44 48.923 N26 9.256
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518458 Y: 2892797
Rms: 2.99 Z: -38.47
Using:1234 Rm: 1

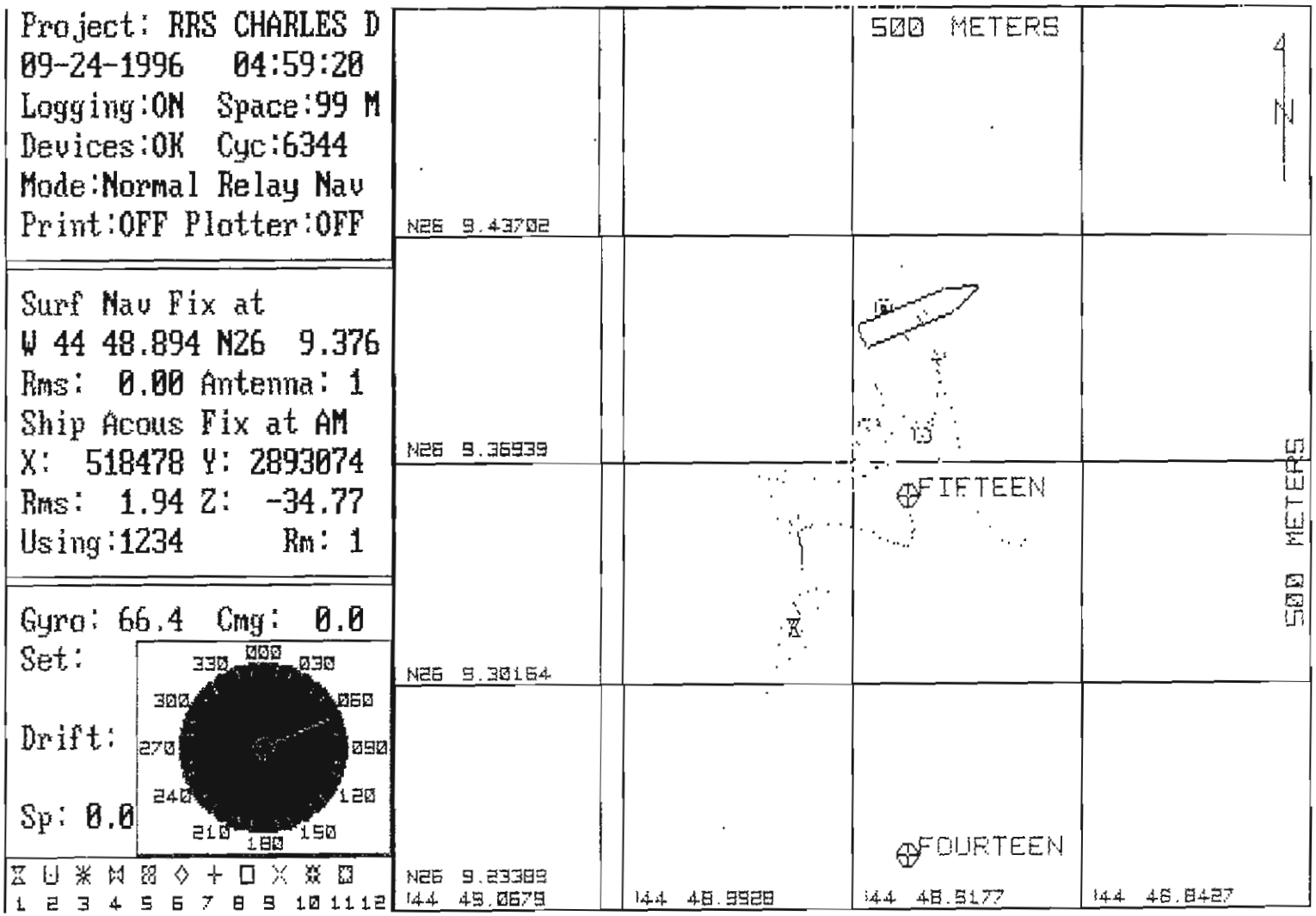
Gyro: 56.3 Cmg: 0.0
Set:
Drift:
Sp: 0.0

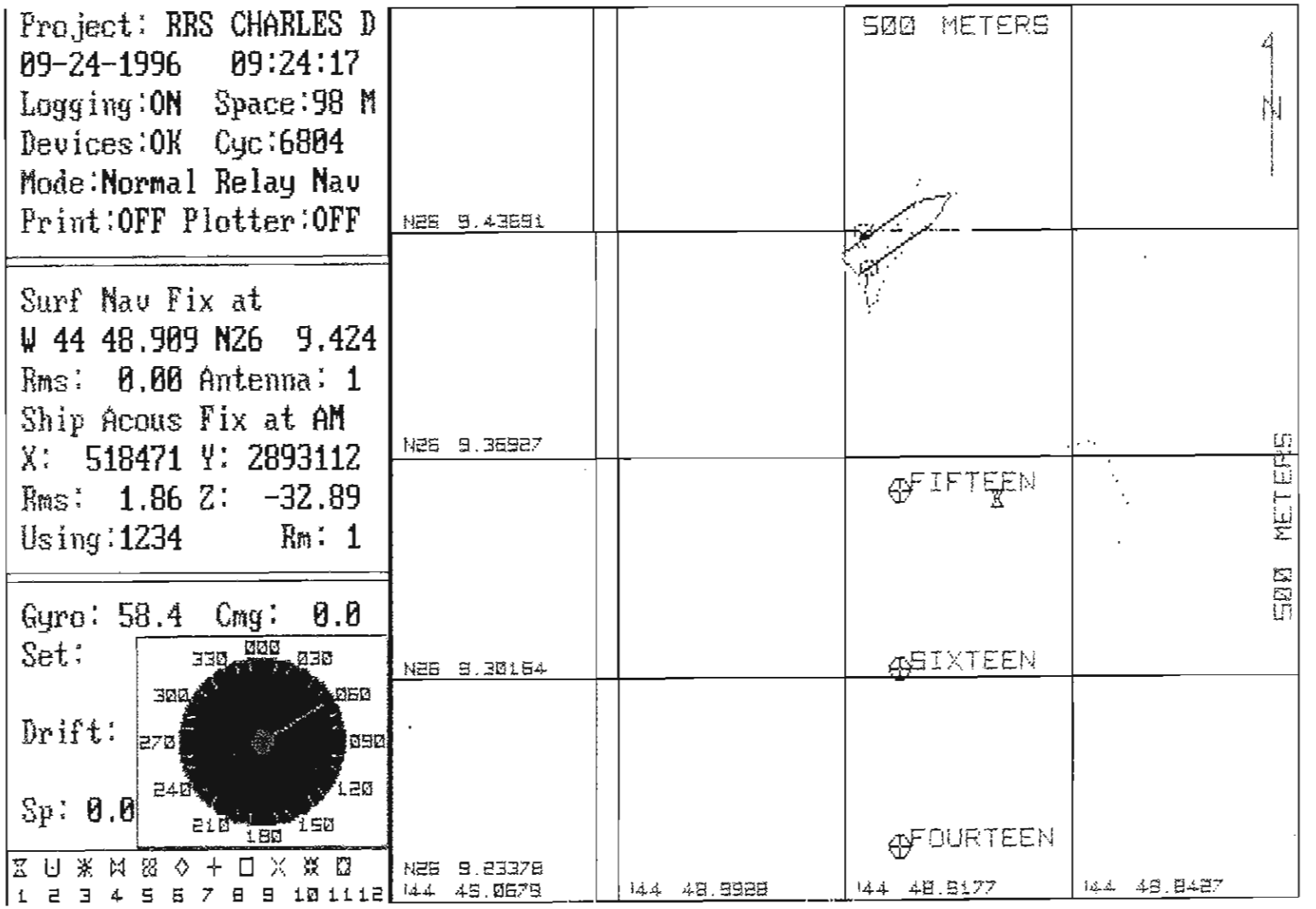


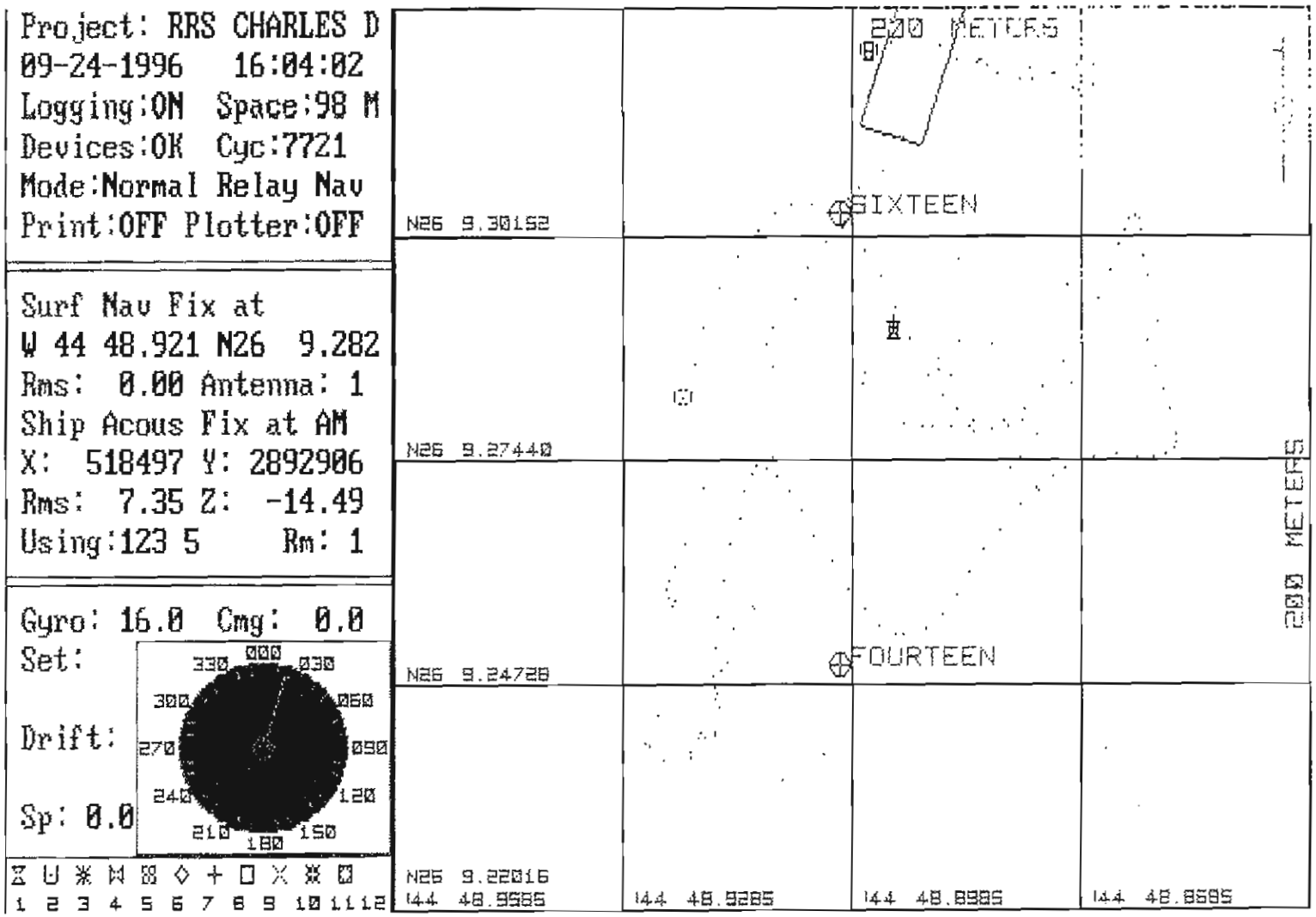
1 2 3 4 5 6 7 8 9 10 11 12




Project: RRS CHARLES D
09-24-1996 01:41:47
Logging:ON Space:99 M
Devices:OK Cyc:6035
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.831 N26 9.330
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518613 Y: 2892918
Rms: 1.96 Z: -35.32
Using:1234 Rm: 1
Gyro: 60.6 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
N
N26 9.35588
N26 9.28802
N26 9.22027
N26 9.15264
144 49.0731
144 48.9981
144 48.9230
144 48.8481
FOURTEEN
500 METERS


Project: RRS CHARLES D
09-24-1996 04:59:20
Logging:ON Space:99 M
Devices:OK Cyc:6344
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.894 N26 9.376
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518478 Y: 2893074
Rms: 1.94 Z: -34.77
Using:1234 Rm: 1
Gyro: 66.4 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
N26 9.43702
N26 9.36939
FIFTEEN
N26 9.30164
N26 9.23389
144 45.0679
144 48.9928
FOURTEEN
144 48.5177
144 46.8427
500 METERS

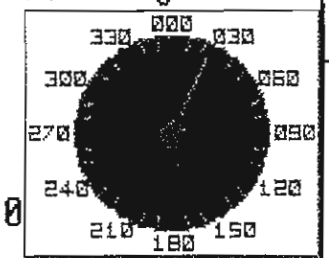

Project: RRS CHARLES D
09-24-1996 09:24:17
Logging:ON Space:98 M
Devices:OK Cyc:6804
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.909 N26 9.424
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518471 Y: 2893112
Rms: 1.86 Z: -32.89
Using:1234 Rm: 1
Gyro: 58.4 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
N
500 METERS
N26 9.43691
N26 9.36927
N26 9.30164
N26 9.23378
W44 48.9988
W44 48.9177
W44 48.8427
FIFTEEN
SIXTEEN
FOURTEEN


Project: RRS CHARLES D
09-24-1996 16:04:02
Logging:ON Space:98 M
Devices:OK Cyc:7721
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.921 N26 9.282
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518497 Y: 2892906
Rms: 7.35 Z: -14.49
Using:123 5 Rm: 1
Gyro: 16.0 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
SIXTEEN
FOURTEEN
200 METERS
N26 9.30152
N26 9.27440
N26 9.24728
N26 9.22016
W44 48.9585
W44 48.9285
W44 48.8985
W44 48.8685
1 2 3 4 5 6 7 8 9 10 11 12

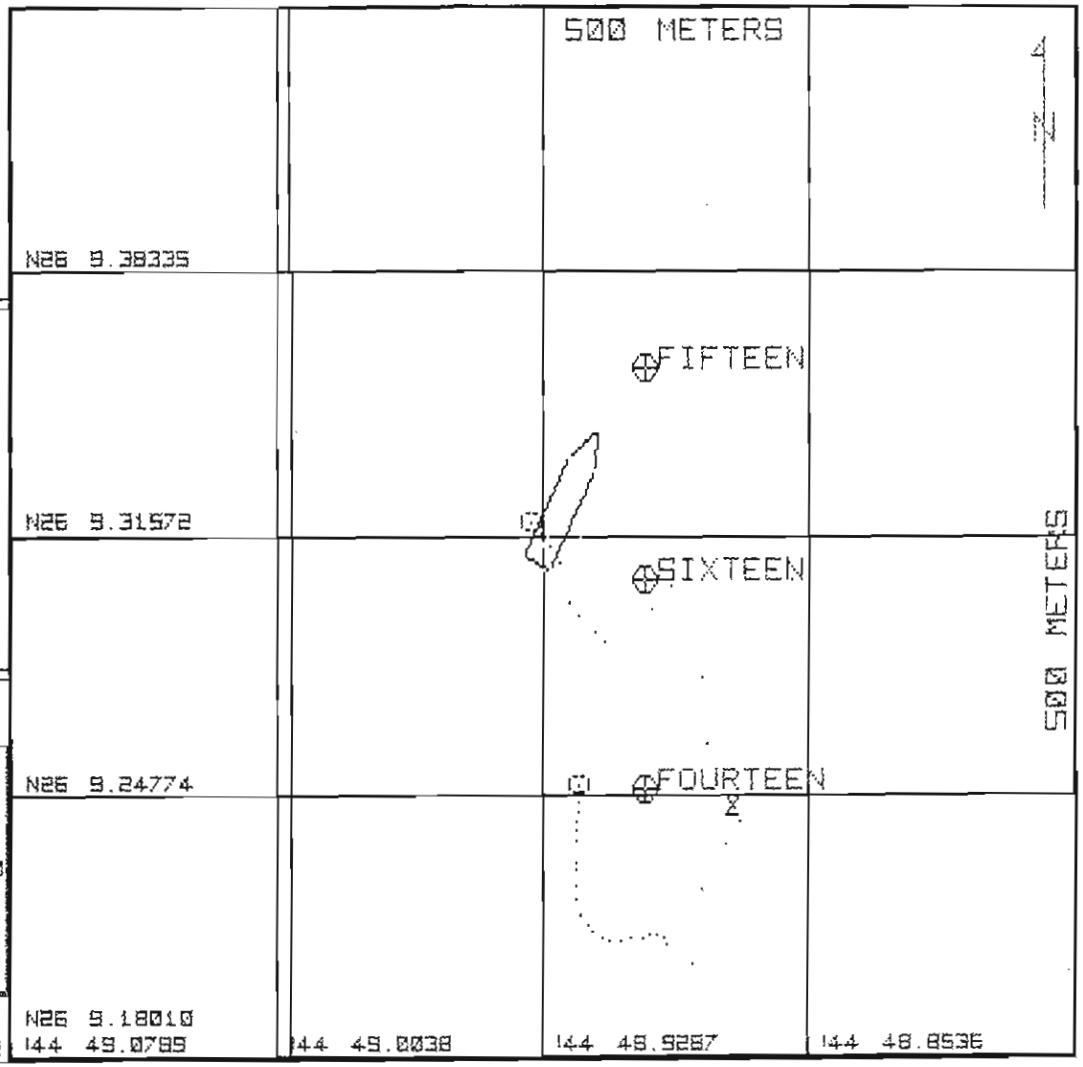
Project: RRS CHARLES D
09-24-1996 20:02:01
Logging:ON Space:97 M
Devices:OK Cyc:7291
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

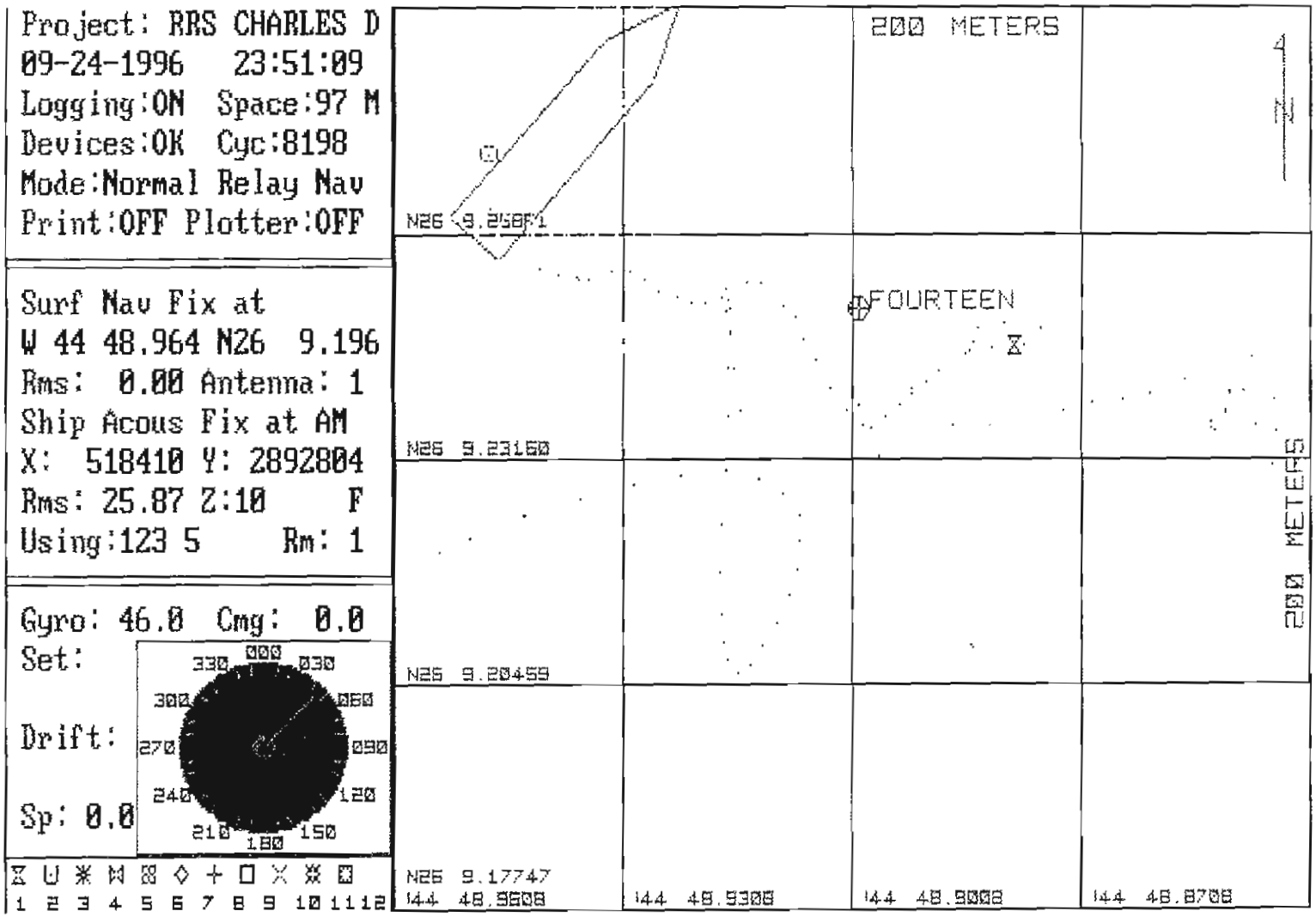
Surf Nav Fix at
W 44 48.918 N26 9.250
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518438 Y: 2892896
Rms: 43.45 Z:10 F
Using:123 5 Rm: 1

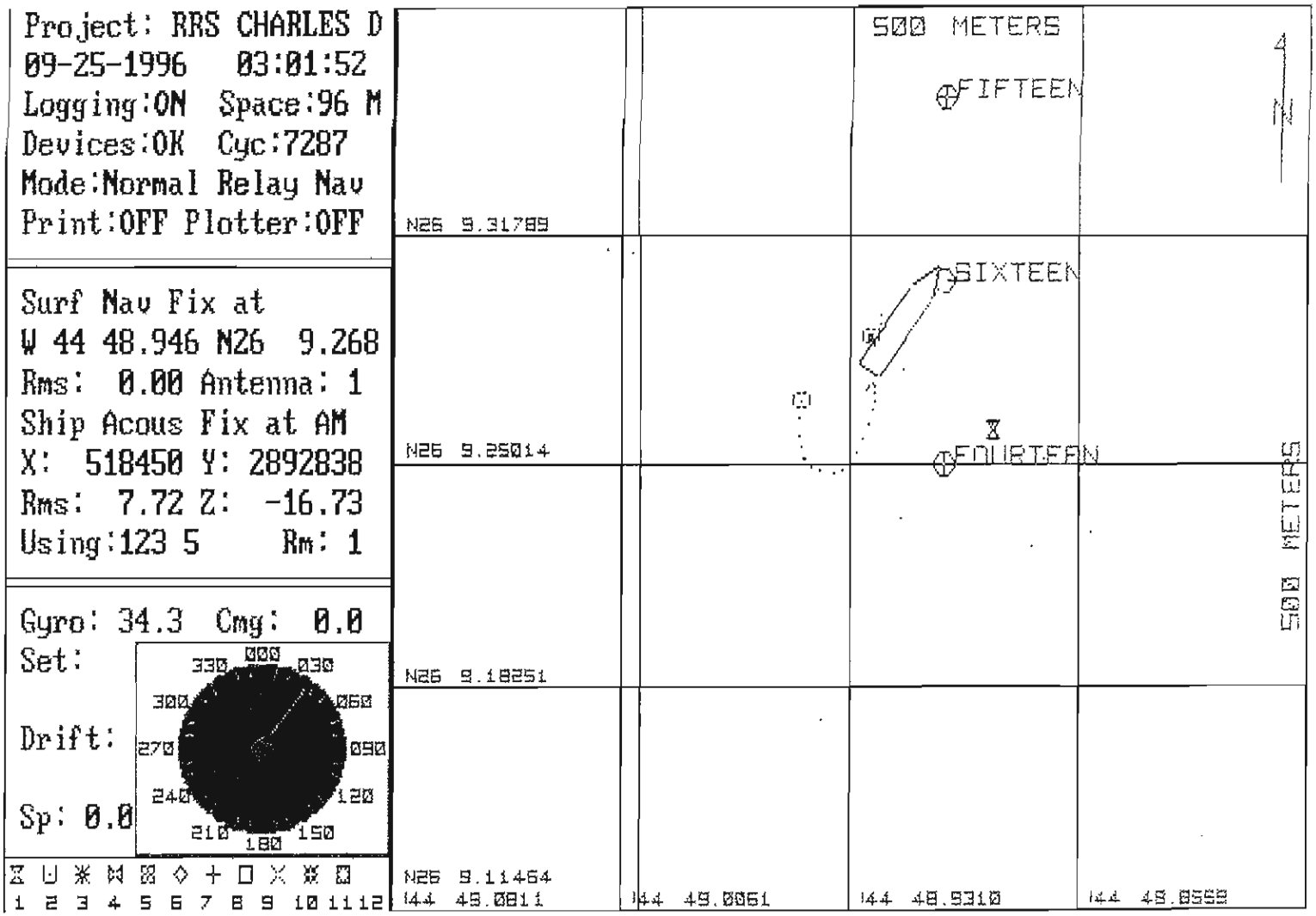
Gyro: 23.9 Cmg: 0.0
Set:
Drift:
Sp: 0.0

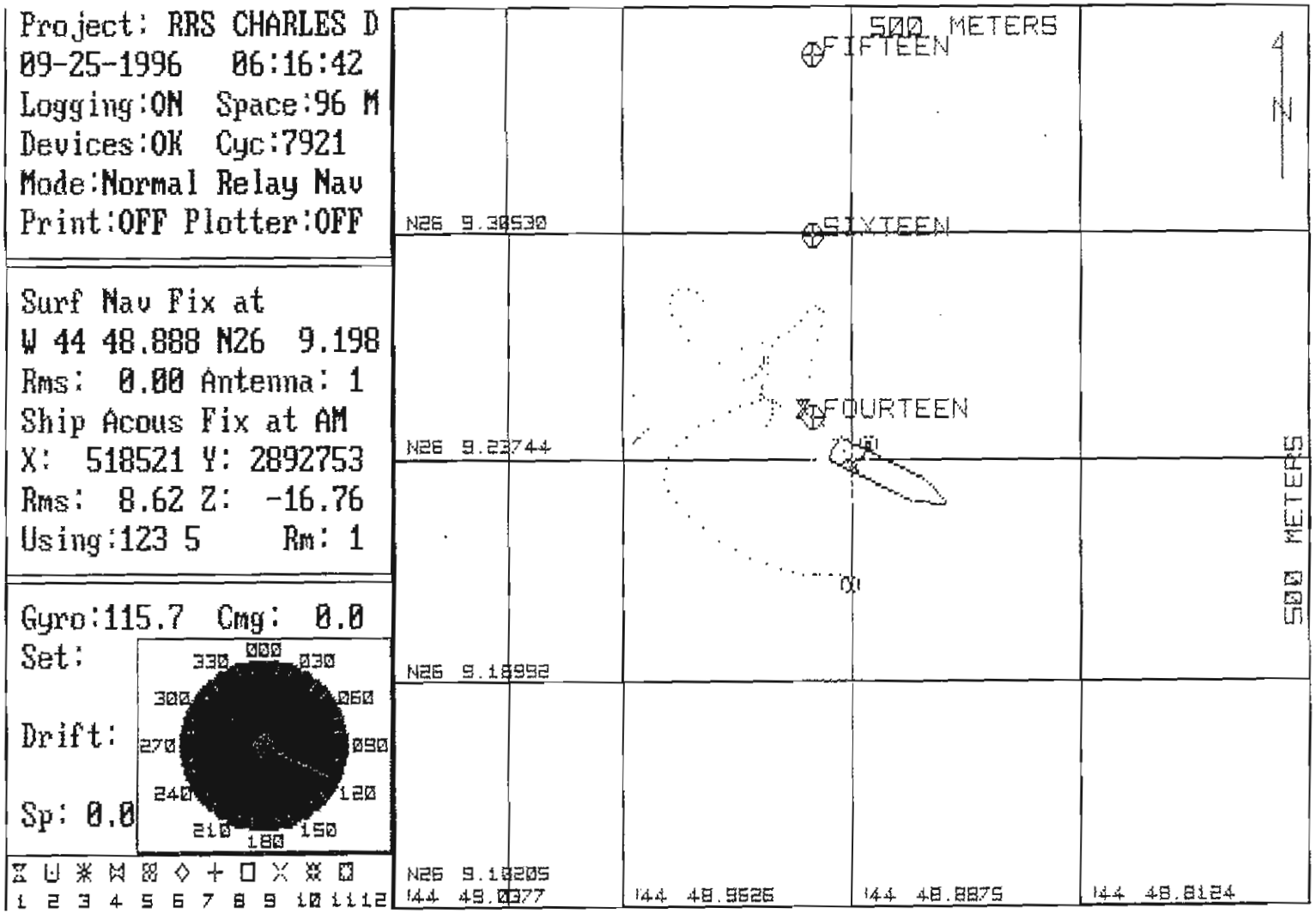


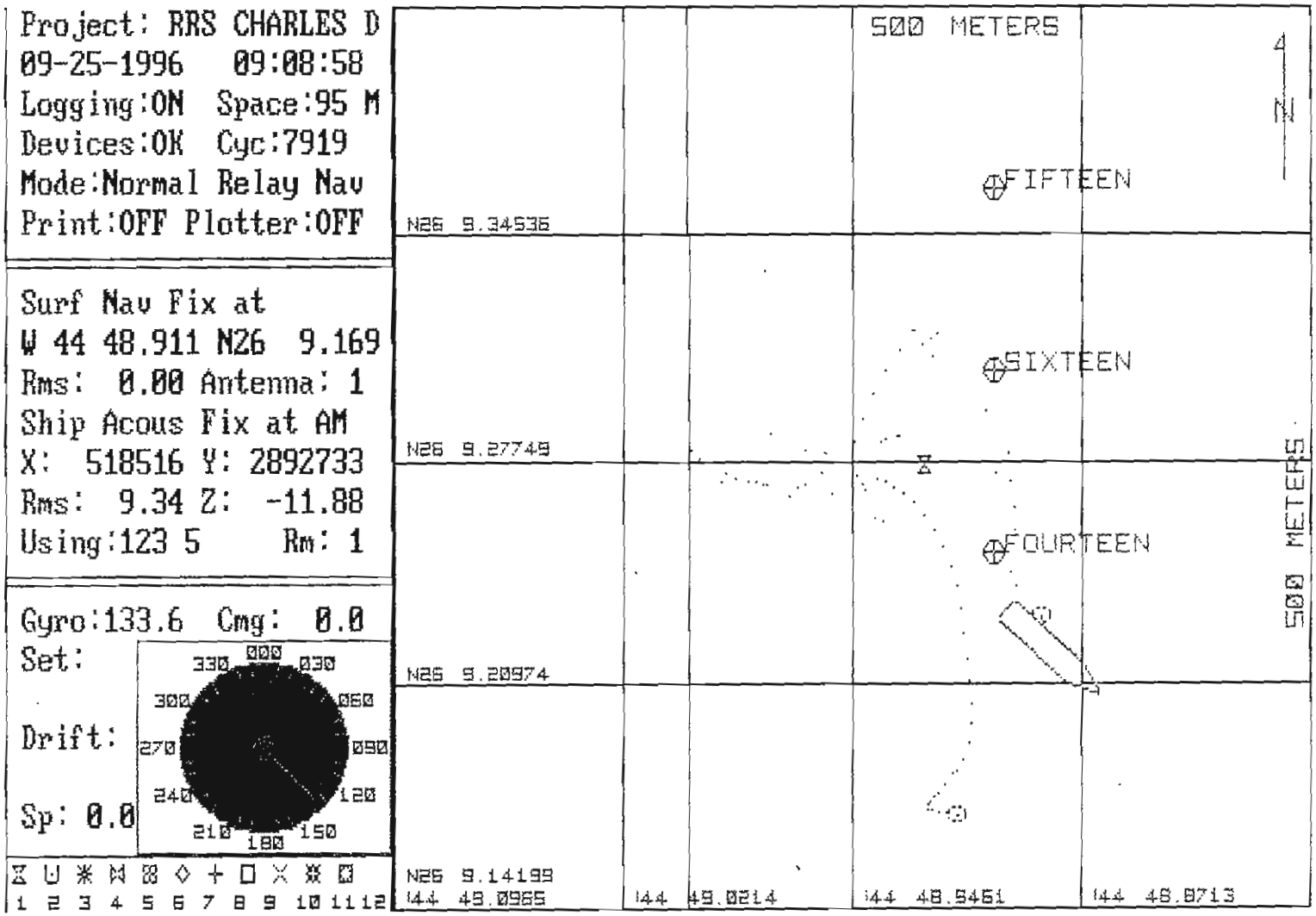
1 2 3 4 5 6 7 8 9 10 11 12




Project: RRS CHARLES D
09-24-1996 23:51:09
Logging:ON Space:97 M
Devices:OK Cyc:8198
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.964 N26 9.196
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518410 Y: 2892804
Rms: 25.87 Z:10 F
Using:123 5 Rm: 1
Gyro: 46.0 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
N26 9.25871
FOURTEEN
N26 9.23160
N26 9.20459
N26 9.17747
144 48.9608
144 48.9308
144 48.9008
144 48.8708
200 METERS


Project: RRS CHARLES D
09-25-1996 03:01:52
Logging:ON Space:96 M
Devices:OK Cyc:7287
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.946 N26 9.268
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518450 Y: 2892838
Rms: 7.72 Z: -16.73
Using:123 5 Rm: 1
Gyro: 34.3 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
FIFTEEN
SIXTEEN
FOURTEEN
N
500 METERS
N26 9.31789
N26 9.25014
N26 9.18251
N26 9.11464
44 49.0811
44 49.0061
44 48.9310
44 48.8558
1 2 3 4 5 6 7 8 9 10 11 12

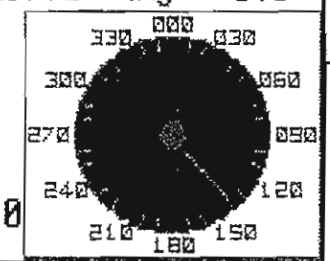

Project: RRS CHARLES D
09-25-1996 06:16:42
Logging:ON Space:96 M
Devices:OK Cyc:7921
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.888 N26 9.198
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518521 Y: 2892753
Rms: 8.62 Z: -16.76
Using:123 5 Rm: 1
Gyro:115.7 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
FIFTEEN
SIXTEEN
FOURTEEN
500 METERS
N26 9.30530
N26 9.23744
N26 9.18992
N26 9.10205
W44 48.9626
W44 48.8875
W44 48.8124


Project: RRS CHARLES D
09-25-1996 09:08:58
Logging:ON Space:95 M
Devices:OK Cyc:7919
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.911 N26 9.169
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518516 Y: 2892733
Rms: 9.34 Z: -11.88
Using:123 5 Rm: 1
Gyro:133.6 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
N
FIFTEEN
SIXTEEN
FOURTEEN
500 METERS
N26 9.34536
N26 9.27749
N26 9.20974
N26 9.14199
44 49.0965
44 49.0214
44 48.9461
44 48.8713

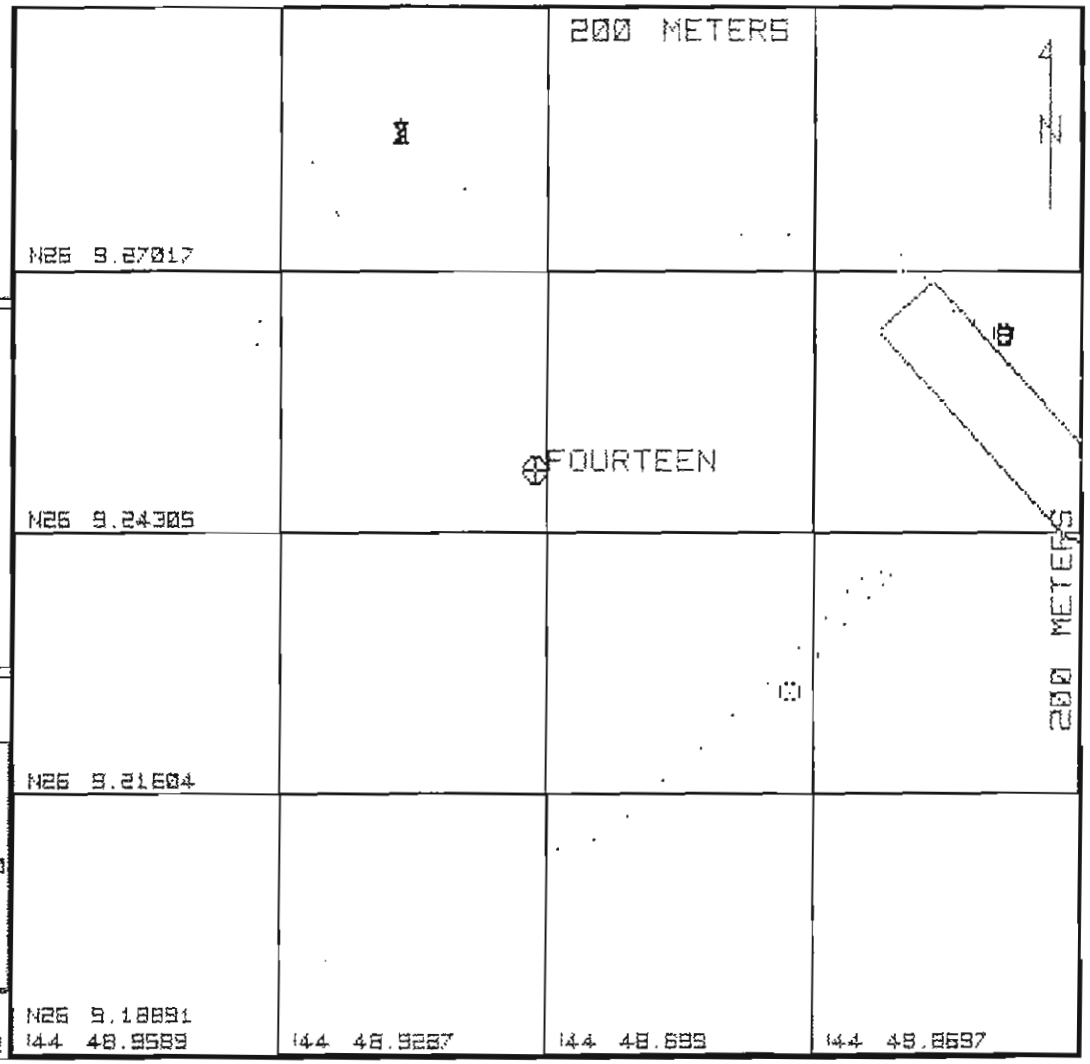
Project: RRS CHARLES D
09-25-1996 13:11:13
Logging:ON Space:95 M
Devices:OK Cyc:7950
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

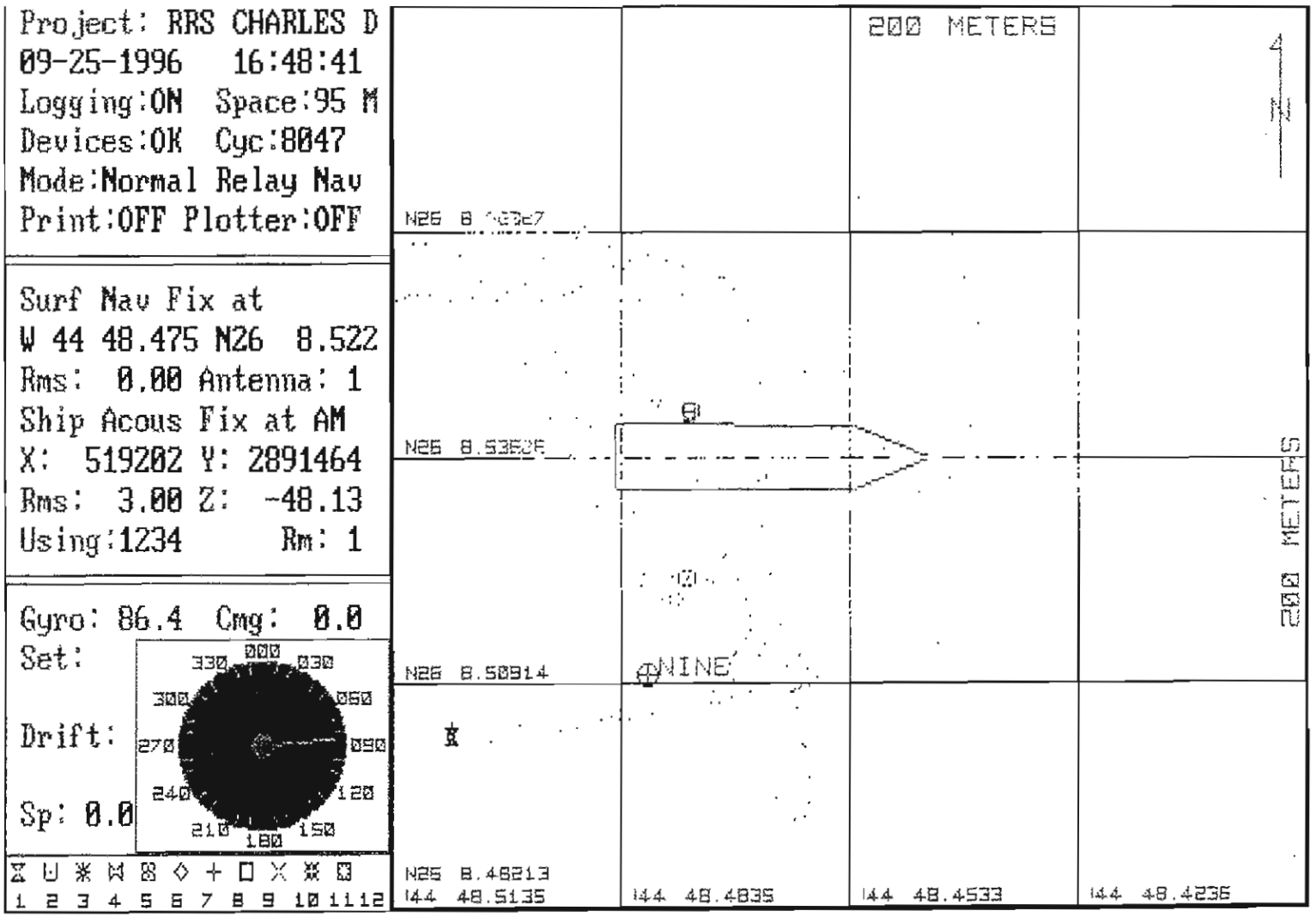
Surf Nav Fix at
W 44 48.872 N26 9.226
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518578 Y: 2892795
Rms: 8.94 Z: -14.48
Using:123 5 Rm: 1

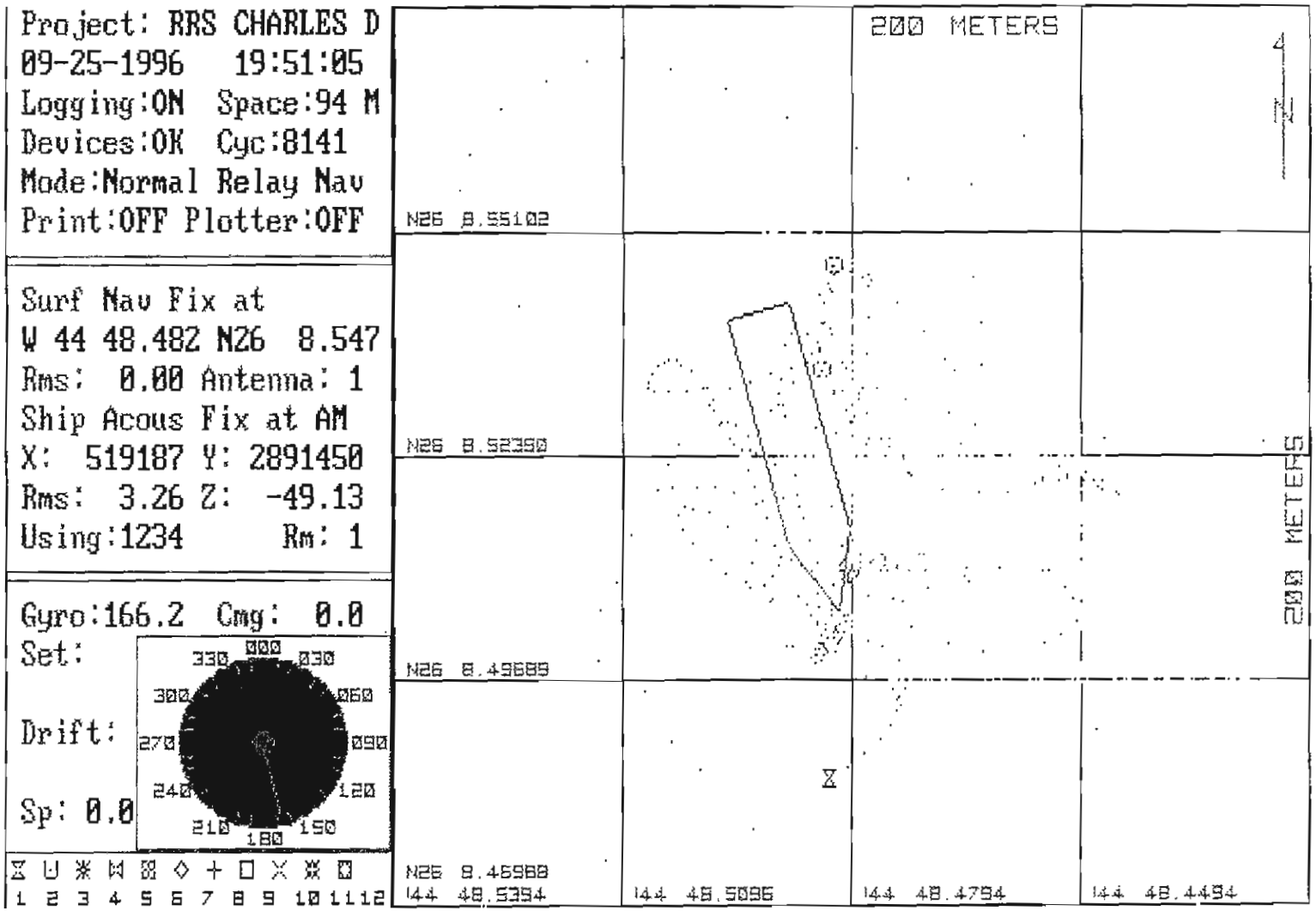
Gyro:139.2 Cmg: 0.0
Set:
Drift:
Sp: 0.0



1 2 3 4 5 6 7 8 9 10 11 12




Project: RRS CHARLES D
09-25-1996 16:48:41
Logging:ON Space:95 M
Devices:OK Cyc:8047
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.475 N26 8.522
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519202 Y: 2891464
Rms: 3.00 Z: -48.13
Using:1234 Rm: 1
Gyro: 86.4 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
200 METERS
N
N26 8.53626
N26 8.50914
NINE
N25 8.48213
W44 48.5135
W44 48.4835
W44 48.4533
W44 48.4236


Project: RRS CHARLES D
09-25-1996 19:51:05
Logging:ON Space:94 M
Devices:OK Cyc:8141
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.482 N26 8.547
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519187 Y: 2891450
Rms: 3.26 Z: -49.13
Using:1234 Rm: 1
Gyro:166.2 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
N
N26 8.55102
N26 8.52350
N26 8.49685
N26 8.46988
W44 48.5394
W44 48.5096
W44 48.4794
W44 48.4494
200 METERS

Project: RRS CHARLES D
09-25-1996 23:06:24
Logging:ON Space:94 M
Devices:OK Cyc:8102
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

Surf Nav Fix at
W 44 48.397 N26 8.598
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519357 Y: 2891585
Rms: 2.97 Z: -43.50
Using:1234 Rm: 1

Gyro:182.9 Cmg: 0.0
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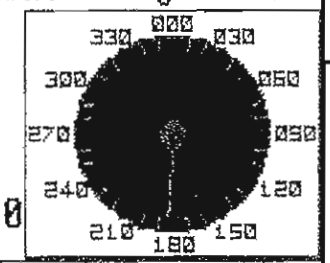
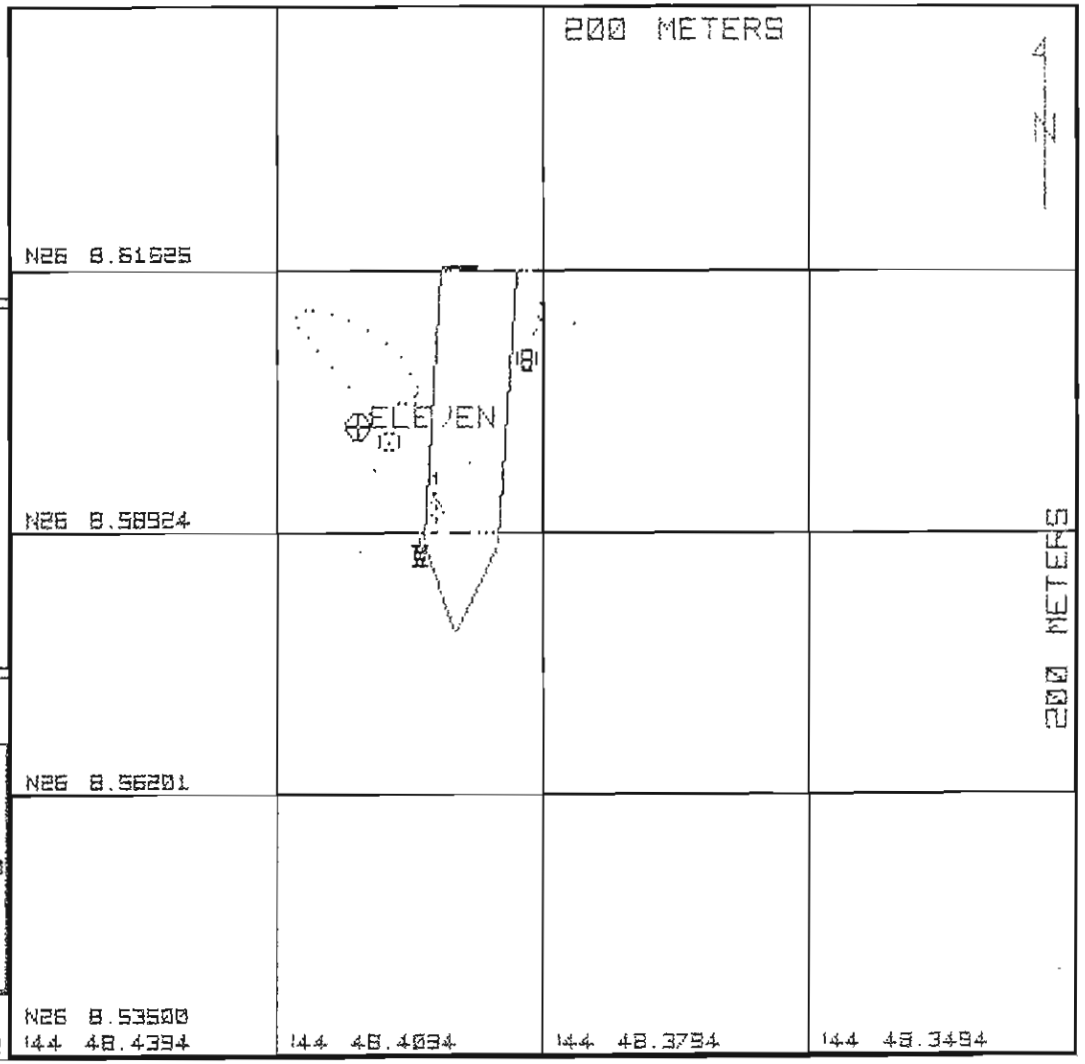
Drift:
Sp: 0.0



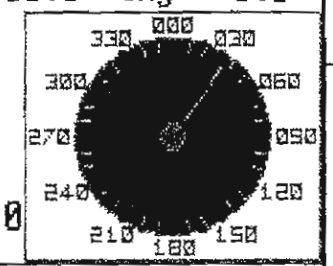
1 2 3 4 5 6 7 8 9 10 11 12



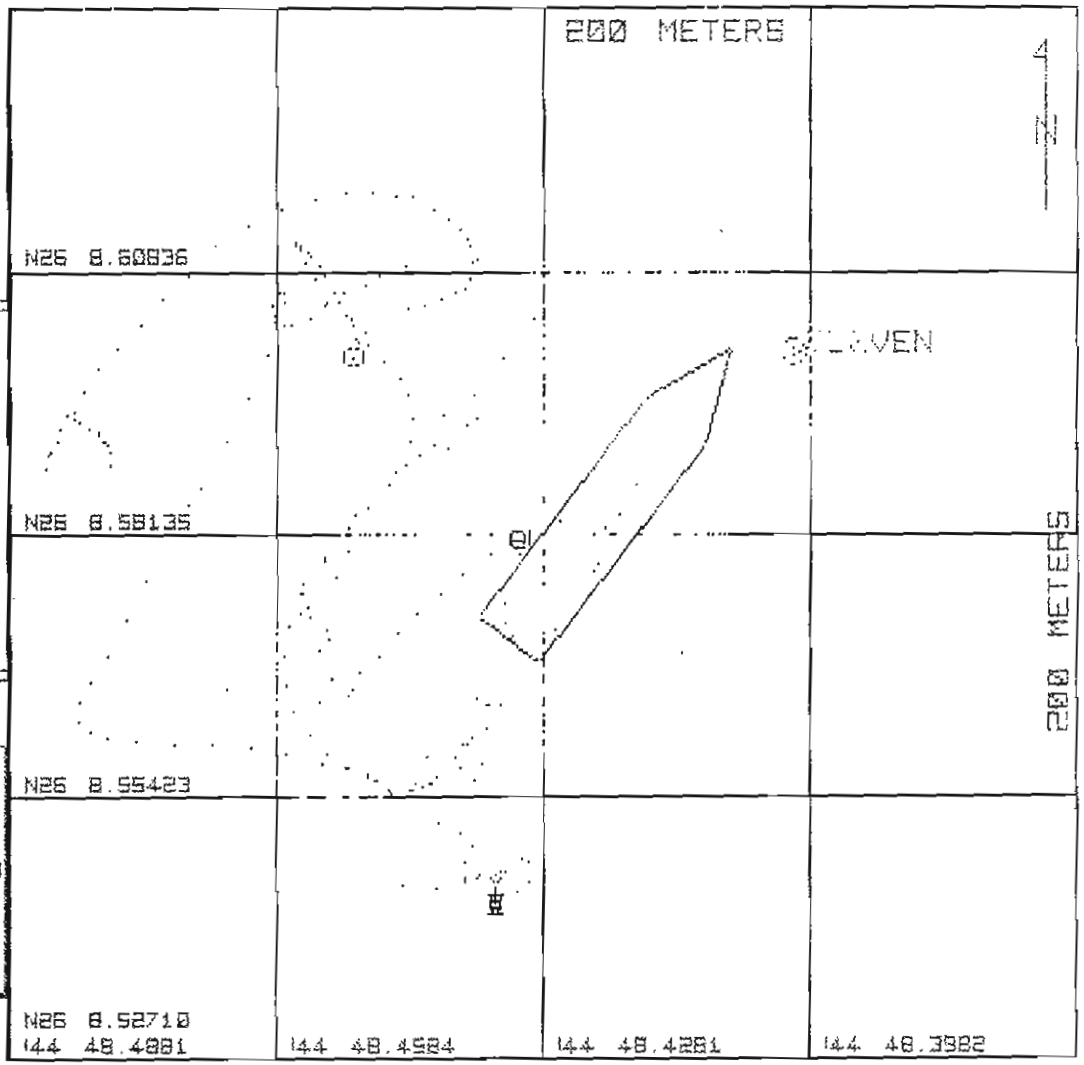
Project: RRS CHARLES D
09-26-1996 02:51:54
Logging:ON Space:93 M
Devices:OK Cyc:8203
Mode:Normal Relay Nav
Print:OFF Plotter:OFF

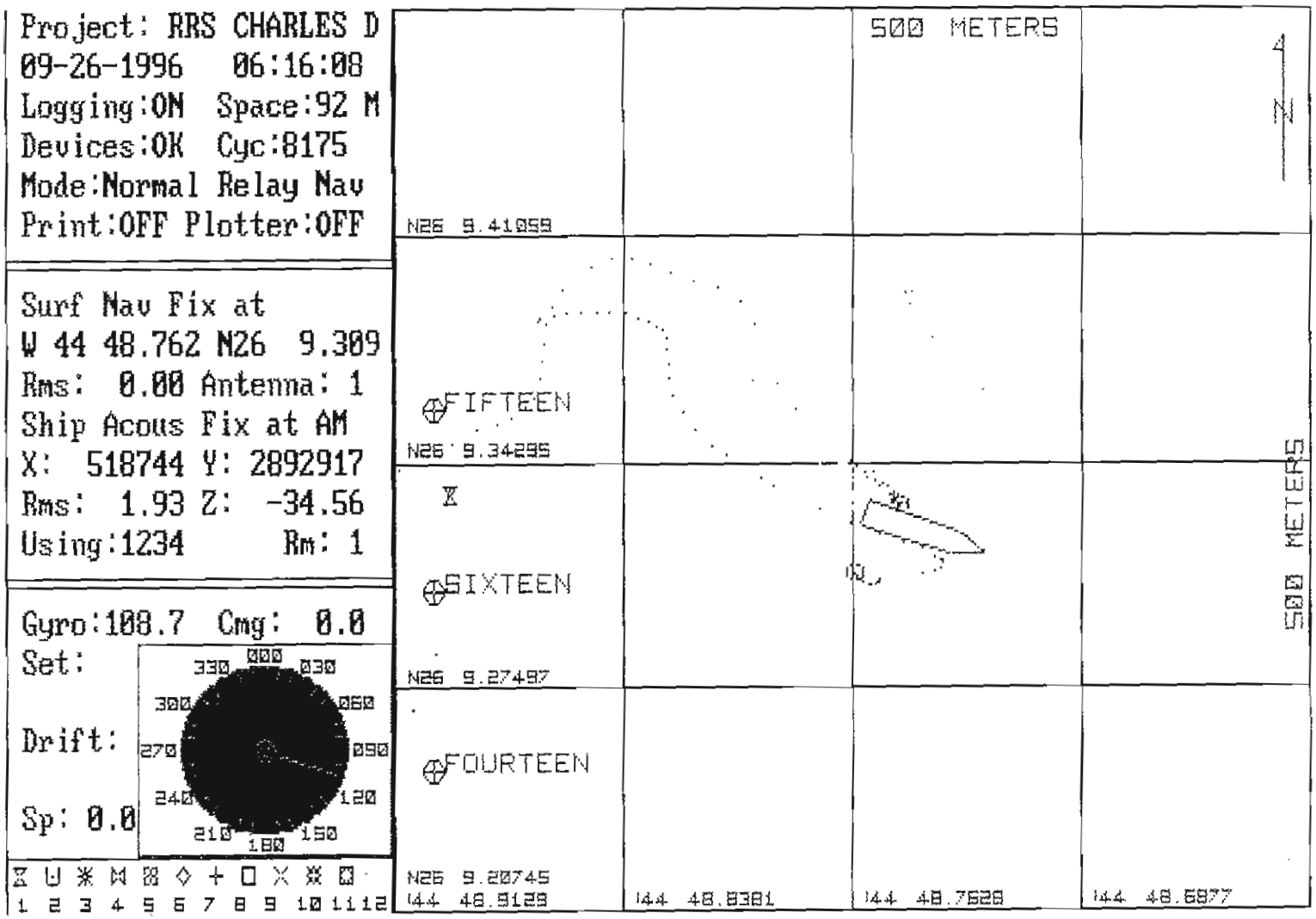
Surf Nav Fix at
W 44 48.449 N26 8.599
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519274 Y: 2891536
Rms: 2.76 Z: -45.99
Using:1234 Rm: 1

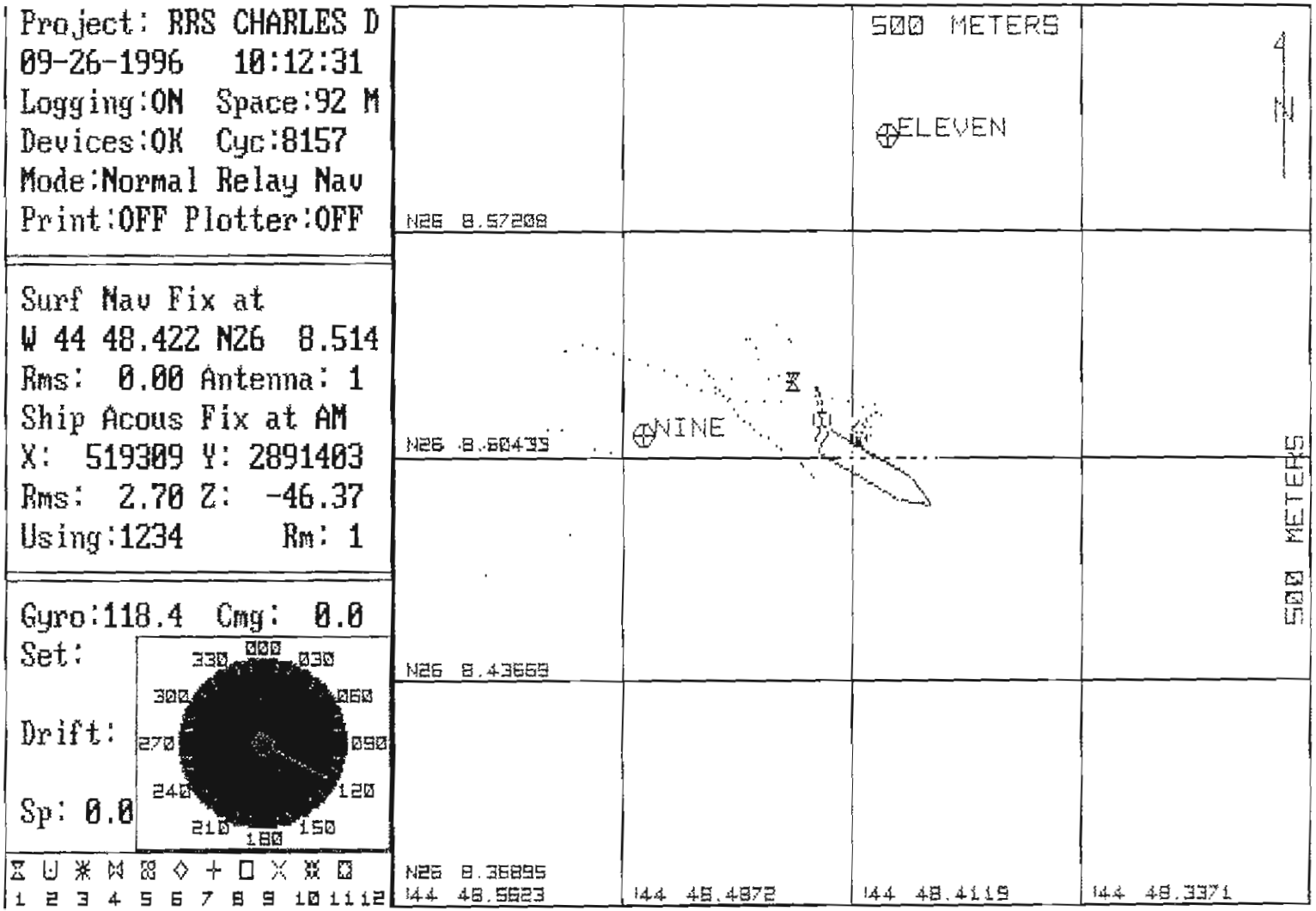
Gyro: 35.3 Cmg: 0.0
Set:
Drift:
Sp: 0.0

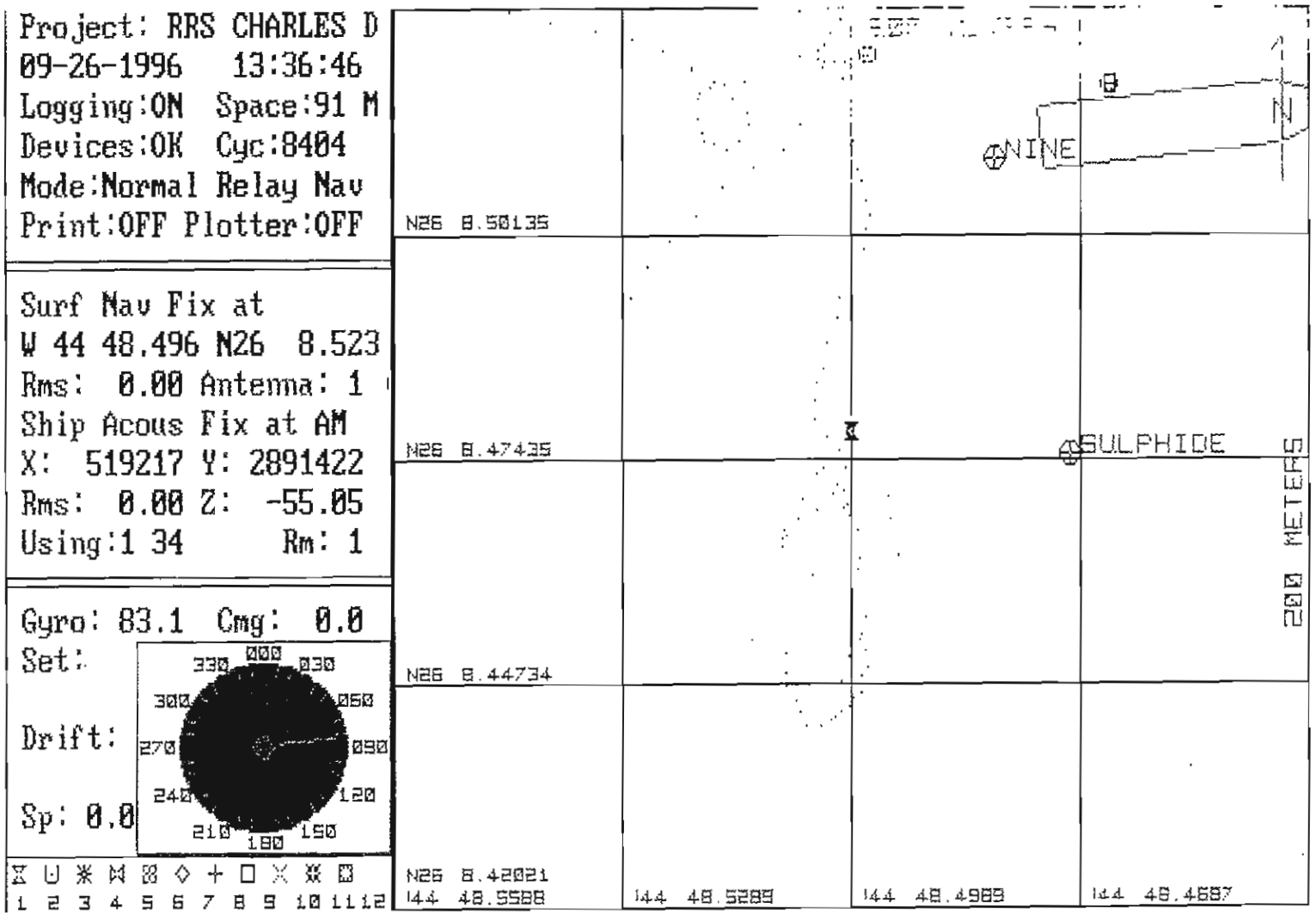


1 2 3 4 5 6 7 8 9 10 11 12




Project: RRS CHARLES D
09-26-1996 06:16:08
Logging:ON Space:92 M
Devices:OK Cyc:8175
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.762 N26 9.309
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 518744 Y: 2892917
Rms: 1.93 Z: -34.56
Using:1234 Rm: 1
Gyro:108.7 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
N
500 METERS
N26 9.41059
FIFTEEN
N26 9.34295
SIXTEEN
N26 9.27497
FOURTEEN
N26 9.20745
W44 48.9129
W44 48.8381
W44 48.7628
W44 48.6877
1 2 3 4 5 6 7 8 9 10 11 12


Project: RRS CHARLES D
09-26-1996 10:12:31
Logging:ON Space:92 M
Devices:OK Cyc:8157
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.422 N26 8.514
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519309 Y: 2891403
Rms: 2.70 Z: -46.37
Using:1234 Rm: 1
Gyro:118.4 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
500 METERS
ELEVEN
NINE
500 METERS
N26 8.57208
N26 8.50435
N26 8.43659
N26 8.36895
W44 48.5623
W44 48.4872
W44 48.4119
W44 48.3371


Project: RRS CHARLES D
09-26-1996 13:36:46
Logging:ON Space:91 M
Devices:OK Cyc:8404
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.496 N26 8.523
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519217 Y: 2891422
Rms: 0.00 Z: -55.05
Using:1 34 Rm: 1
Gyro: 83.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
NINE
SULPHIDE
200 METERS
N26 8.50135
N26 8.47435
N26 8.44734
N26 8.42021
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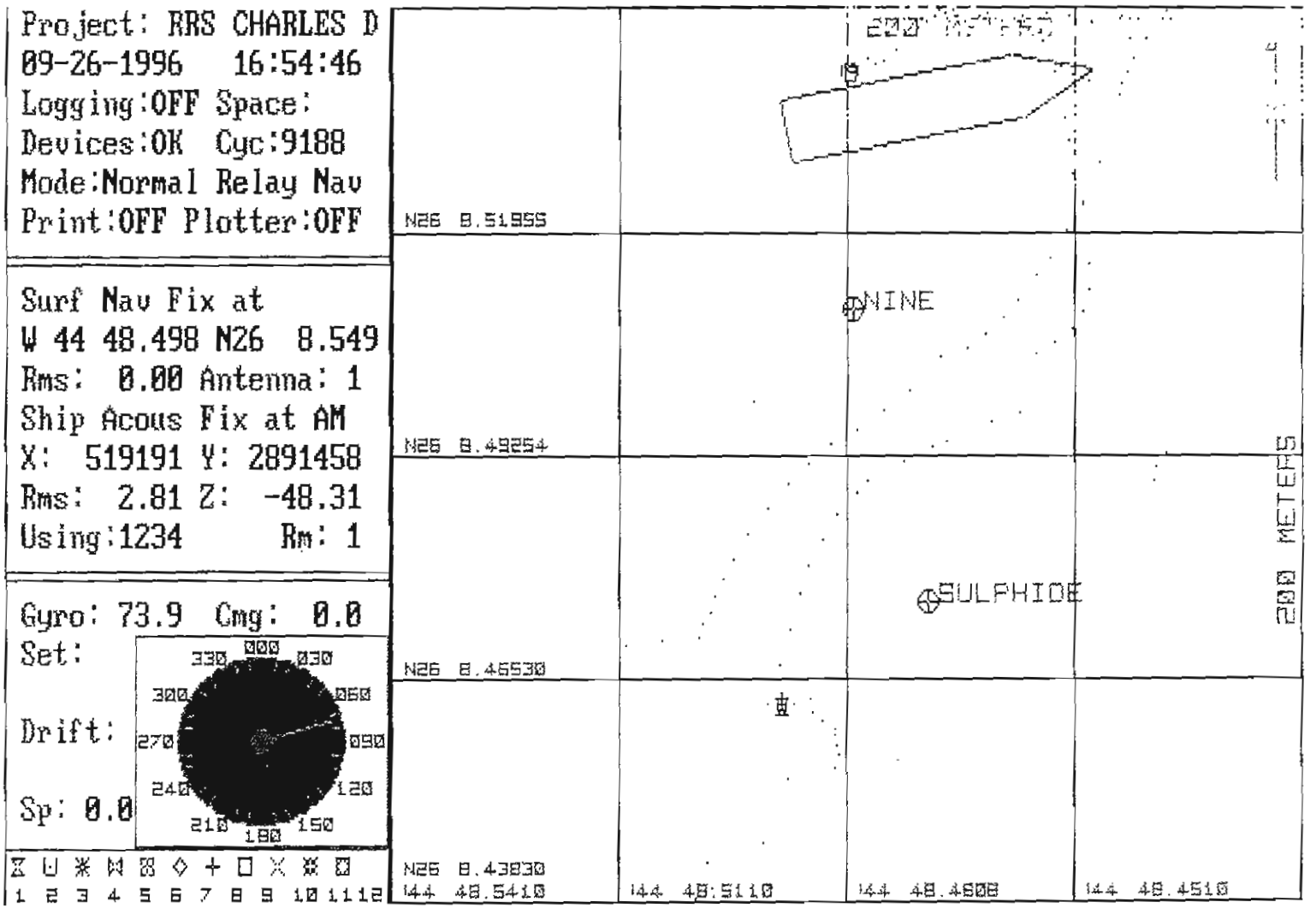
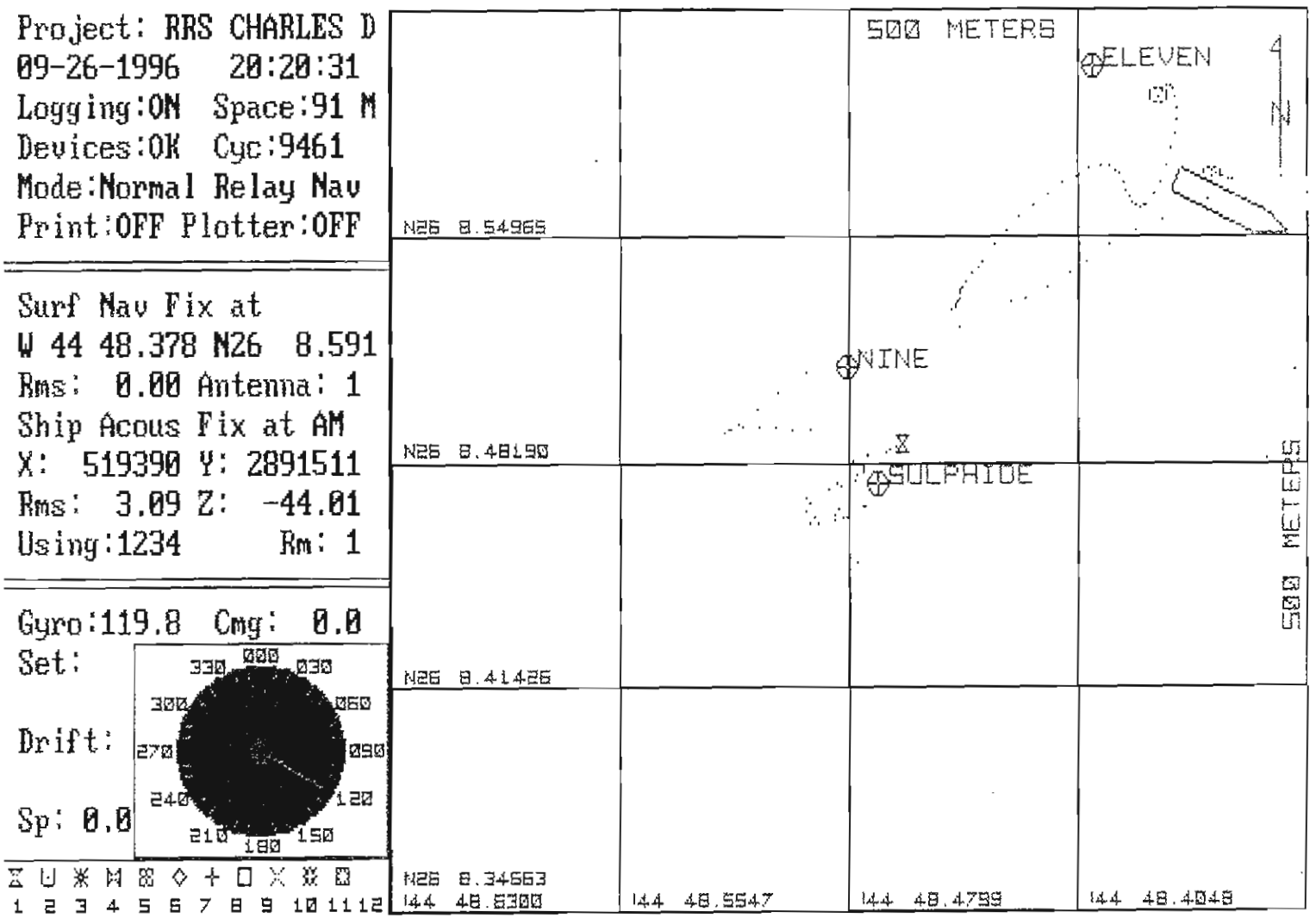
W44 48.5289
W44 48.4989
W44 48.4687


Project: RRS CHARLES D
09-26-1996 16:54:46
Logging:OFF Space:
Devices:OK Cyc:9188
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.498 N26 8.549
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519191 Y: 2891458
Rms: 2.81 Z: -48.31
Using:1234 Rm: 1
Gyro: 73.9 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
N26 8.51855
N26 8.49254
N26 8.46530
N26 8.43830
W44 48.5410
W44 48.5110
W44 48.4808
W44 48.4510
NINE
SULPHIDE
200 METERS


Project: RRS CHARLES D
09-26-1996 20:20:31
Logging:ON Space:91 M
Devices:OK Cyc:9461
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.378 N26 8.591
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519390 Y: 2891511
Rms: 3.09 Z: -44.01
Using:1234 Rm: 1
Gyro:119.8 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
500 METERS
ELEVEN
NINE
SULPHIDE
N
500 METERS
N26 8.54965
N26 8.48190
N26 8.41426
N26 8.34663
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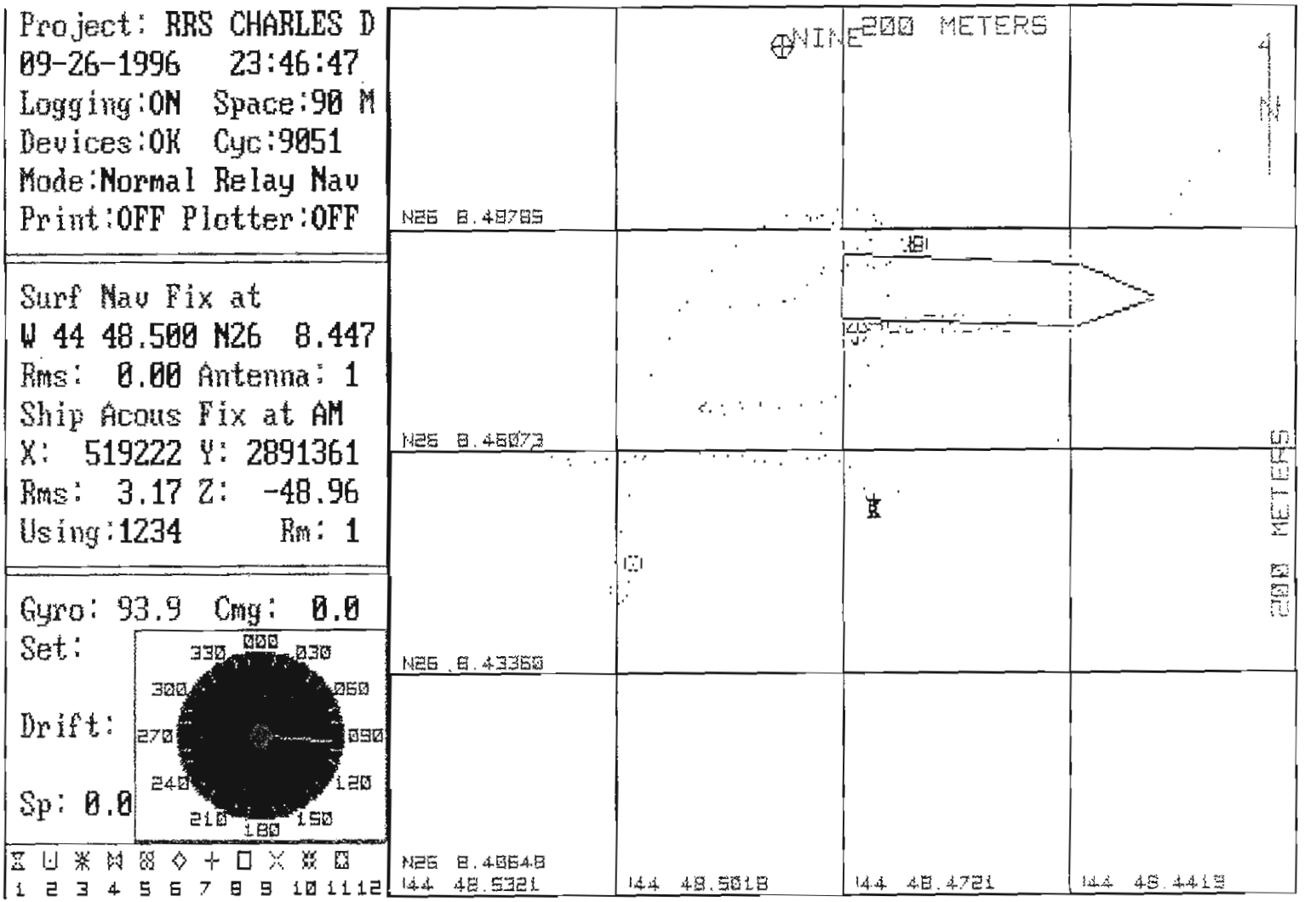
W44 48.5547
W44 48.4799
W44 48.4048


Project: RRS CHARLES D
09-26-1996 23:46:47
Logging:ON Space:90 M
Devices:OK Cyc:9051
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.500 N26 8.447
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519222 Y: 2891361
Rms: 3.17 Z: -48.96
Using:1234 Rm: 1
Gyro: 93.9 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
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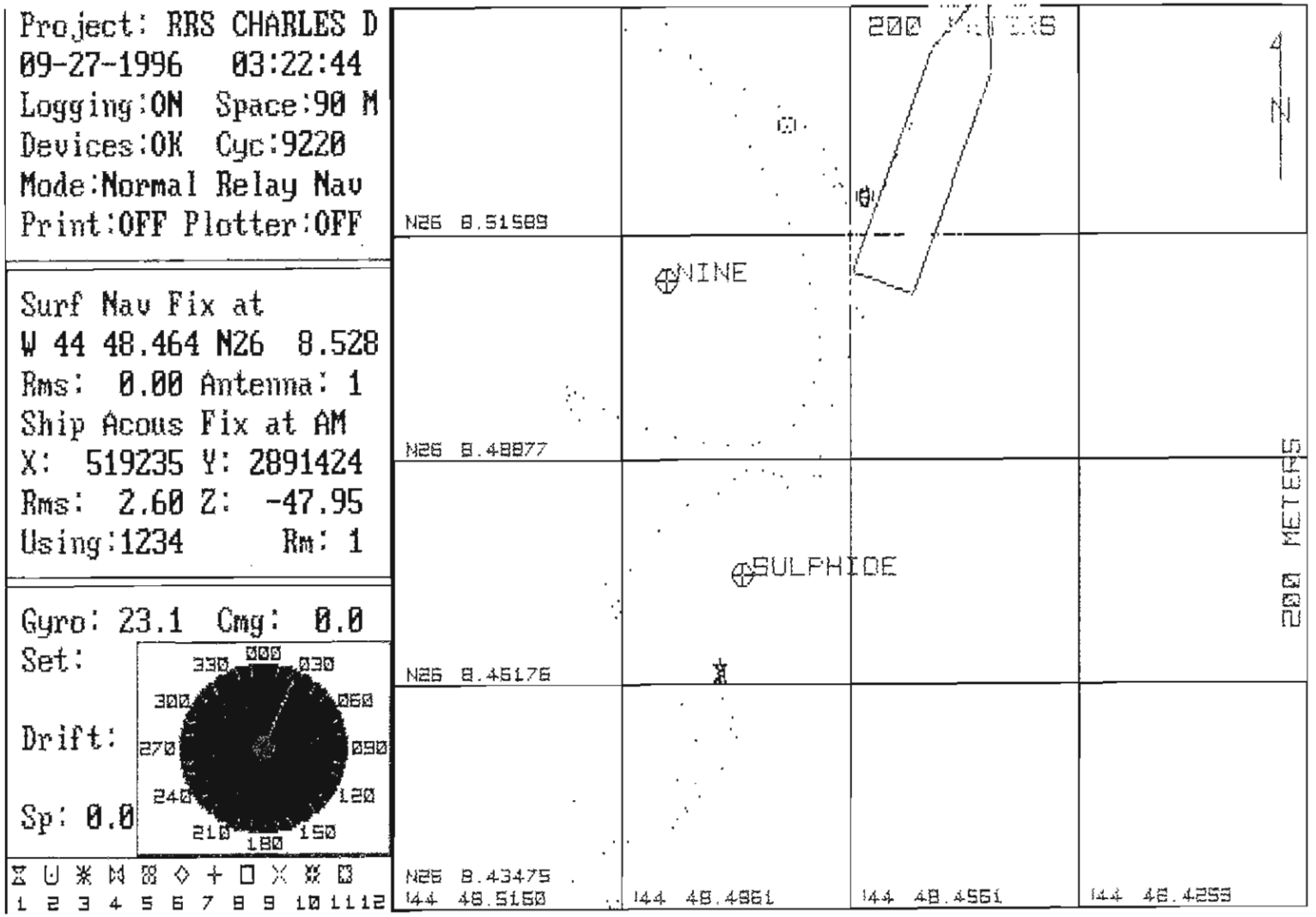
270
300
330
NINE
200 METERS
200 METERS
N26 8.48785
N26 8.48073
N26 8.43360
N26 8.40648
W44 48.5321
W44 48.5018
W44 48.4721
W44 48.4413
1 2 3 4 5 6 7 8 9 10 11 12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09-27-1996 03:22:44
Logging:ON Space:90 M
Devices:OK Cyc:9220
Mode:Normal Relay Nav
Print:OFF Plotter:OFF
Surf Nav Fix at
W 44 48.464 N26 8.528
Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519235 Y: 2891424
Rms: 2.60 Z: -47.95
Using:1234 Rm: 1
Gyro: 23.1 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
1 2 3 4 5 6 7 8 9 10 11 12
200 METERS
N
NINE
SULPHIDE
N26 8.51589
N26 8.48877
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N26 8.43475
W44 48.5150
W44 48.4861
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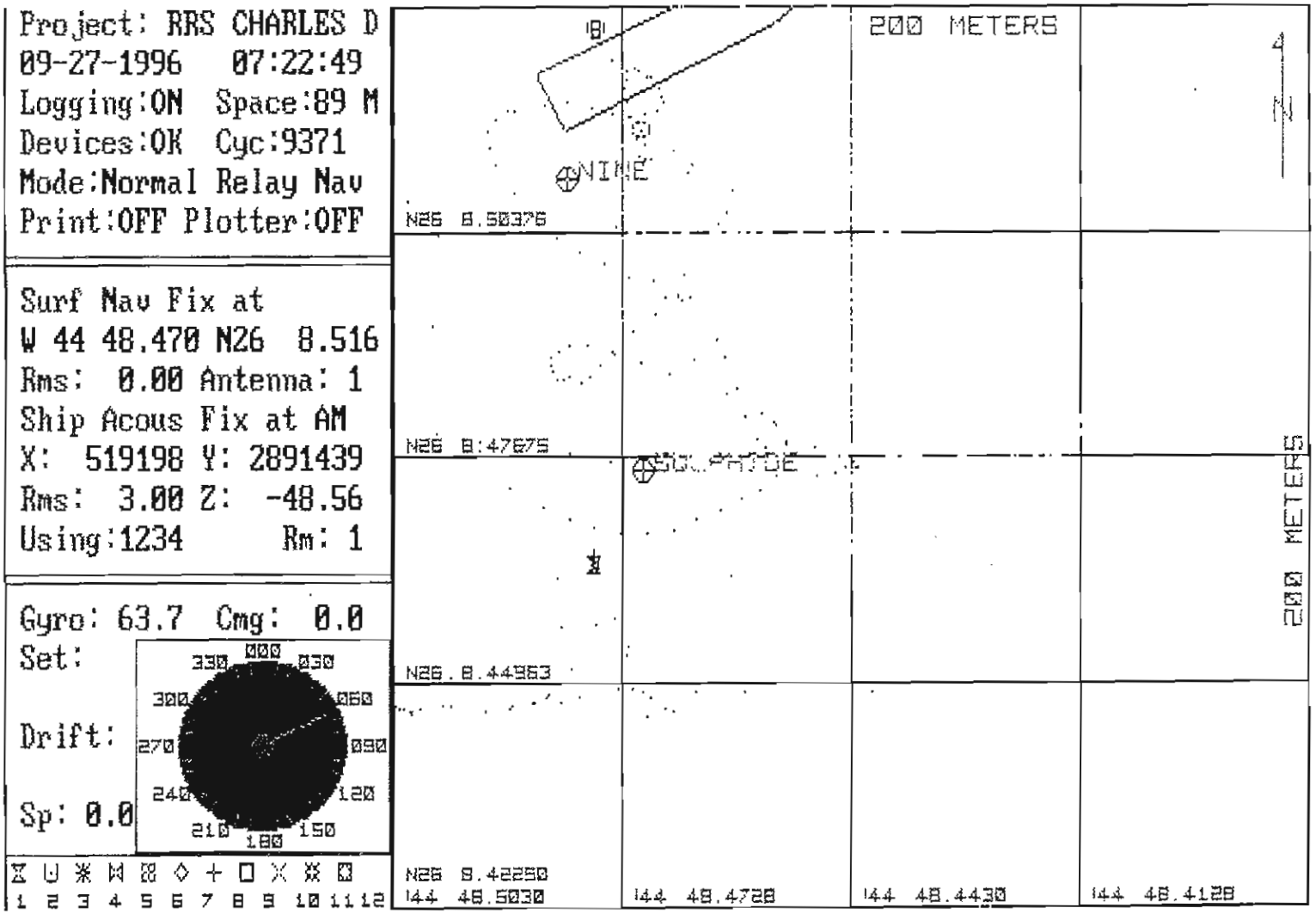
W44 48.4253
200 METERS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09-27-1996 07:22:49
Logging:ON Space:89 M
Devices:OK Cyc:9371
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Surf Nav Fix at
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Rms: 0.00 Antenna: 1
Ship Acous Fix at AM
X: 519198 Y: 2891439
Rms: 3.00 Z: -48.56
Using:1234 Rm: 1
Gyro: 63.7 Cmg: 0.0
Set:
Drift:
Sp: 0.0
000
030
060
090
120
150
180
210
240
270
300
330
200 METERS
NINE
N26 8.50376
N26 8.47875
N26 8.44963
N26 8.42250
144 48.5030
144 48.4728
144 48.4430
144 48.4128
200 METERS