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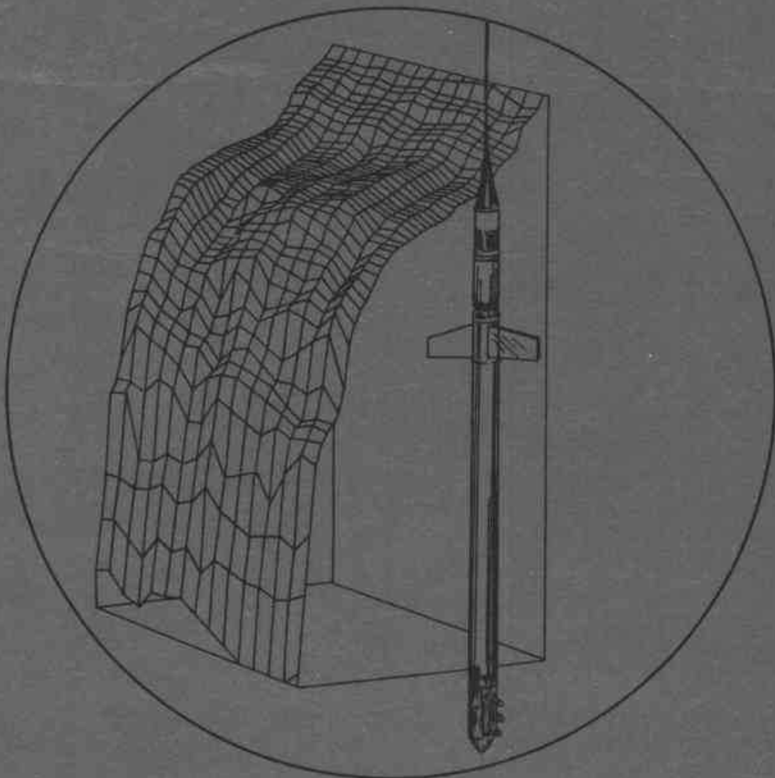

The Rapid-Sampling Vertical Profiler Test Cruise, July 1982 "FRONTS 82"

by

Priscilla A. Newberger
Herve H. Dannelongue
Douglas R. Caldwell
Thomas M. Dillon
Stephen D. Wilcox
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OREGON STATE UNIVERSITY

The Rapid-Sampling Vertical Profiler

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ACKNOWLEDGEMENTS

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I. Introduction

In this report we describe a preliminary version of a temperature/conductivity profiler that combines the calibration accuracy of a CTD with the vertical resolution of a microstructure instrument and the ease of deployment of an XBT. We also describe the results of a test of this version on a month-long cruise from Honolulu to 42 N and back in July 1982. This instrument system, which we call the Rapid-Sampling Vertical Profiler, has two versions. One uses a Neil Brown conductivity transducer and a fast-tip thermistor as sensors, and has a vertical resolution of 3 cm in salinity and temperature. The other has a micro-scale conductivity sensor, with a fast-tip thermistor. It has a resolution of less than one millimeter in conductivity, but only 3 cm in the thermistor signal so that density information can still only be acquired on the 3-cm scale.

The system used for this test and described in this document is only a trial version, definitely not the final version which is under construction in 1983. We will issue a report in 1984 which will describe the final version and the results of a test of it to be conducted as part of the "Mildex" experiment in October/November 1983.

The probe is designed to be deployed from a ship moving at speeds to 8 knots, but on this cruise considerations involved with the other instruments in use kept the ship's speed at 4.2 knots. The other instruments were the Towed Thermistor/Conductivity Chain (Clayton Paulson, Oregon State University) and an Acoustic Doppler Log (Lloyd Regier, Scripps Institution of Oceanography). The RSVP has been designed to complement these instruments in producing a 3-dimensional picture of the temperature, salinity, density and shear fields in the upper ocean, and especially the spatial distributions of the gradients of these fields. The same suite of instruments will be used in the "MILDEX" experiment and in the "TROPIC HEAT" cruises of 1984 and 1986.

II. Cruise report

The FRONTS 82 cruise lasted for 23 days from 4 July 1982 to 25 July 1982. During this period the towed thermistor/ conductivity chain (Clayton Paulson, OSU) and the acoustic doppler log (Lloyd Regier, SIO) were kept in operation around the clock, but the RSVP was deployed only between lunch and sunset (7 hours a day), mostly because we were allotted only three berths. During the cruise the weather was nice to fair with winds of 0 - 2 knots and swell 0 - 5 feet.

Five versions of the RSVP (Table II-1) were tried in order to determine the effect of design variation and possible interaction among elements. The temperature-measurement system was the same for all units as was the conductivity circuitry. Each of these measurement systems is discussed in detail in section IV of this report.

In addition to the vertically profiling RSVP, a similar unit equipped with a microconductivity sensor was modified to attach to Paulson's towed chain. It was hoped that the extremely fast response time of this sensor would enable us to calculate horizontal towed spectra of the temperature fluctuations. The unit did not work due to electronic and connector difficulties, but the technique shows great promise and will be used again.

The RSVP units were deployed during 14 seven hour working periods. A profile was recorded every 6 minutes, so that about 65 profiles were recorded each day for a total of 890 profiles. This includes 662 profiles with Neil Brown conductivity sensor units and 228 with the Michael Head microconductivity sensor (Table II-2).

At the beginning of each working period (and more frequently if there was any question of the conductivity signal drifting), a file was recorded with the instrument in a bucket on deck and a water sample was taken to be analysed on shore. Additional surface water samples were taken every two hours throughout the cruise. Thus we are able to monitor any changes in conductivity calibration.

Table II-1. Description of RSVP units

Unit #	1	2	3	4	5	6 CHAIN
POWER	9 V BATTERY	DC/DC # 2	DC/DC # 3	9 V BATTERY	DC/DC # 3	DC/DC # 1
PRESSURE	FM # 3	FM # 7	DC # 10	DC # 20	DC # 20	FROM CHAIN
TEMPERATURE MODULE	# 12	# 13	# 14	# 15	# 15	# 16
SENSOR	FP07 # 72	FP07 # 73	FP07 # 77 REPLACED FP14 # 147	FP07 # 75	FP07 # 75	FP14 # 143
CONDUCTIVITY MODULE	# 2	# 5	# 4	# 6	# 6	# 3
SENSOR	NBIS # 479	NBIS # 844	NBIS # 743	MICRO # 6 REPLACED MICRO # 1	MICRO # 6	MICRO # 3
VOLTAGE REGULATOR	# 10 REPLACED # 12	# 11	# 12	# 17	# 17	# 15

Unit # 5 was used for one day only to test microconductivity powered by a dc/dc converter. Unit # 3 was not used after July 18.

Table II-2. RSVP cast summary

			Number of casts				
DATE LOCAL	START LATITUDE	END LATITUDE	UNIT # 1	UNIT # 2	UNIT # 3	UNIT # 4	UNIT # 5
6	27 08' N	27 14' N	2			5	
7					MOORING		
8	28 20' N	28 44' N	52				
9	30 02' N	30 36' N		60			
10	31 57' N	32 23' N	15		41		
11	33 48' N	34 23' N				59	
12	35 51' N	36 19' N	68				
13	37 42' N	38 13' N		73			
14	39 35' N	40 05' N			71		
15	41 30' N	41 59' N	44			25	
16	42 45' N	42 26' N	11			58	
17					MOORING		
18	39 38' N	SURVEY		41			12
19	38 09' N	37 43' N	60				
20	36 13' N	35 39' N		71			
21	34 01' N	33 41' N	41				
22	32 18' N	31 44' N				69	
23	30 21' N	30 15' N	13				

III. FRONTS 82 data plots

a) Temperature, salinity and density profiles

The data collected were divided into sequences of consecutive profiles, one sequence per day unless there was an extended period with no data taken. There are a total of 19 sequences. An average sequence consists of 60 profiles. As a rule, profiles are 6 minutes apart. The data were processed as described in section VI. Twenty centimeter averages are plotted.

For each sequence, two series of plots are presented:

On the left-hand page, temperature (in degrees Celsius) versus depth (in meters). Profiles separated by 6 minutes in time are offset 3 degrees Celsius. If a profile is missing, consecutive profiles are 12 minutes apart in time, and correspondingly separated by 6 degrees Celsius on the plot. If there is a 12 minute gap at the end of a page within a sequence, the first profile on the next page is offset by 3 degrees.

On the right hand page, a plot of 5 variables versus depth for a chosen profile of the left hand page. The 3 lines in the main panel are temperature (T, in degrees Celsius), salinity (S, in parts per thousands) and density (unmarked, in grams per centimeter cubed). The mark plot in the main panel is the Brunt-Vaisala frequency, or buoyancy frequency (in cyles per hour). This frequency is computed from the potential density on a length scale of 2 meters. The right-hand panel shows the arc tangent of the stability ratio versus depth. The stability ratio (Turner,1973) is the most important external parameter indicating the relative strength of double-diffusive processes. Ruddick(1981) suggests that the (four quadrant) arc tangent of this quantity is a practical indicator of whether these processes can be important in a region. For values between minus PI/4 and zero double diffusion can occur. The water column is stable for values between zero and PI/2 while salt fingering may occur for values between PI/2 and 3PI/4. This parameter is computed over a 2 meter scale.

The profiles are identified by tape name and tape file number. The tape name is a string of 8 characteres, 6 for the GMT date, one for the tape identification (A,B,C...), and one for the instrument type (N for NBIS conductivity sensor, M for microconductivity). For the left page, the tape name(s) is printed above the plot, and the file number is printed at the top of each profile. Location, wind and time of the sequence are shown at the bottom of the plot.

Following is a list of some of the profiles in which the problems discussed in section VII can be observed:

-failing conductivity data line (10JLA file 7, 10JLB file 1, 10JLB file 10, 10JLC file 1).

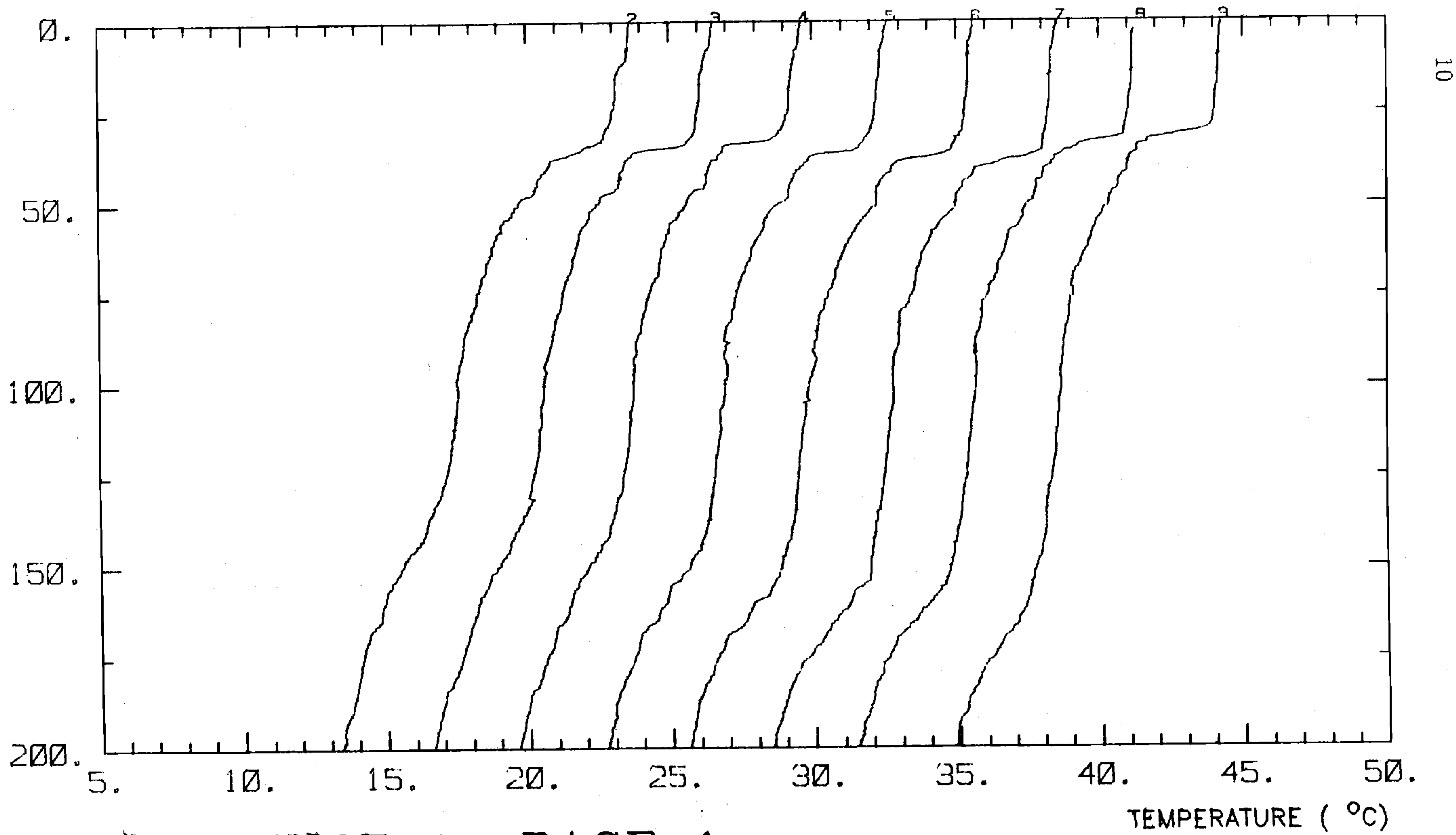
-broken wire in winch connector (11JLC file 9).

-x 5 on-board gain was too great for the temperature range observed at the southern stations so that the temperature profiles are not on scale to the end of the drop (sequences 6, 18).

In addition the data from units 2 and 3 tend to be noisier because of the voltage regulator oscillation associated with the dc/dc power.

For unit 4 (microconductivity), right hand page plots have been replaced by blank pages when the conductivity signal was unreliable (sequences 6, 11) and all sequences after the microconductivity sensor was replaced (Table II-2, section VII).

9JL82AN



SEQUENCE 1 PAGE 1

START TIME 00:13 GMT 07/09/82

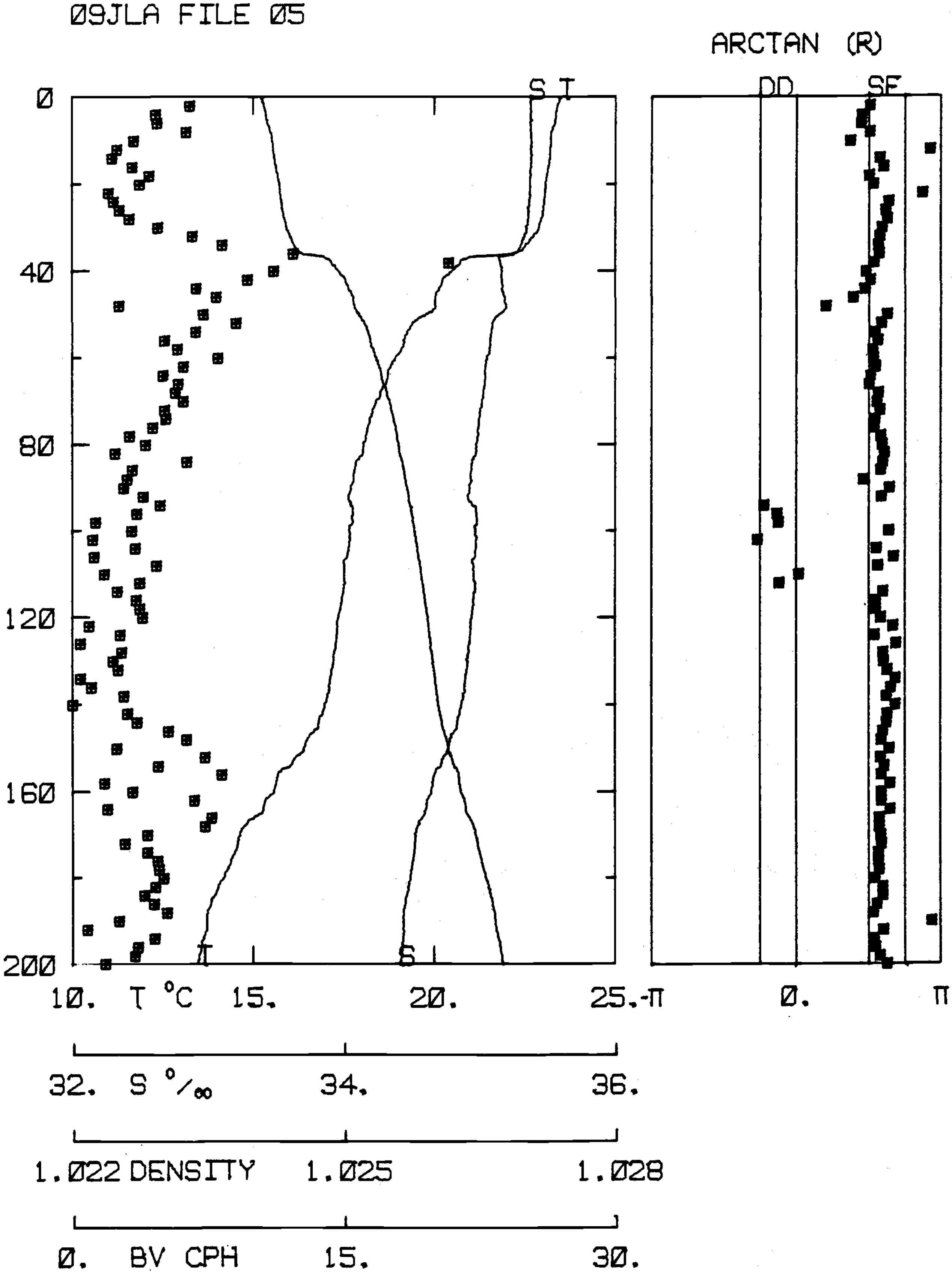
LOCATION 28°20'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 0°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DD
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T
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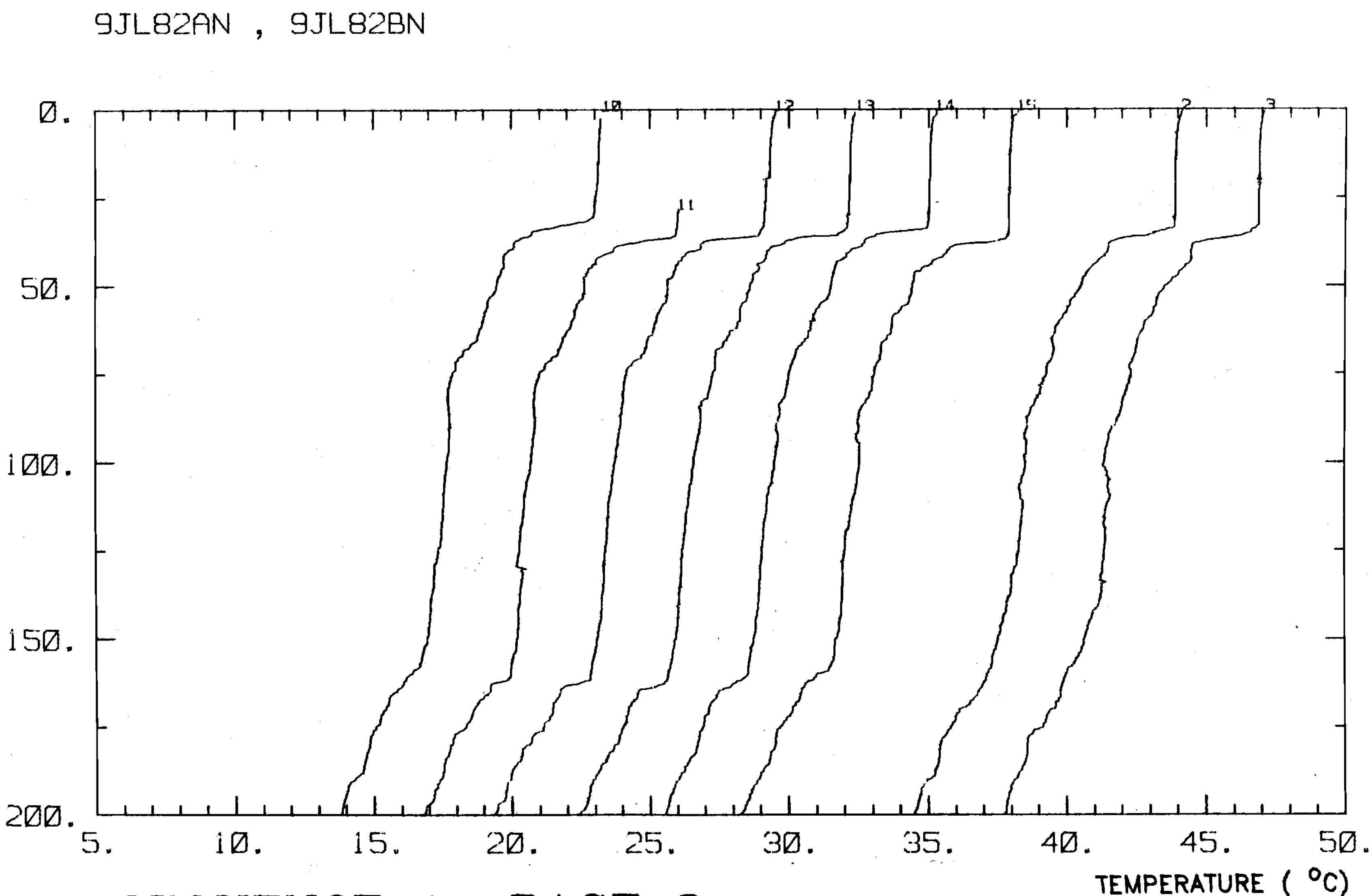
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.



SEQUENCE 1 PAGE 2

START TIME 01:09 GMT 07/09/82

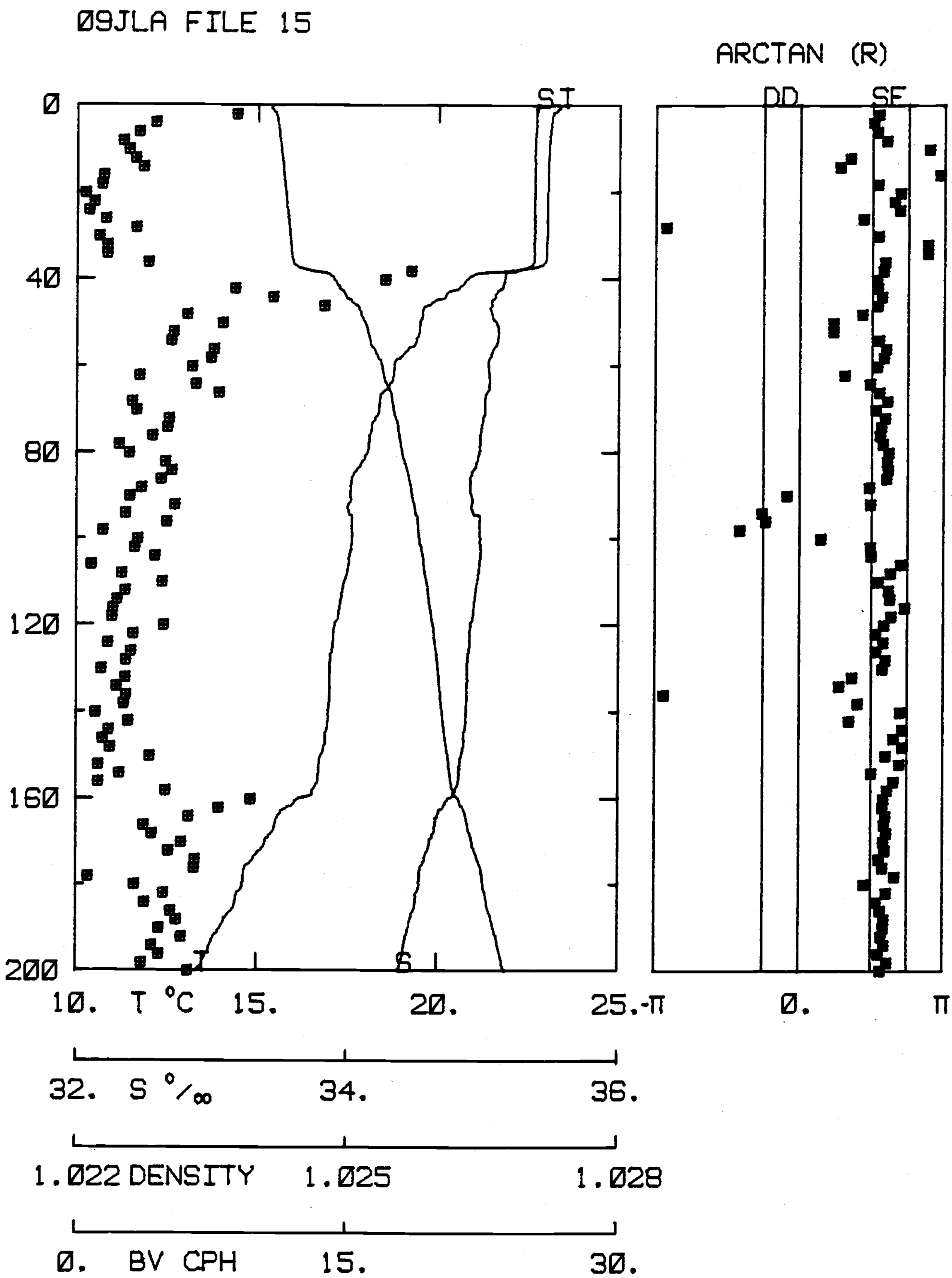
LOCATION 28°29'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 0°



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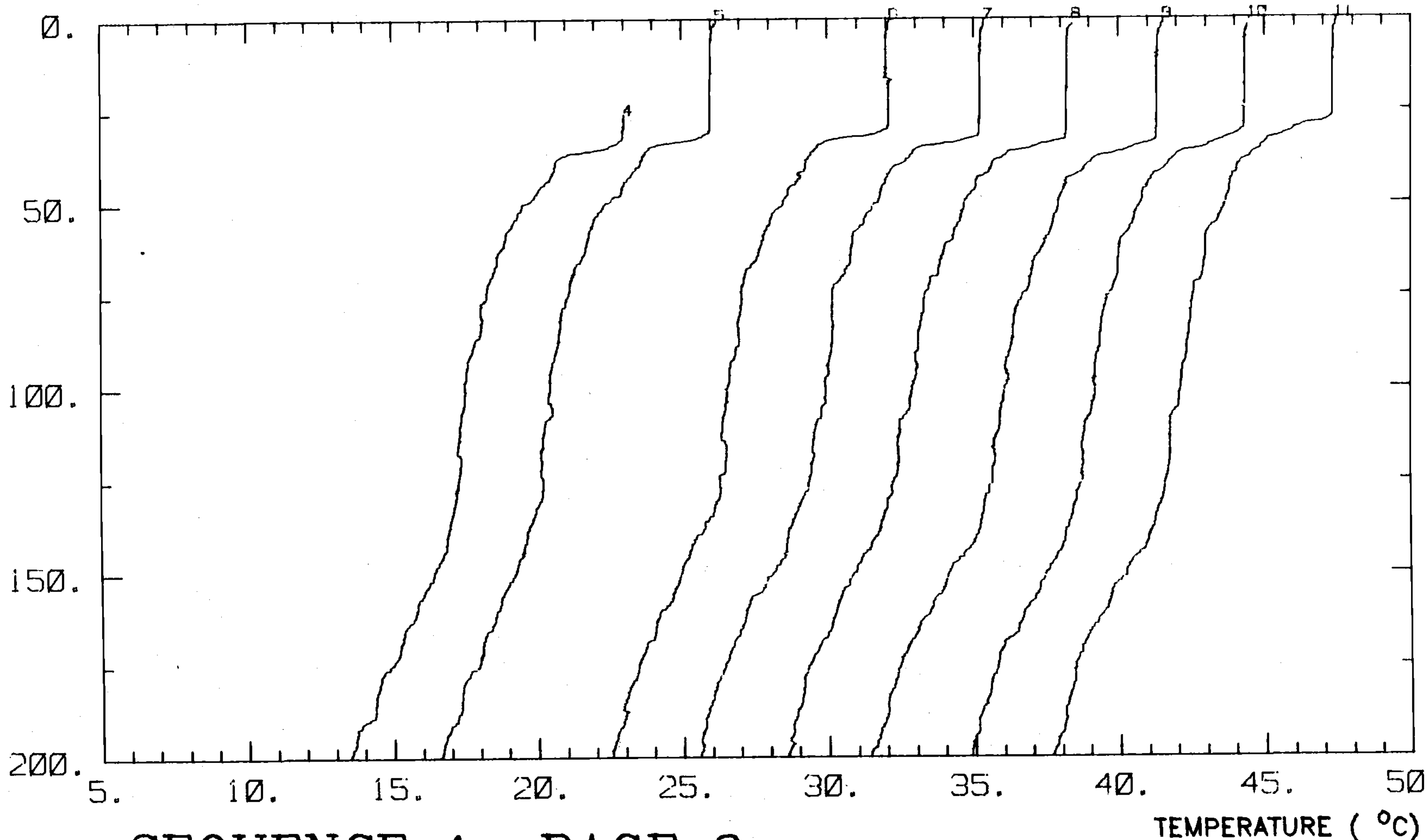
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

9JL82BN



SEQUENCE 1 PAGE 3

START TIME 02:03 GMT 07/09/82

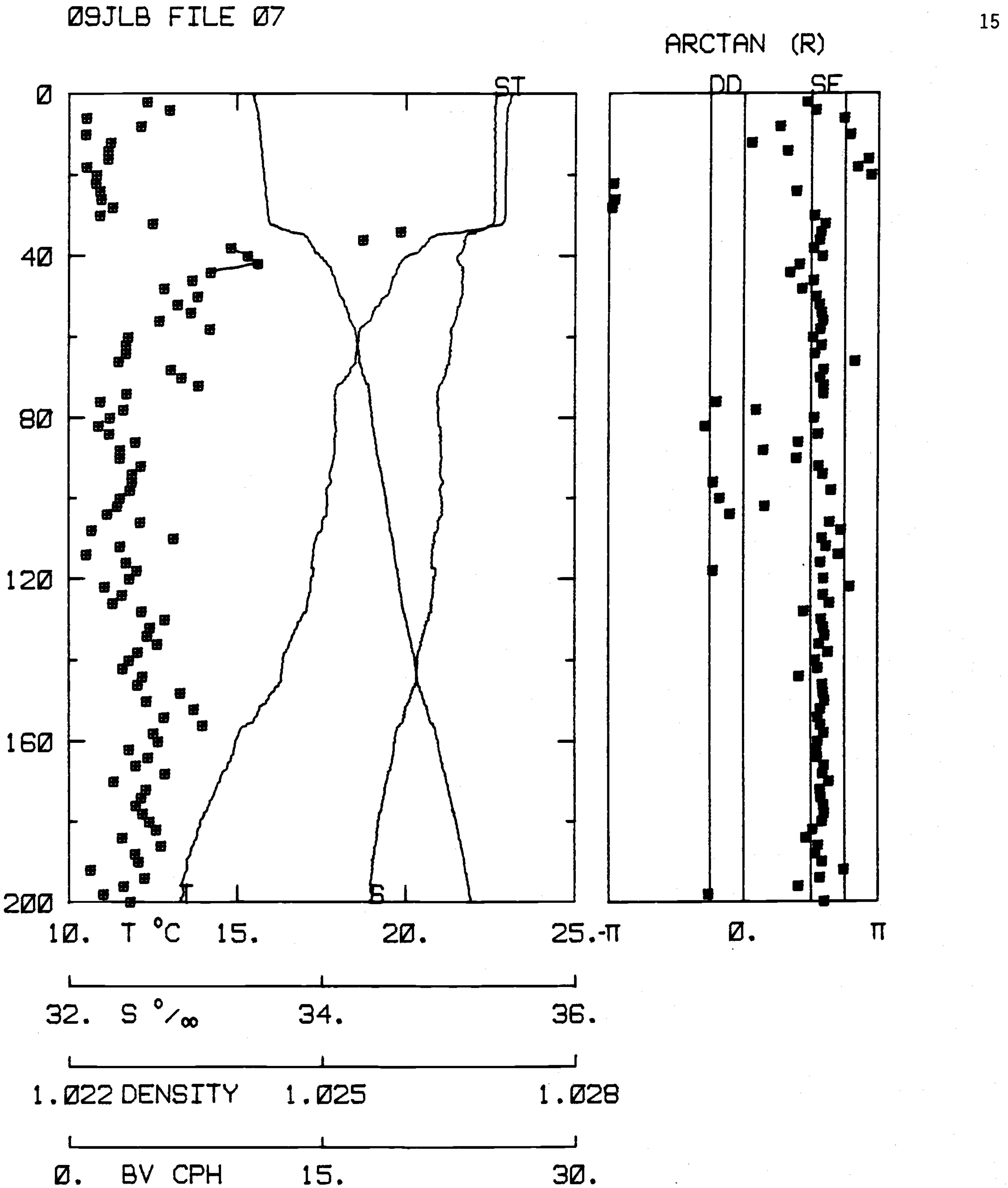
LOCATION 28°30'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 0°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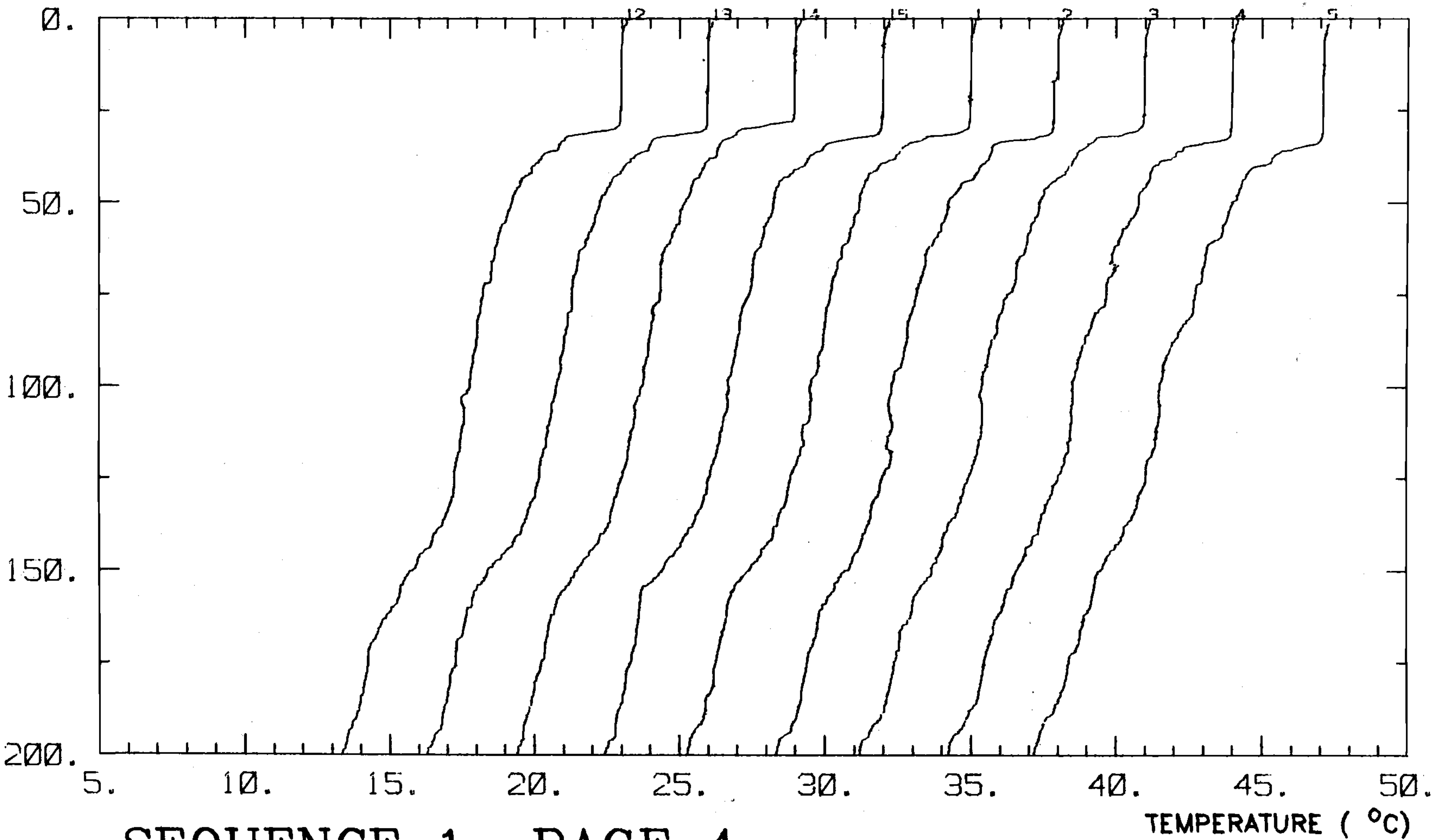
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

9JL82BN , 9JL82CN



SEQUENCE 1 PAGE 4

START TIME 02:58 GMT 07/09/82

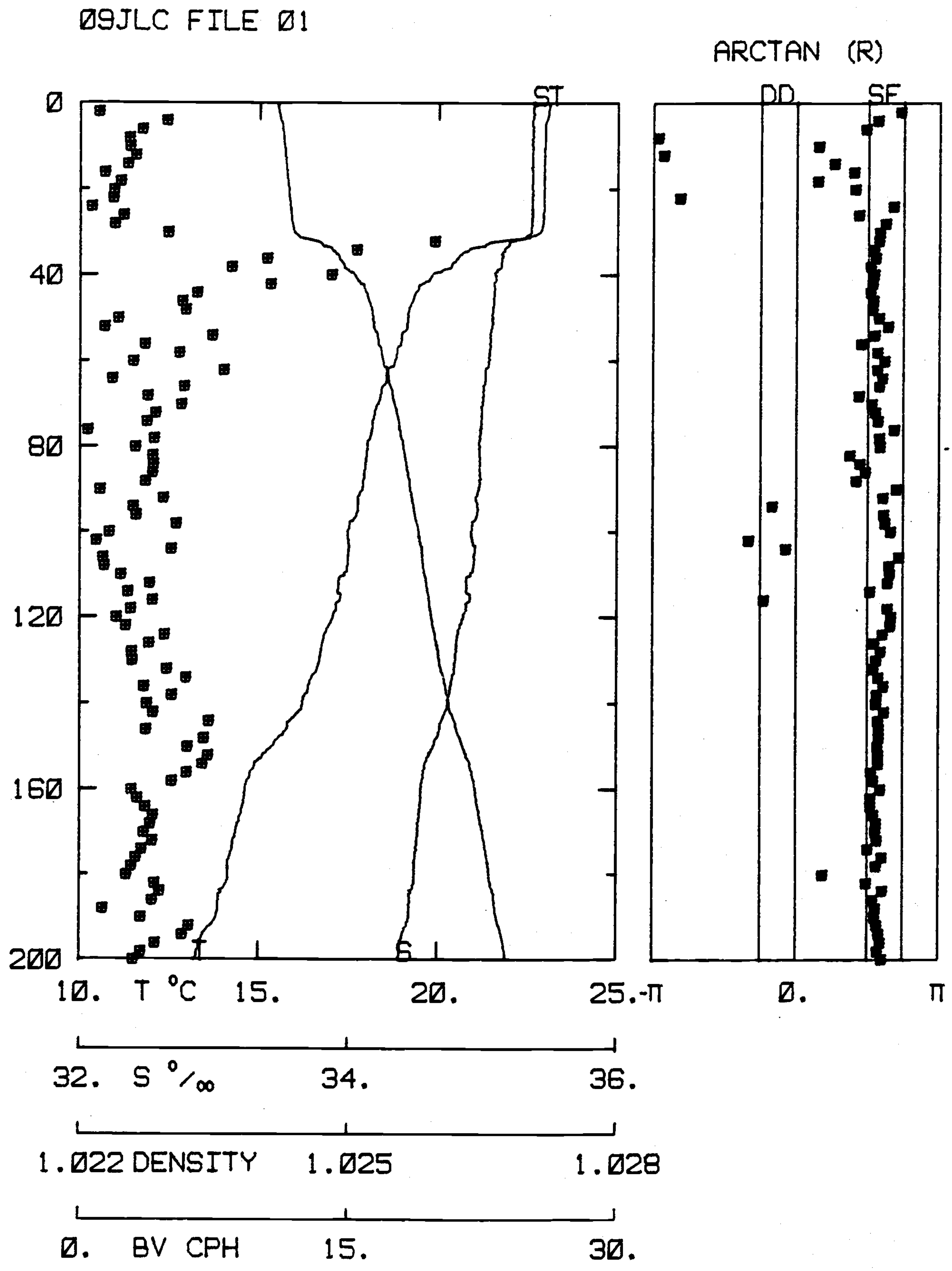
LOCATION 28°35'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 0°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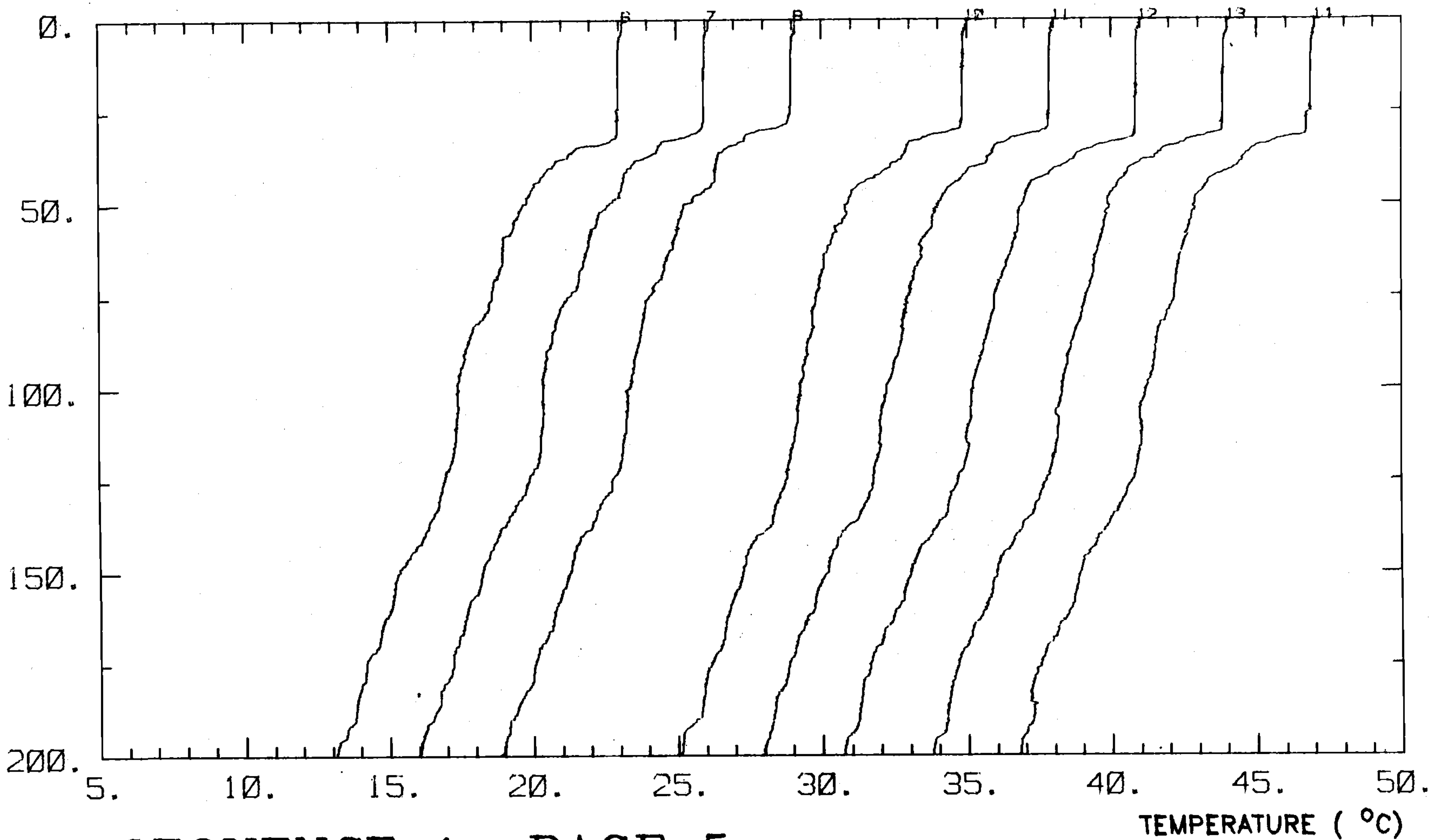
Ø. BV CPH 15. 3Ø.

9JL82CN



SEQUENCE 1 PAGE 5

START TIME 03:53 GMT 07/09/82

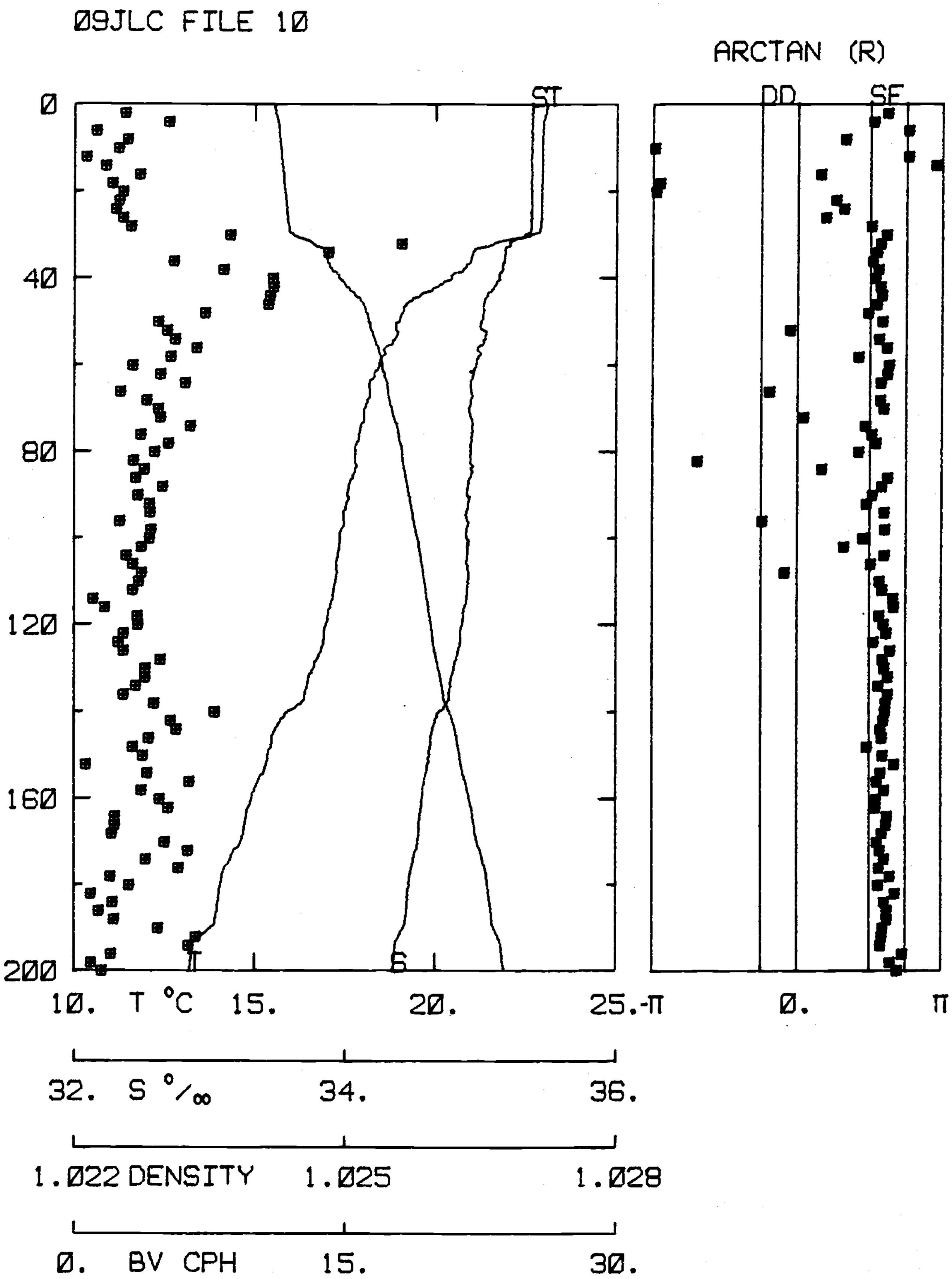
LOCATION 28°35'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 0°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1.Ø22 DENSITY 1.Ø25 1.Ø28
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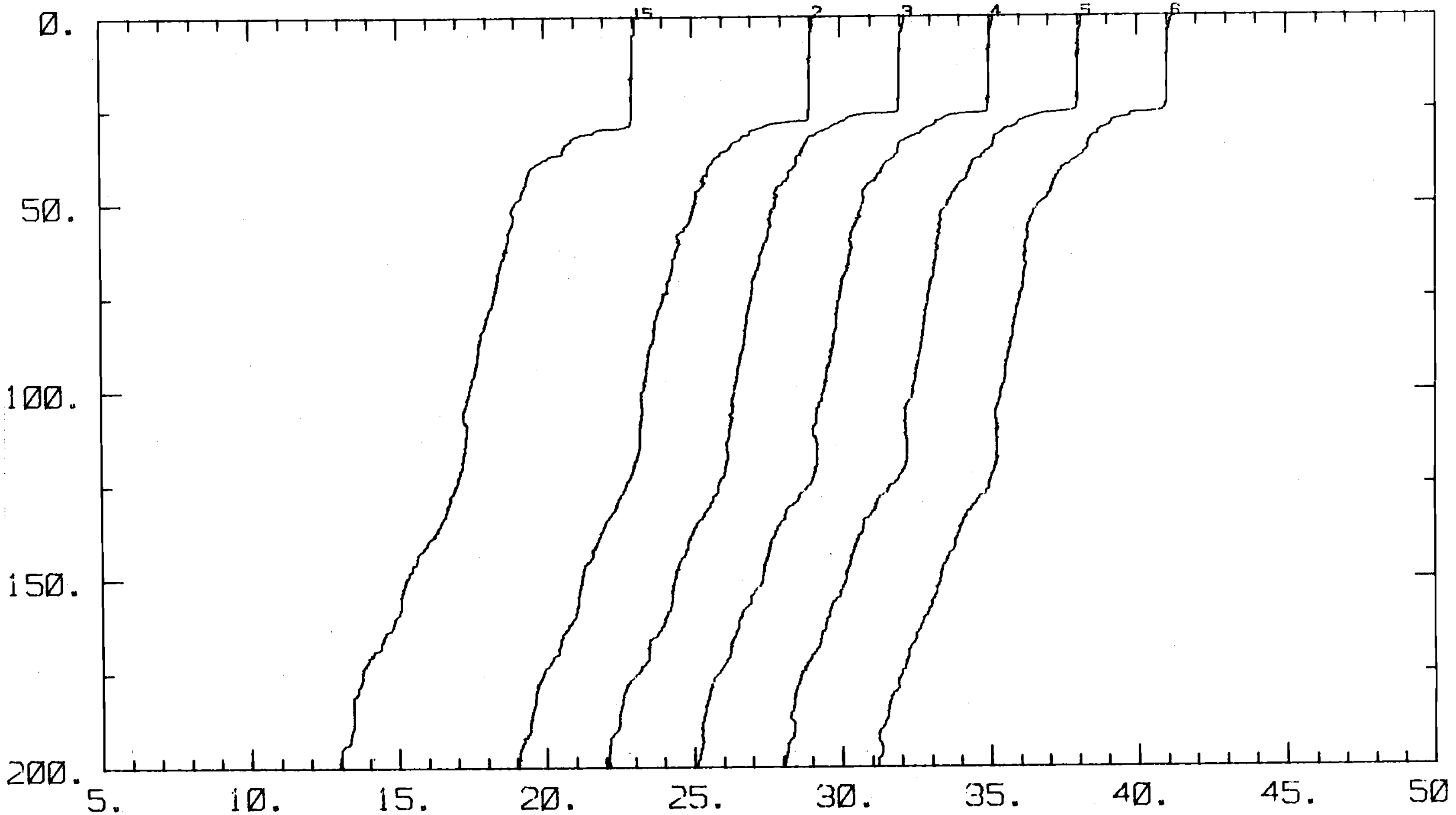
9JL82CN , 9JL82DN



SEQUENCE 1 PAGE 6

START TIME 04:49 GMT 07/09/82

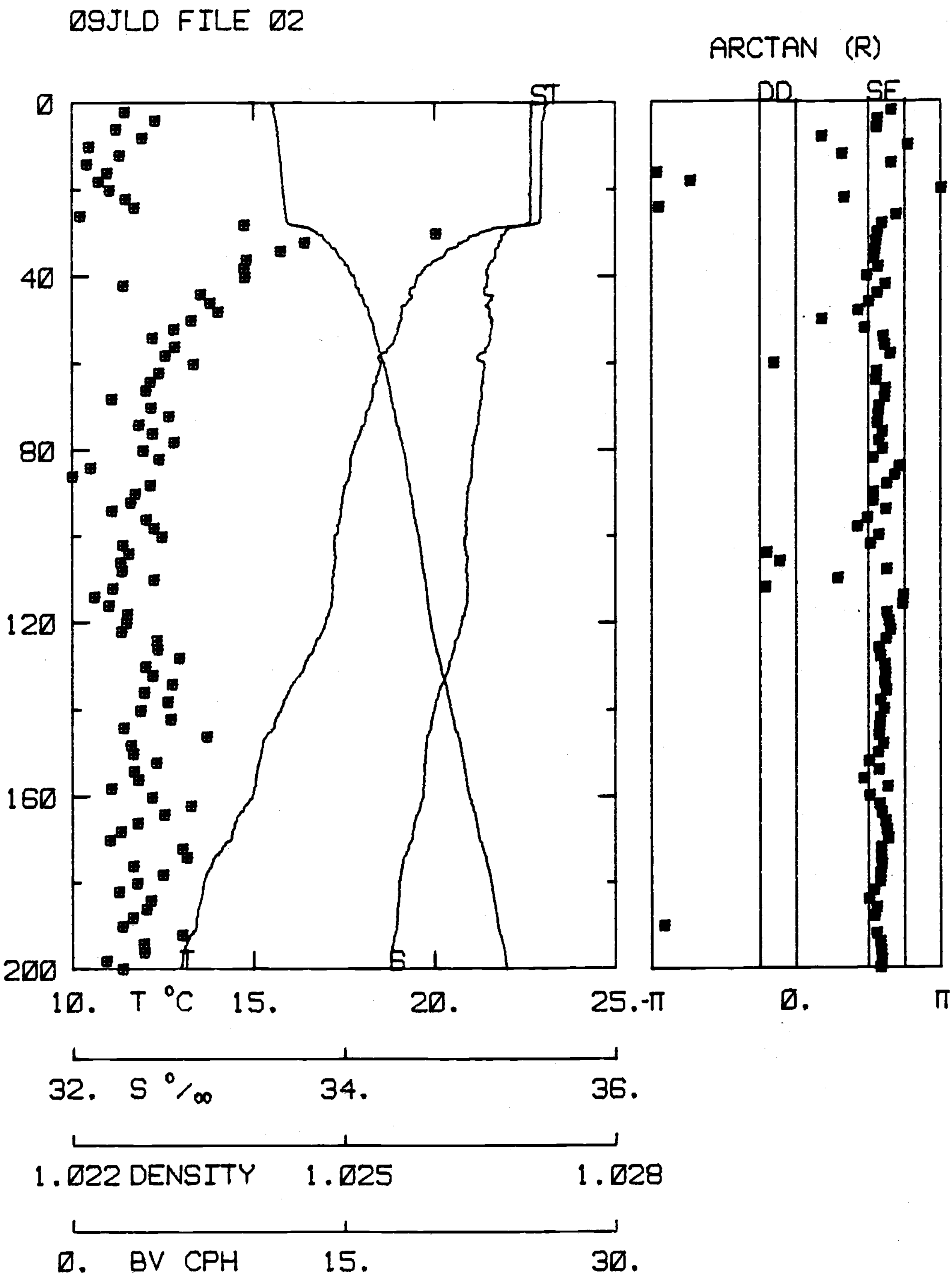
LOCATION 28°40'N 151°40'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 100°

Ship's heading 00



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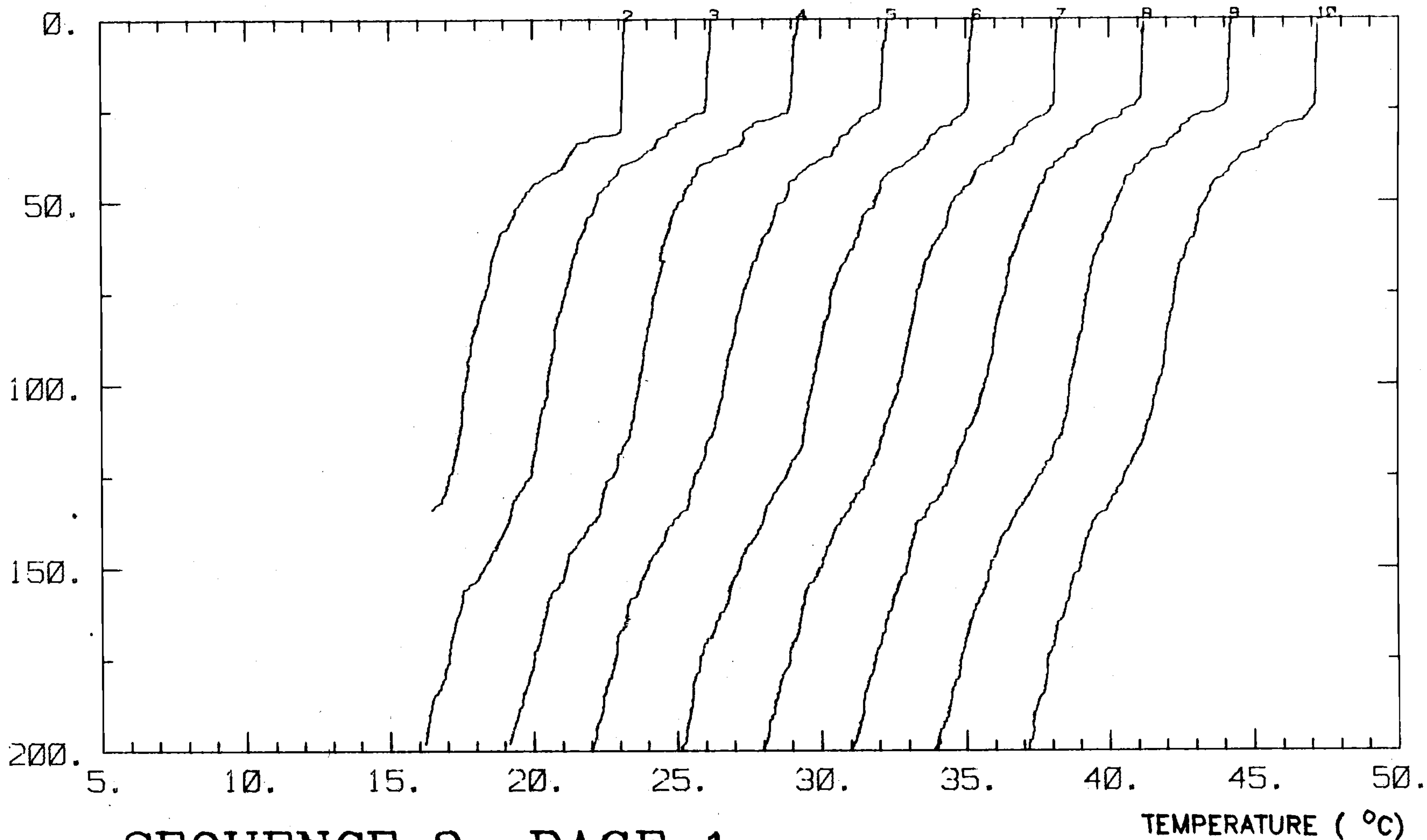
9JL82EN



SEQUENCE 2 PAGE 1

START TIME 22:24 GMT 07/09/82

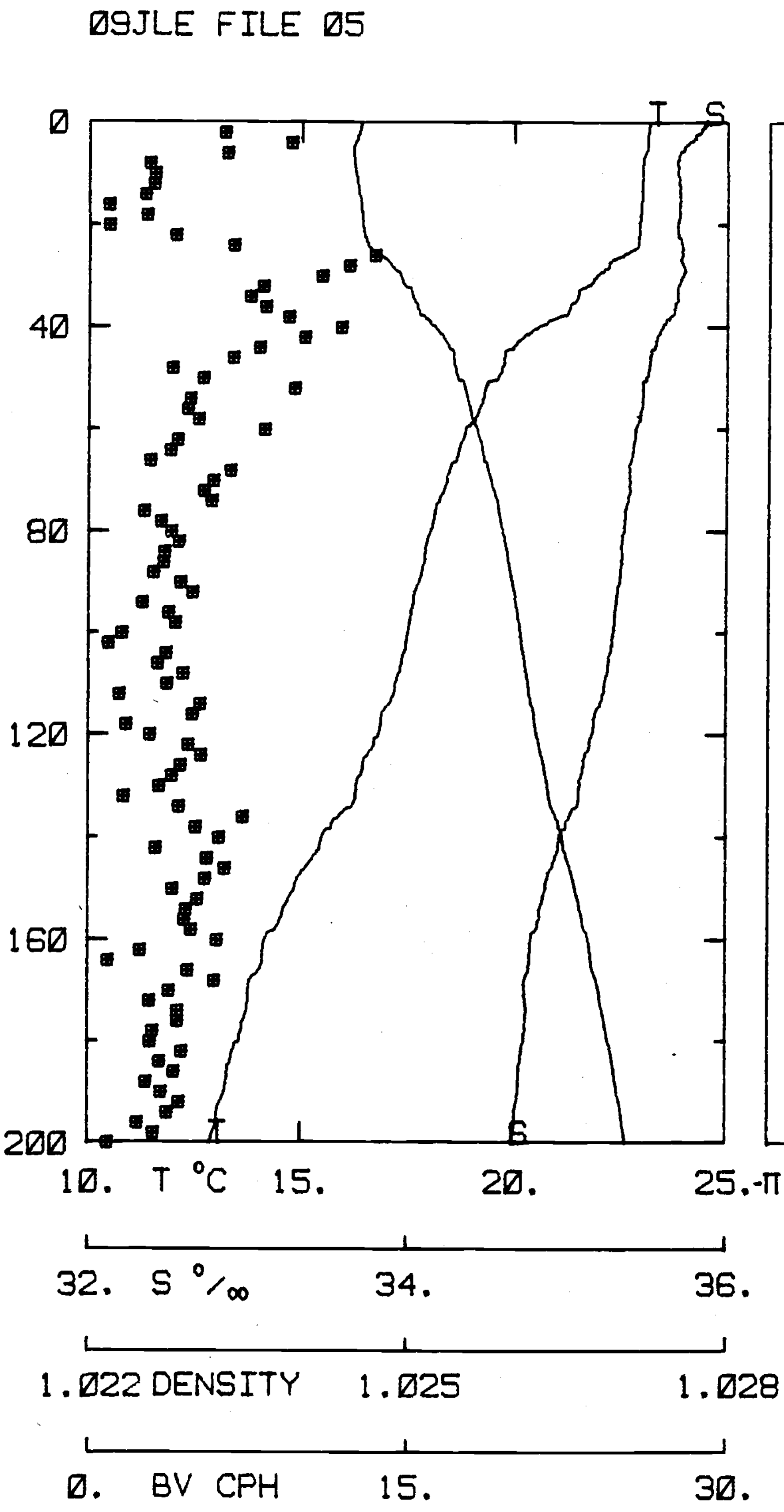
LOCATION 30°03'N 151°46'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°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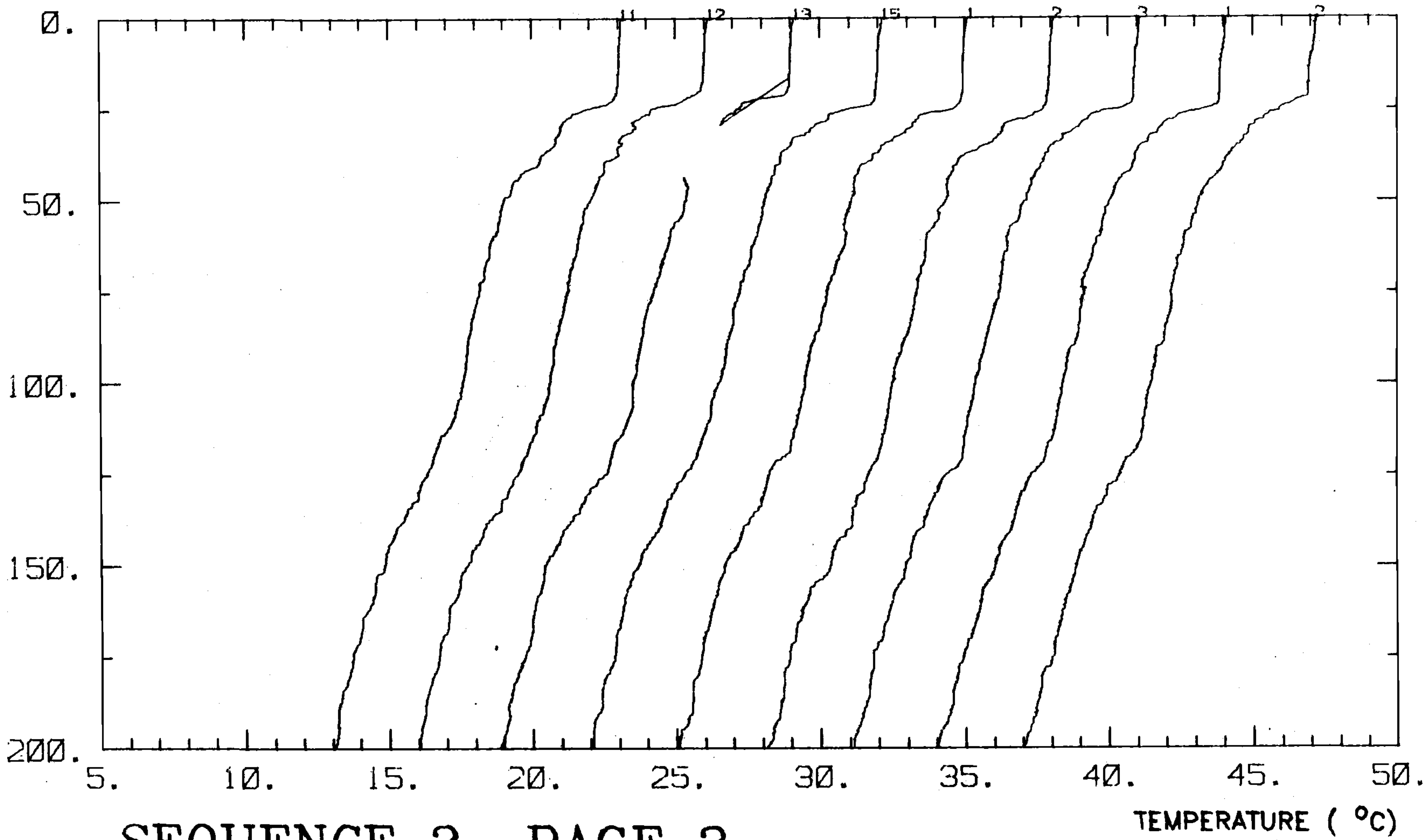
9JL82EN ,9JL82FN ,10JL82AN



SEQUENCE 2 PAGE 2

START TIME 23:19 GMT 07/09/82

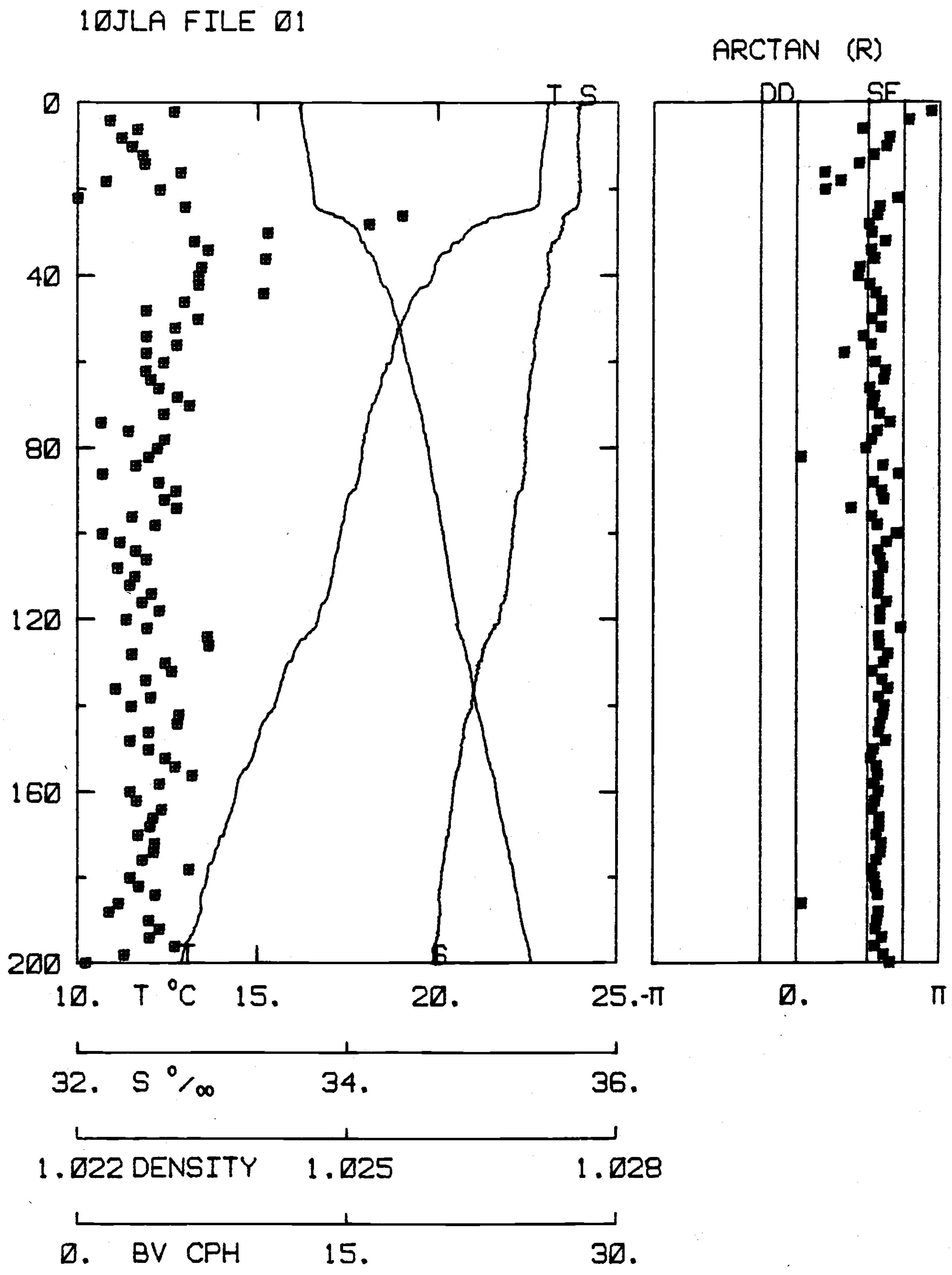
LOCATION 30°07'N 151°46'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°



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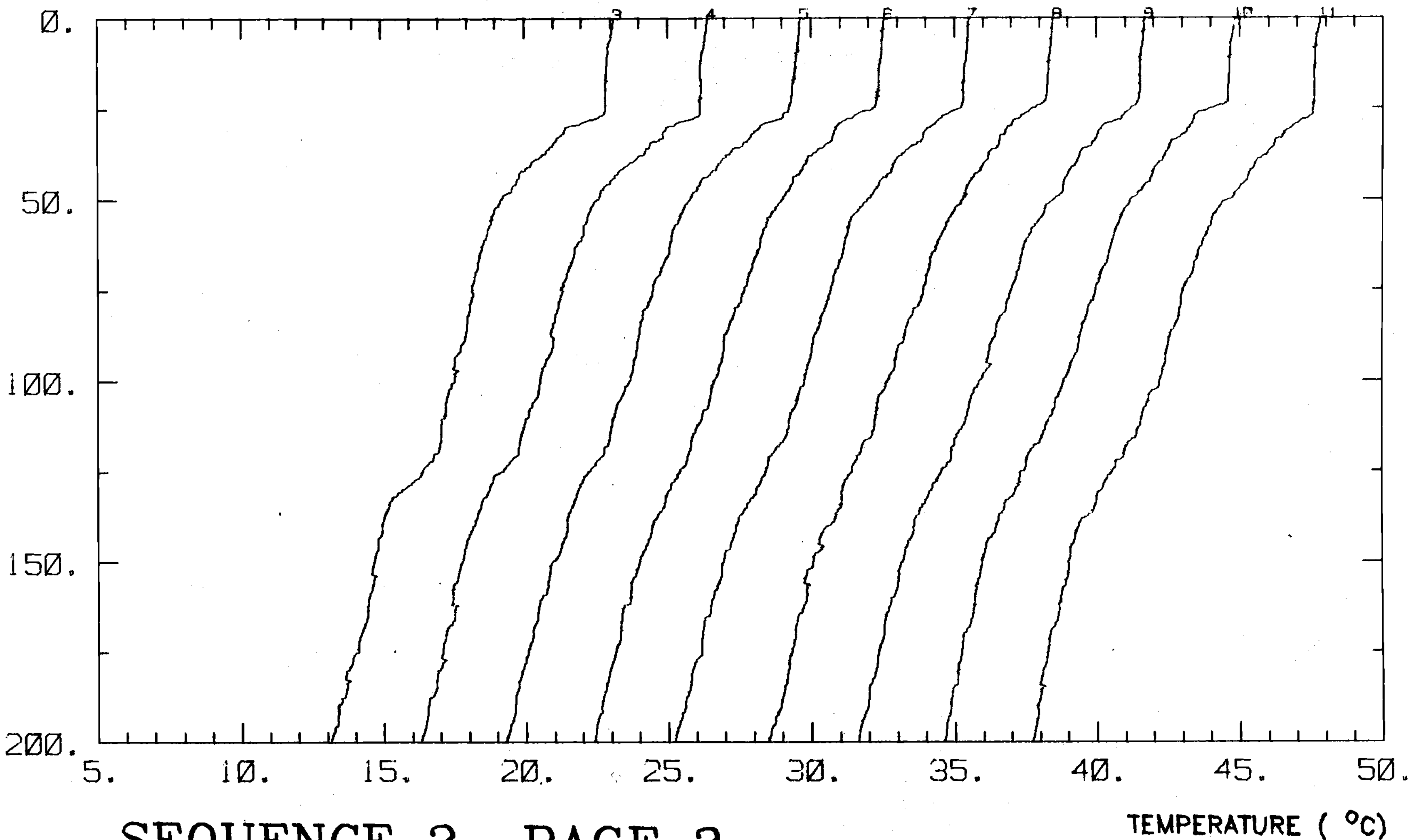
10JL82AN



SEQUENCE 2 PAGE 3

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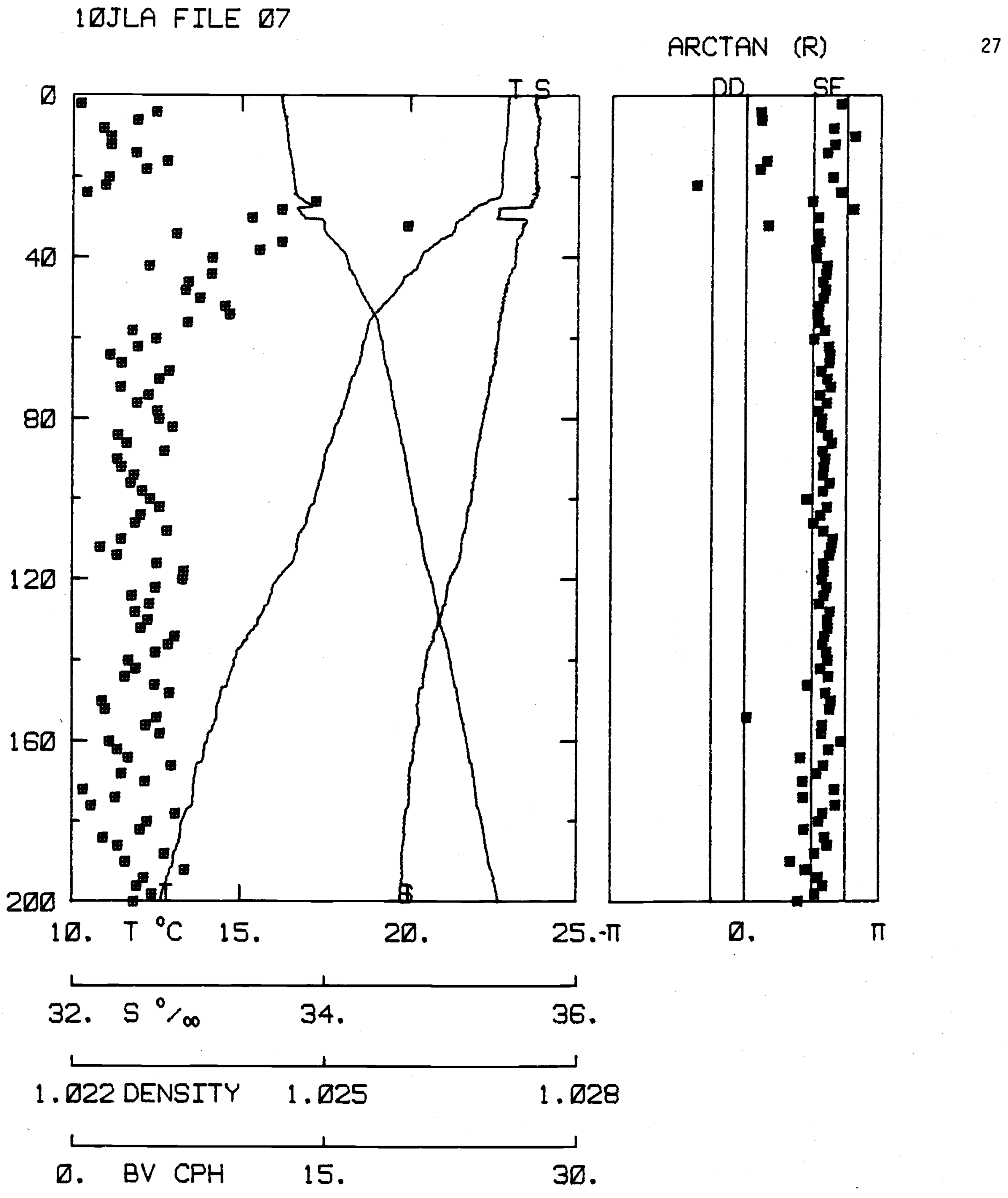
LOCATION 30°11'N 151°47'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°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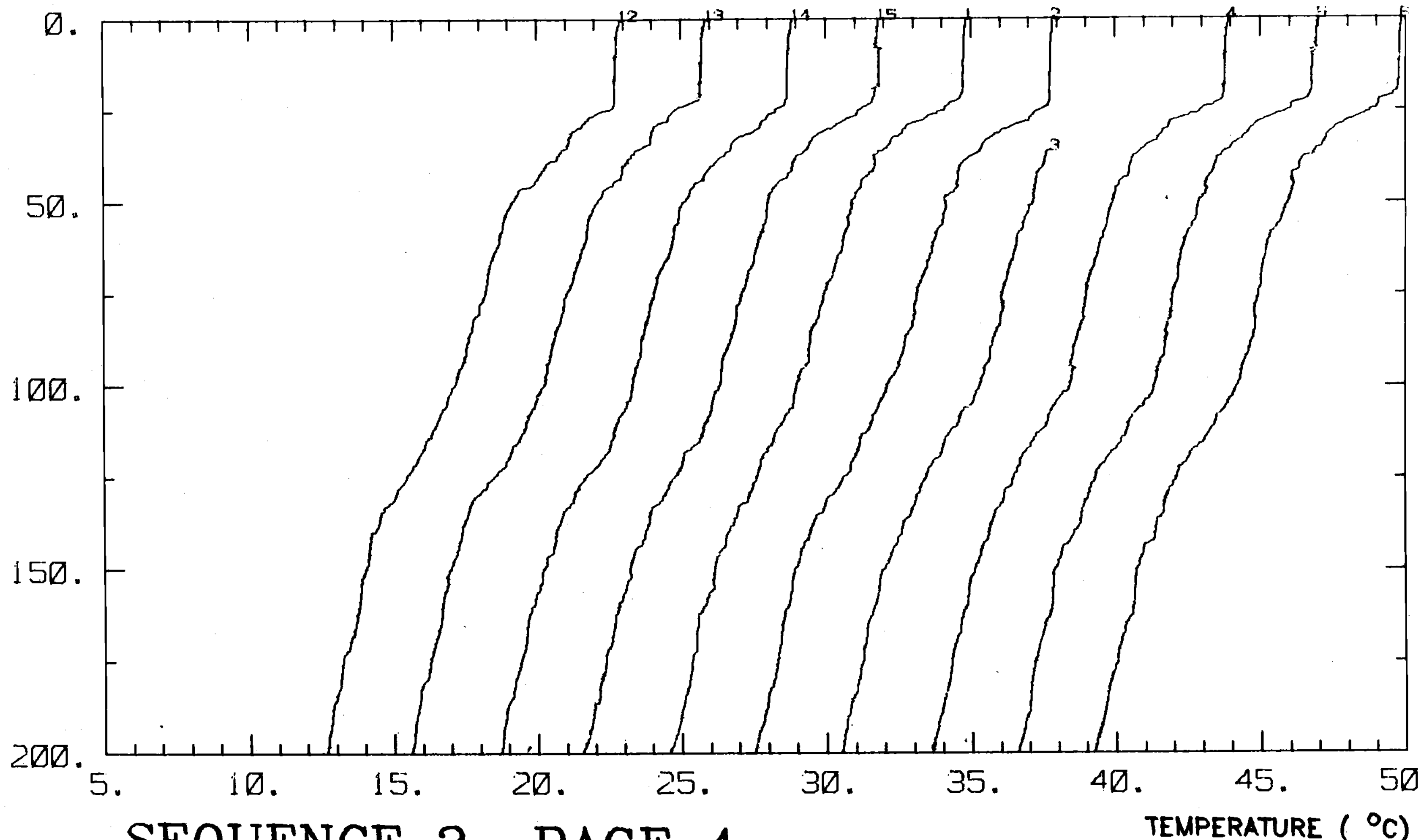
10JL82AN ,10JL82BN



SEQUENCE 2 PAGE 4

START TIME 01:09 GMT 07/10/82

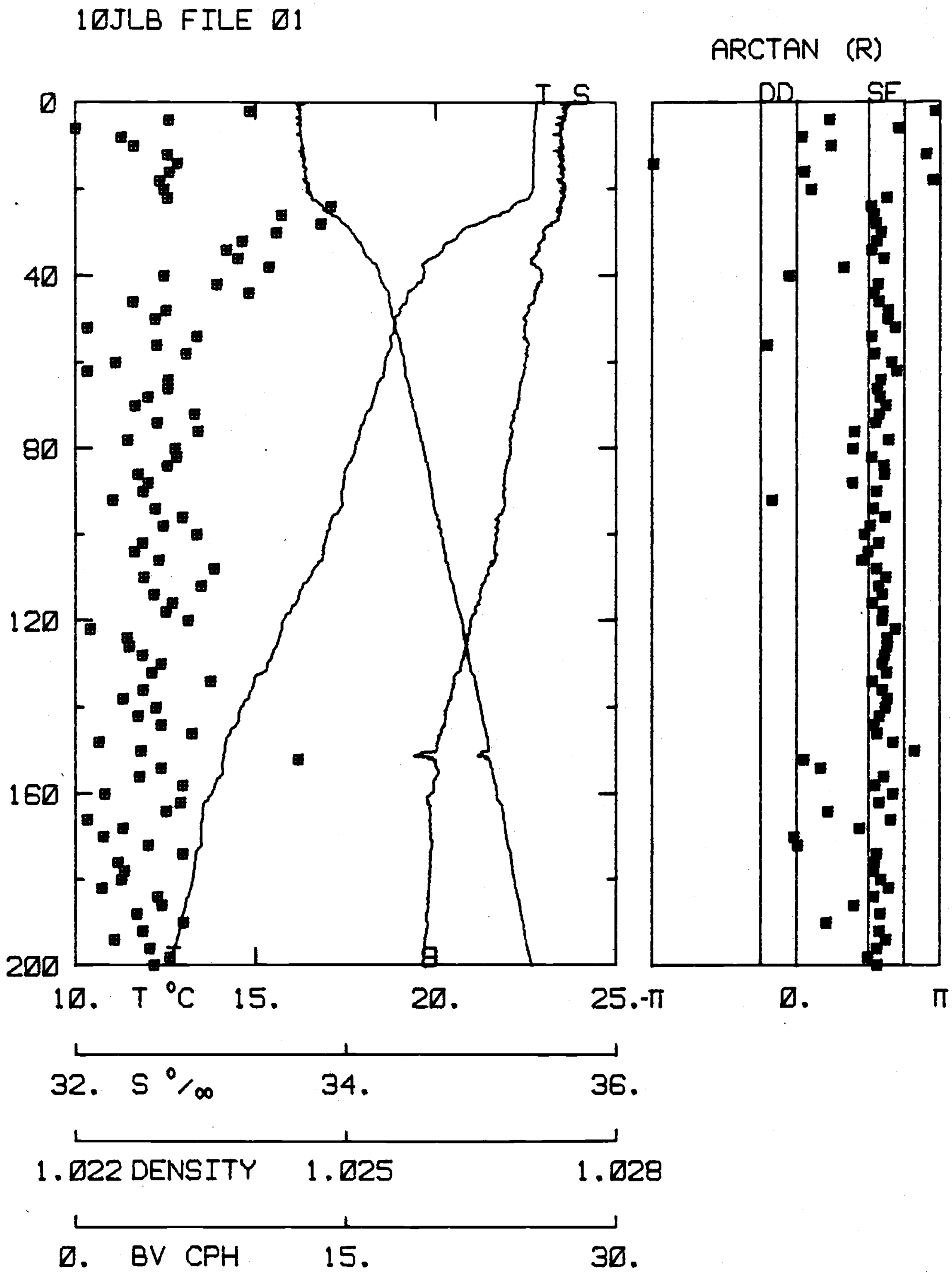
LOCATION 30°15'N 151°45'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°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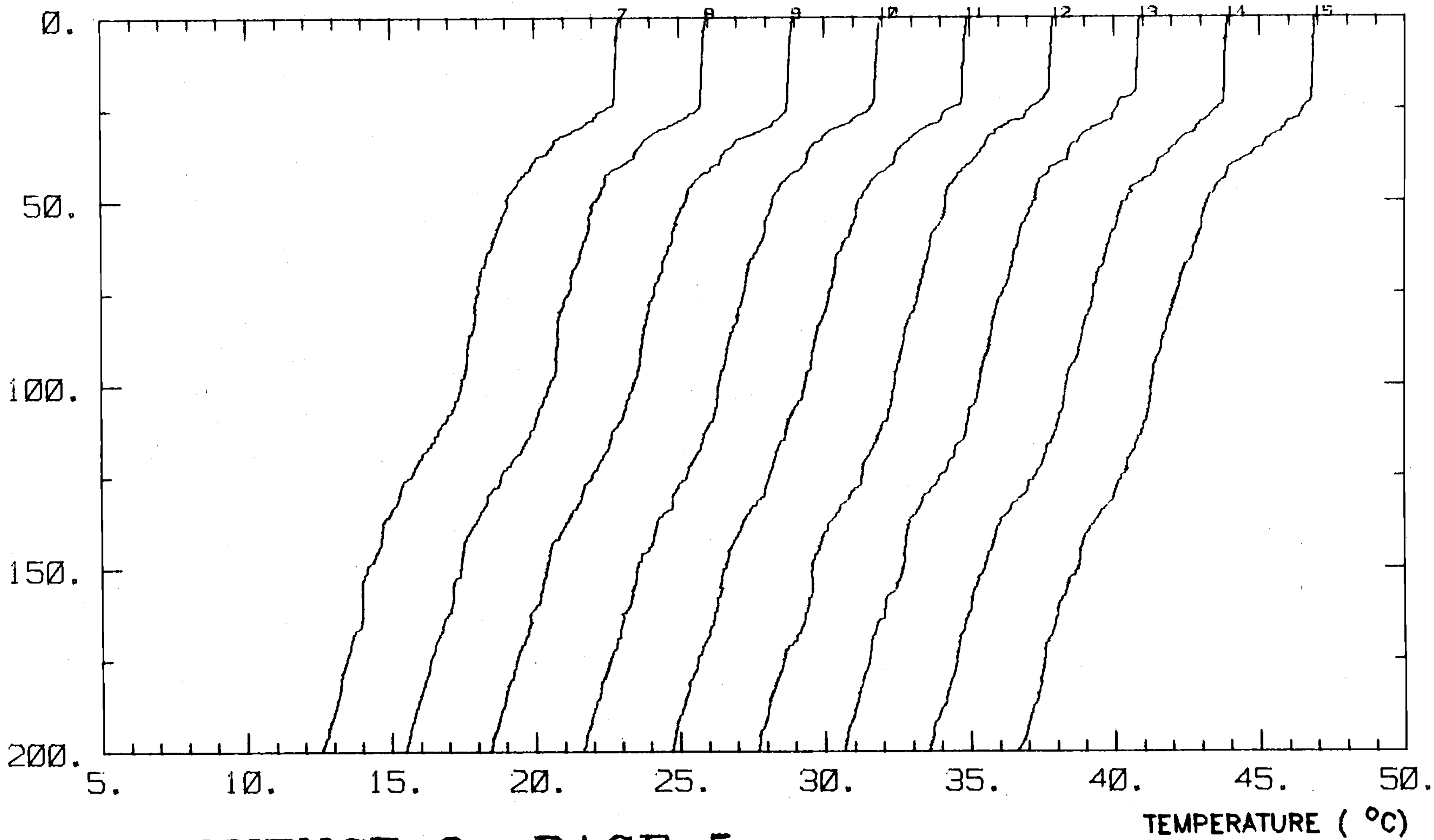
10JL82BN



30

SEQUENCE 2 PAGE 5

START TIME 02:10 GMT 07/10/82

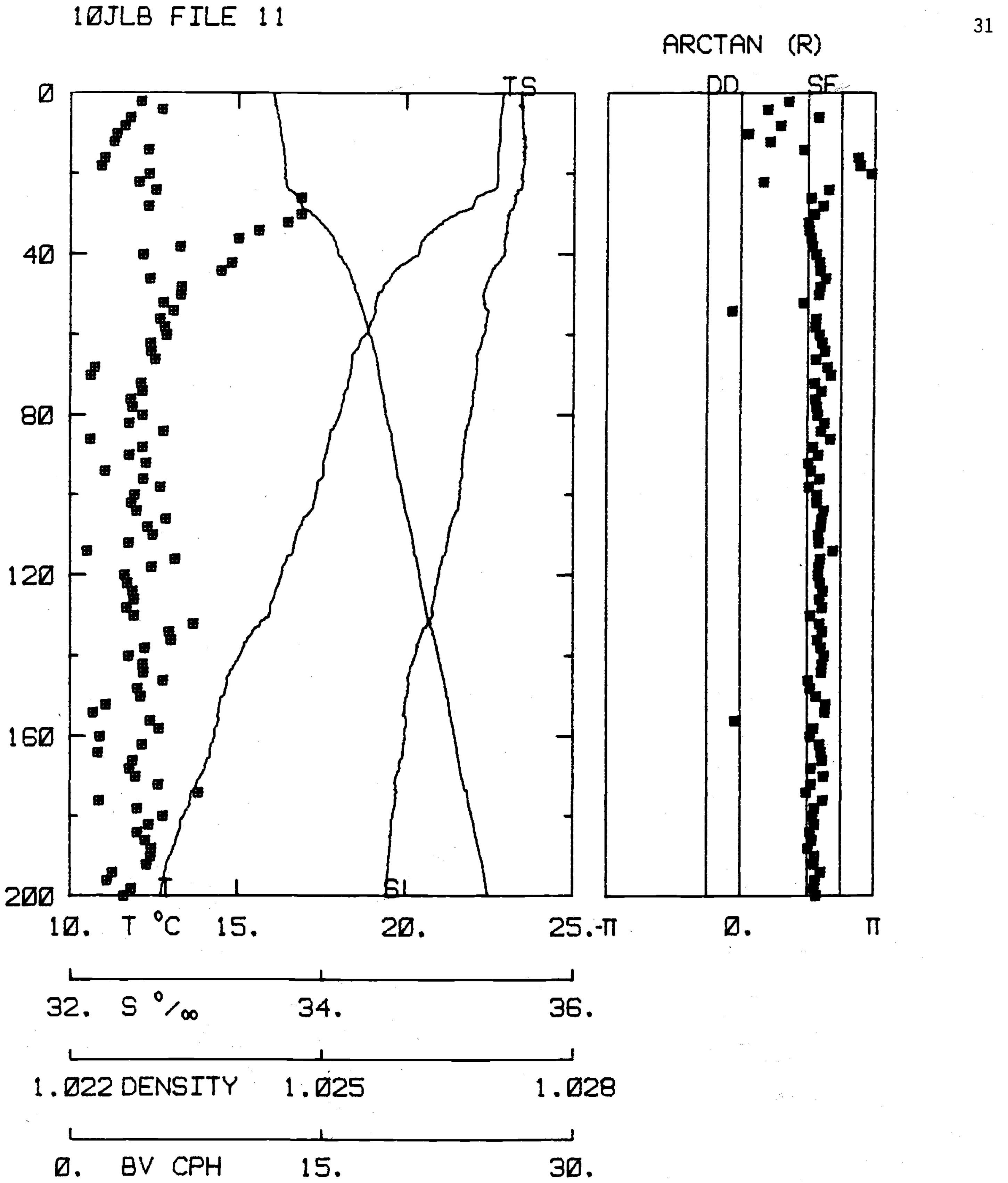
LOCATION 30°19'N 151°45'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°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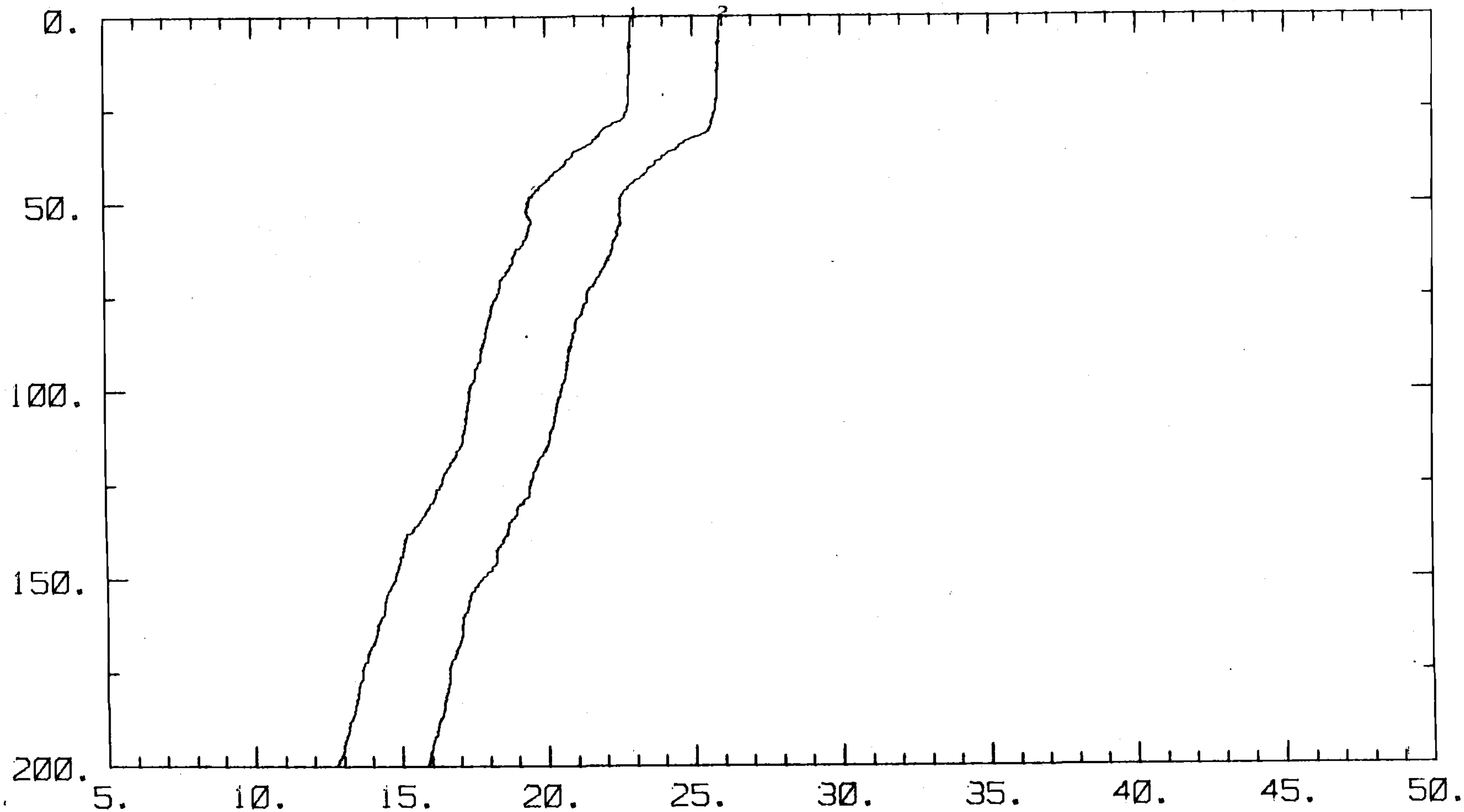
10ØJL82CN



32

SEQUENCE 2 PAGE 6

START TIME 03:05 GMT 07/10/82

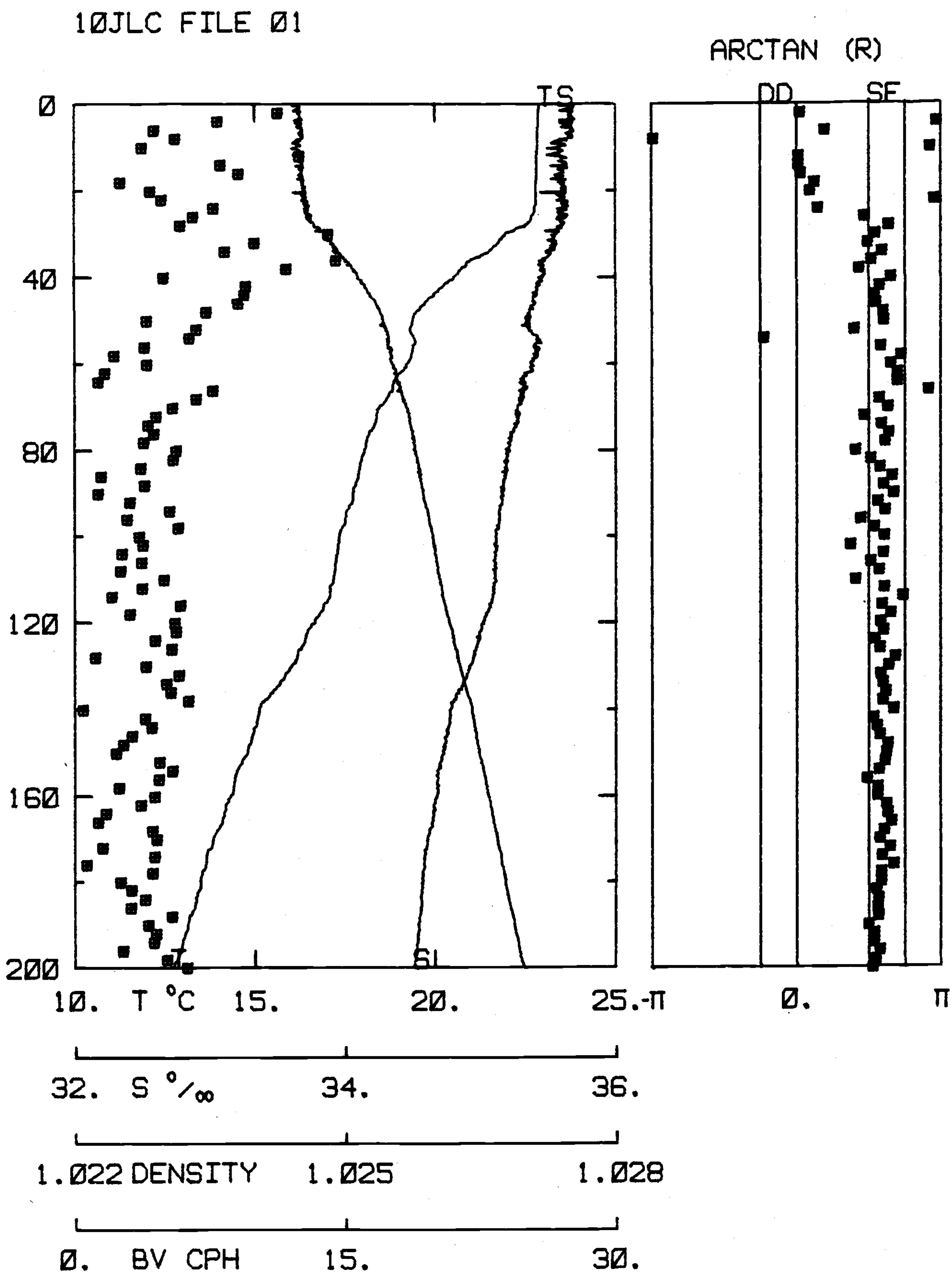
LOCATION 30°23'N 151°45'W

Profile spacing 800m

WIND SPEED 2. m/s

DIRECTION 100°

Ship's heading 0°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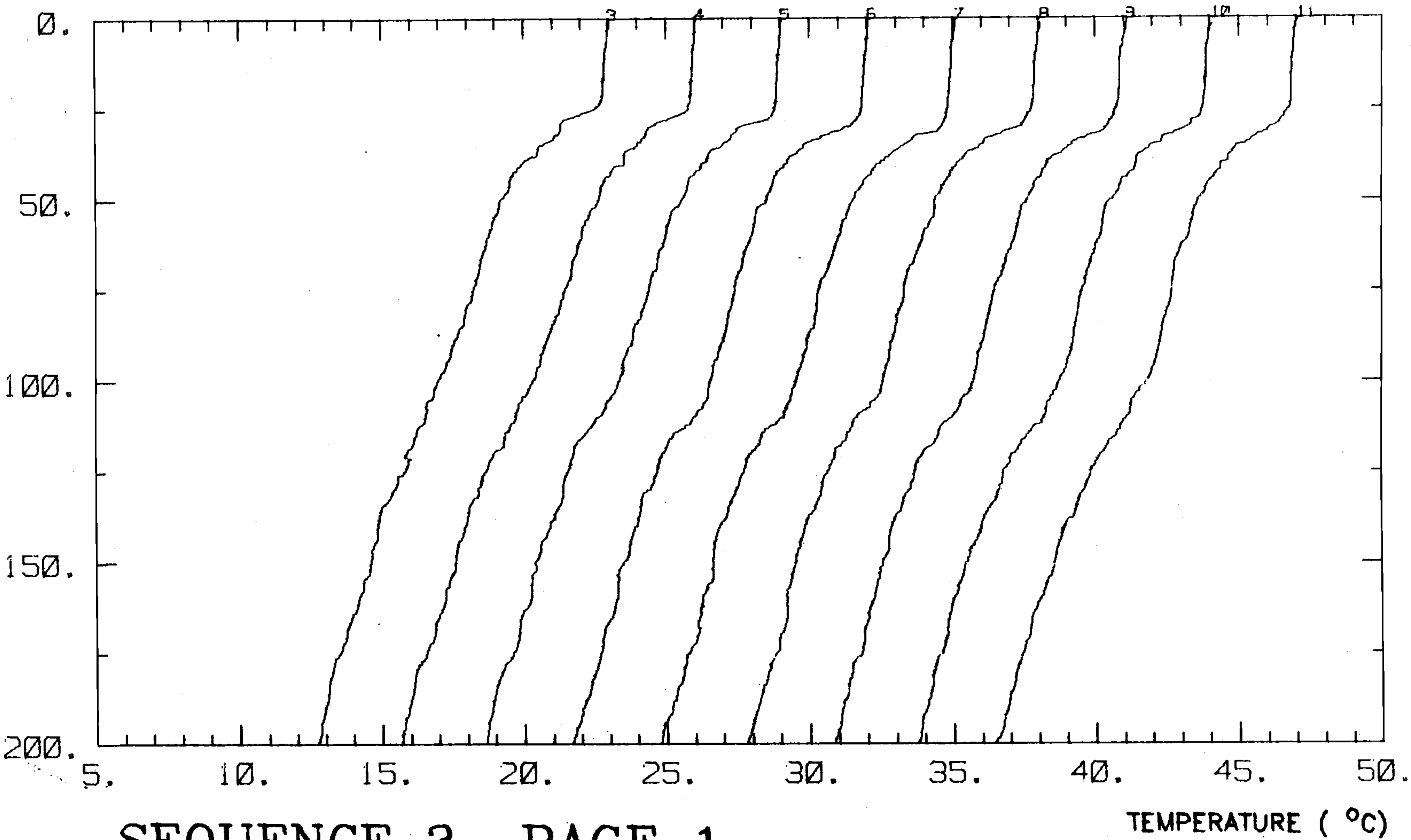
10ØJL82CN



SEQUENCE 3 PAGE 1

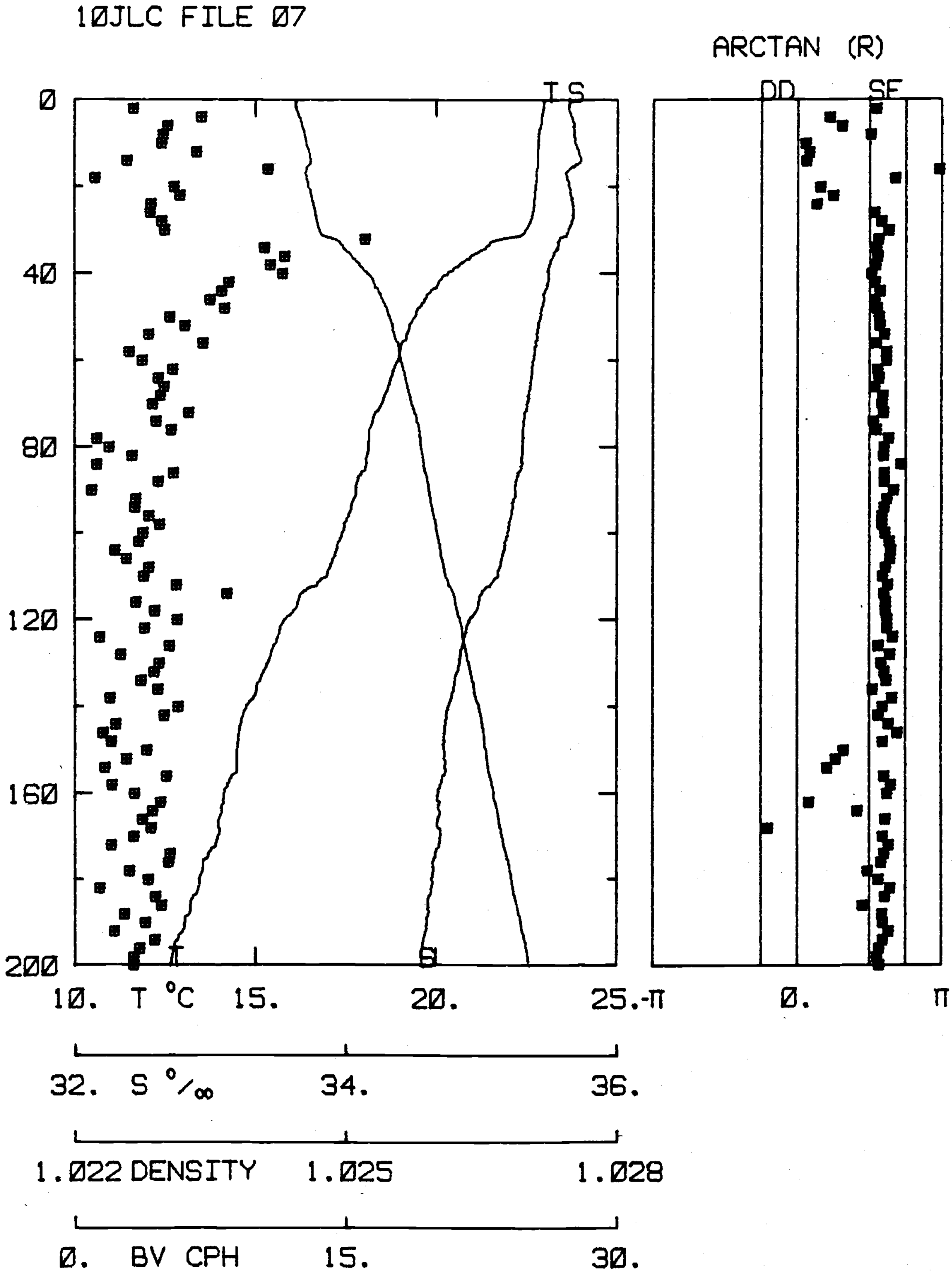
START TIME 04:07 GMT 07/10/82

LOCATION 30°27'N 151°45'W

Profile spacing 800m

WIND SPEED 0. m/s

Ship's heading 0°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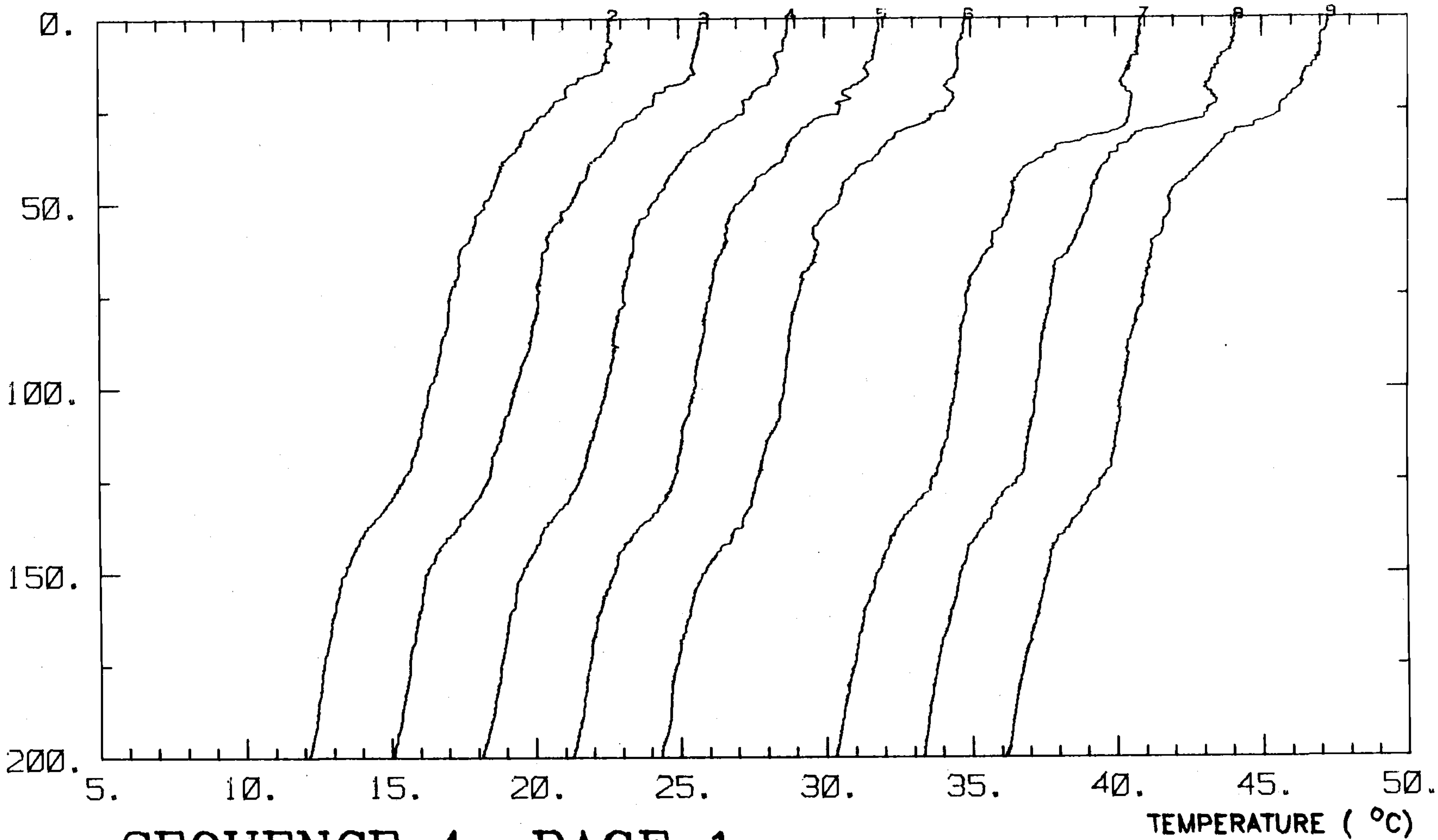
10ØJL82DN



36

SEQUENCE 4 PAGE 1

START TIME 22:35 GMT 07/10/82

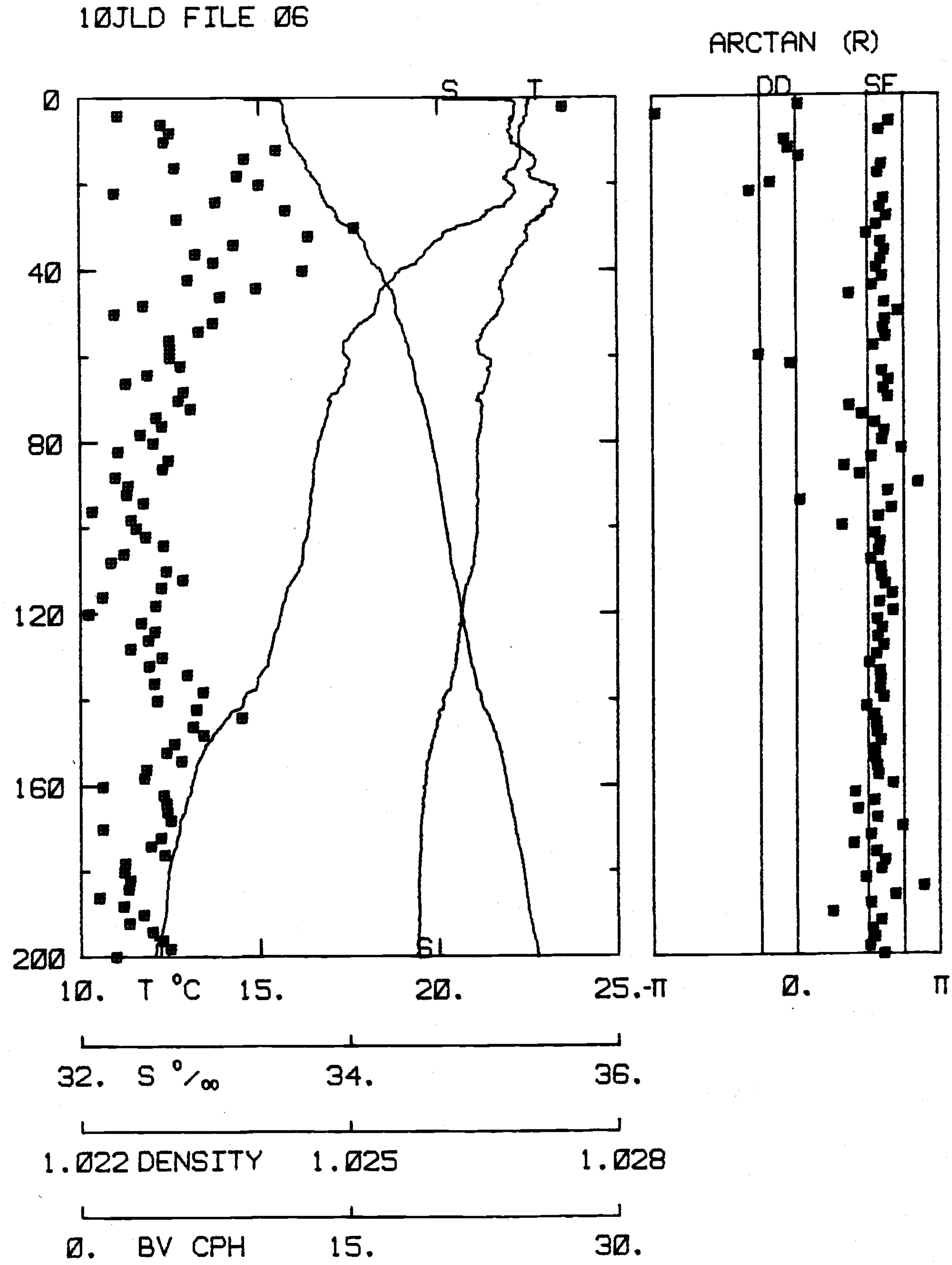
LOCATION 31°55'N 151°43'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


10JLD FILE 06
ARCTAN (R)
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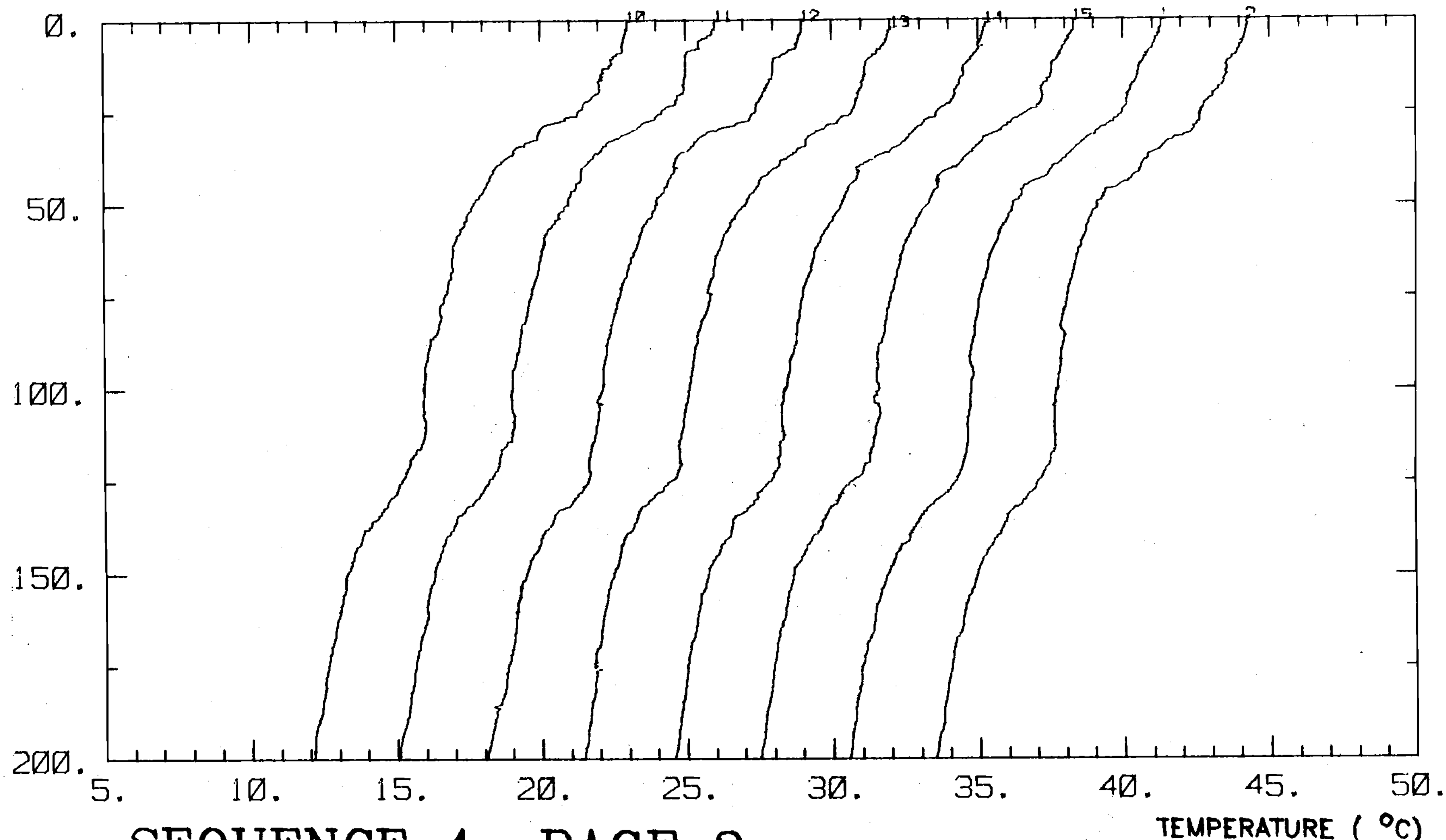
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

10JL82DN , 11JL82AN



SEQUENCE 4 PAGE 2

START TIME 23:30 GMT 07/10/82

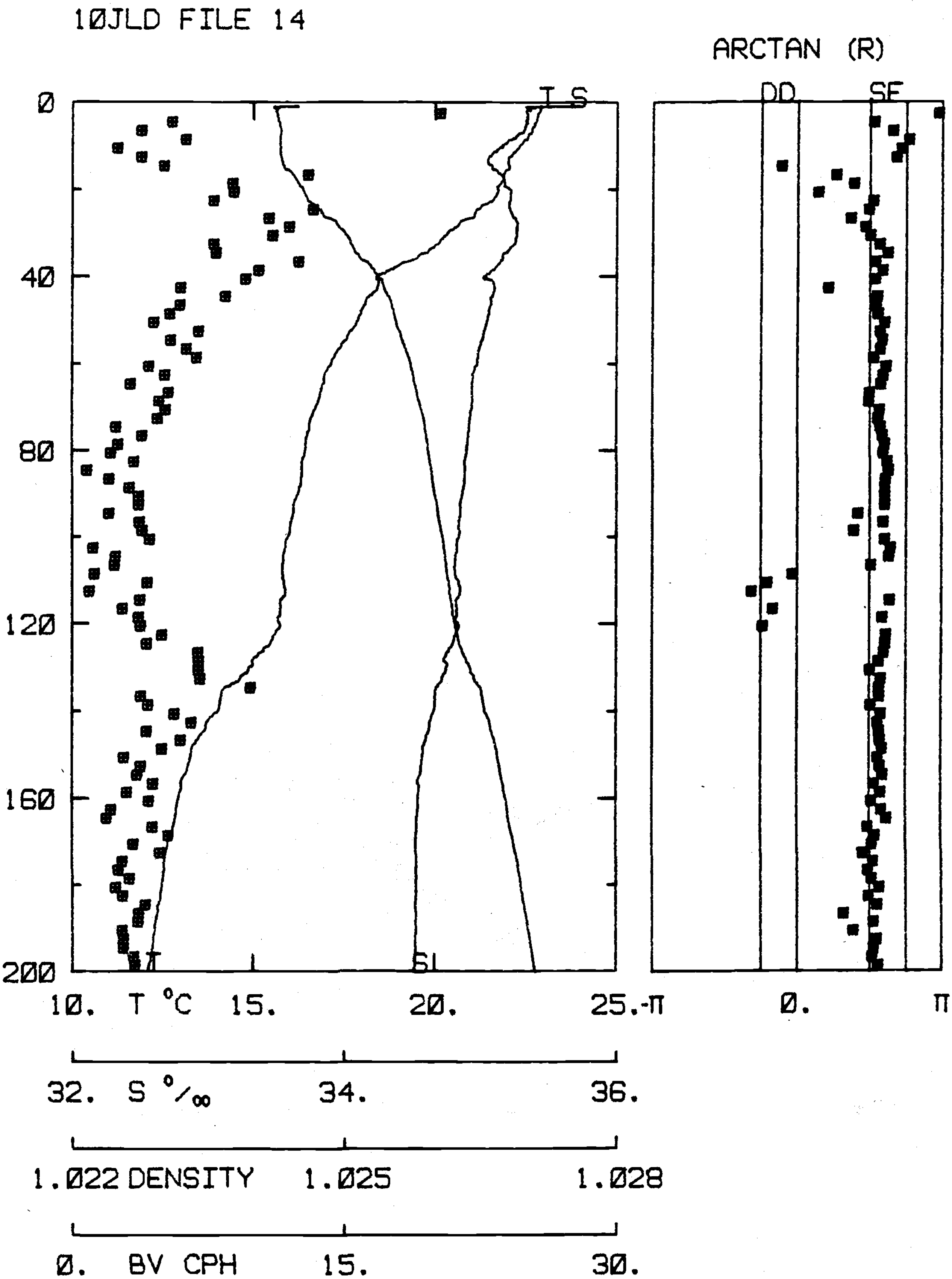
LOCATION 31°59'N 151°43'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°



1ØJLD FILE 14
ARCTAN (R)
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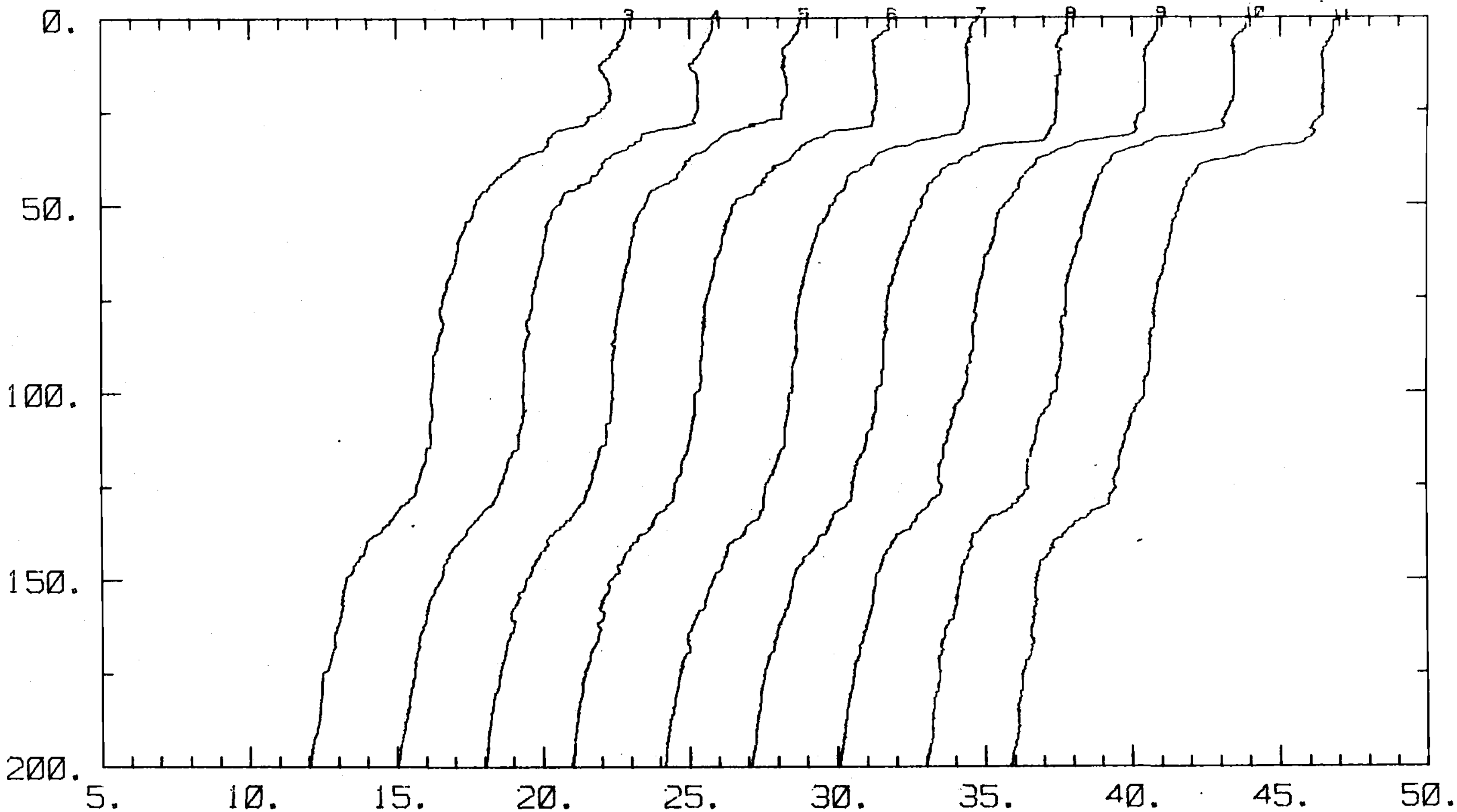
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

11JL82AN



40

SEQUENCE 4 PAGE 3

START TIME 00:24 GMT 07/11/82

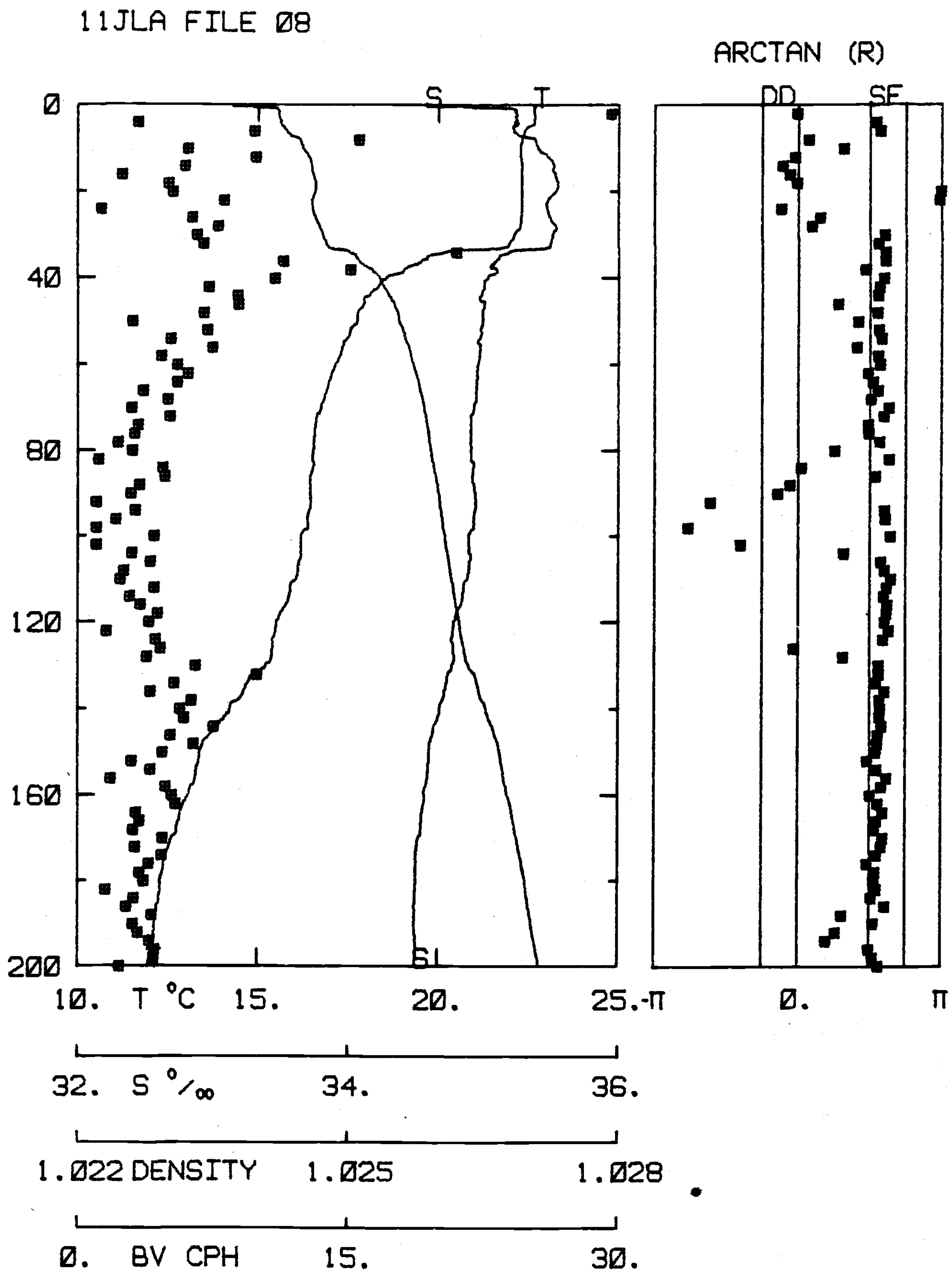
LOCATION 32°03'N 151°43'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°



11JLA FILE Ø8
ARCTAN (R)
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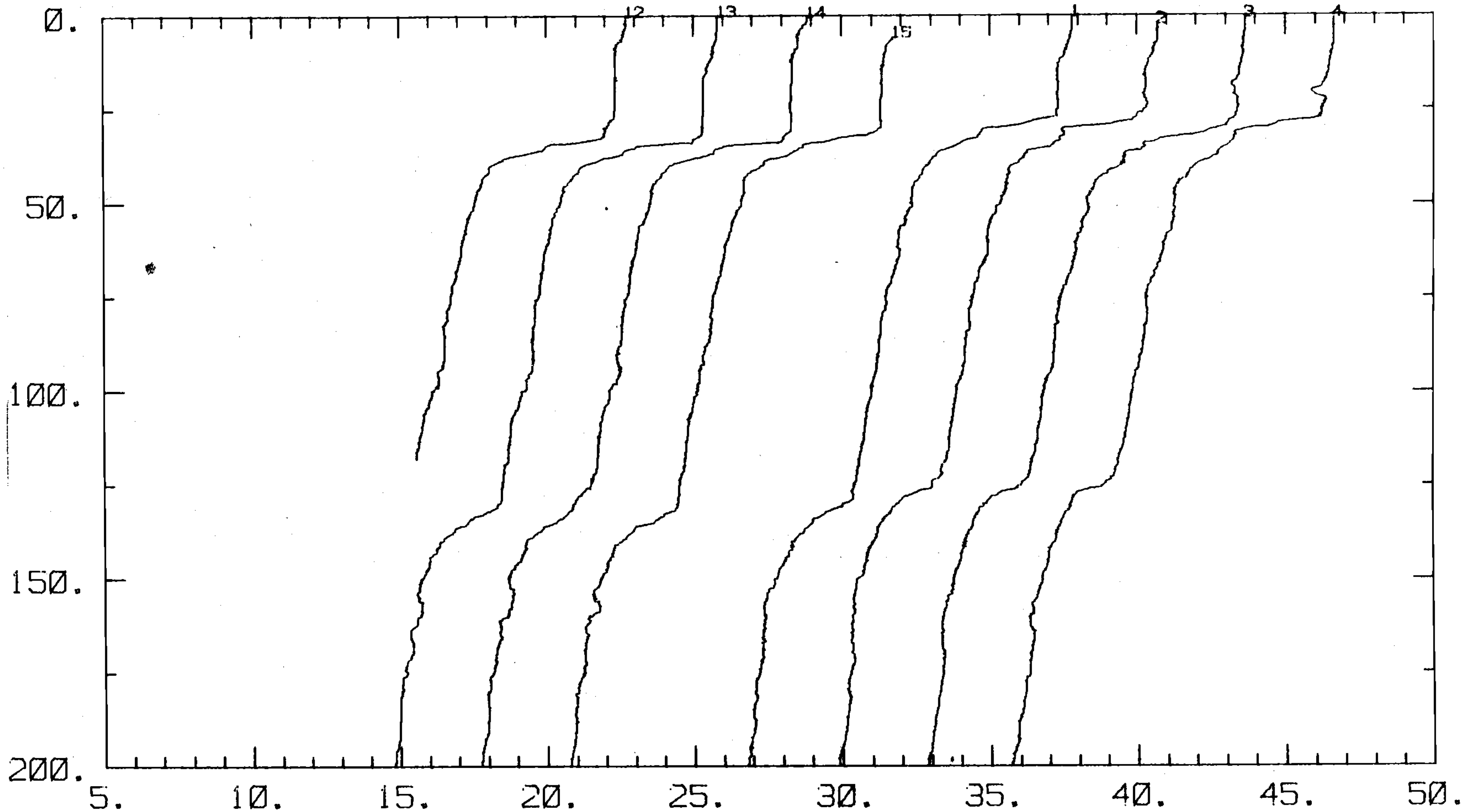
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

11JL82AN , 11JL82BN



SEQUENCE 4 PAGE 4

START TIME 01:18 GMT 07/11/82

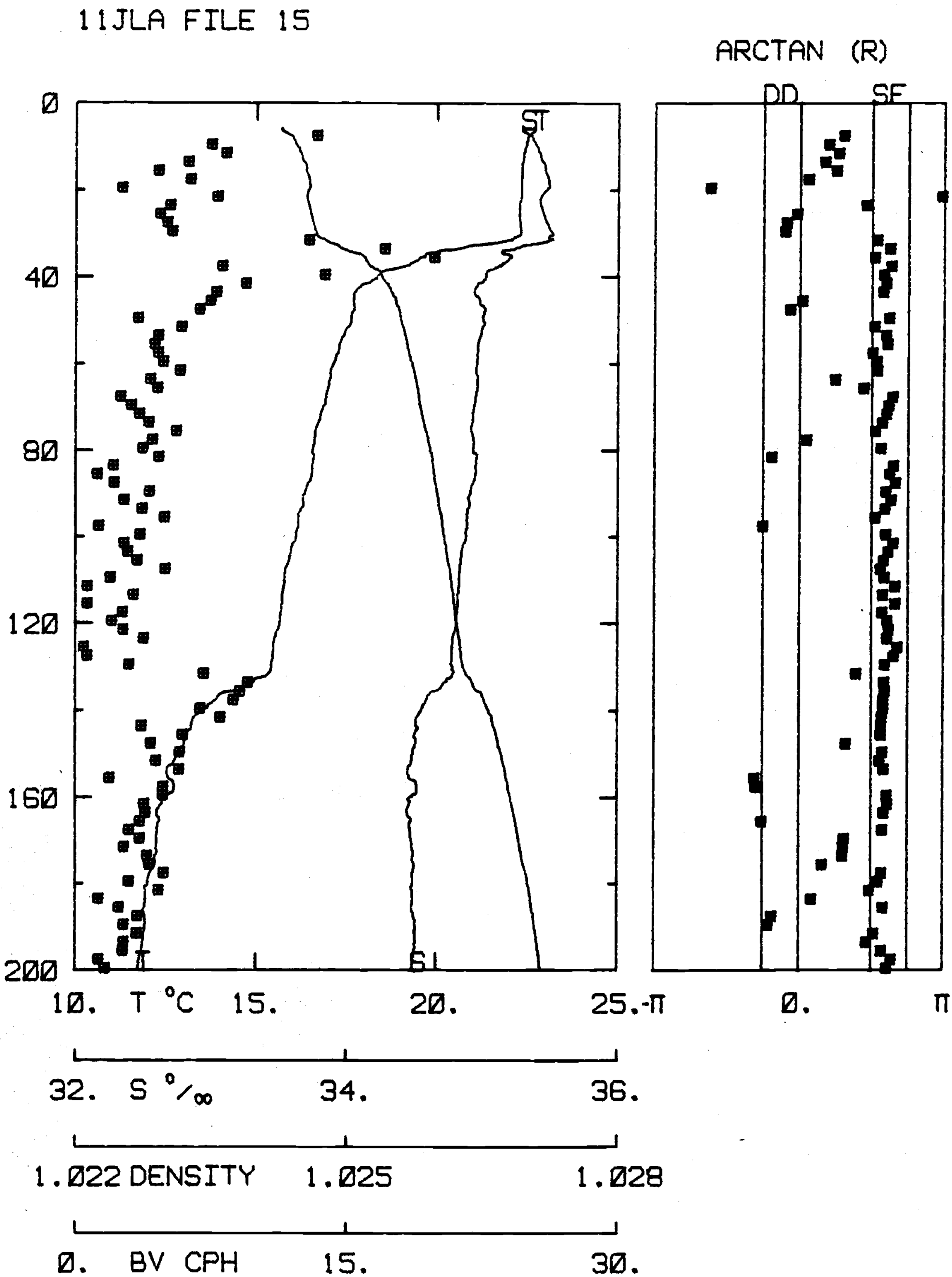
LOCATION 32°07'N 151°44'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


11JLA FILE 15
ARCTAN (R)
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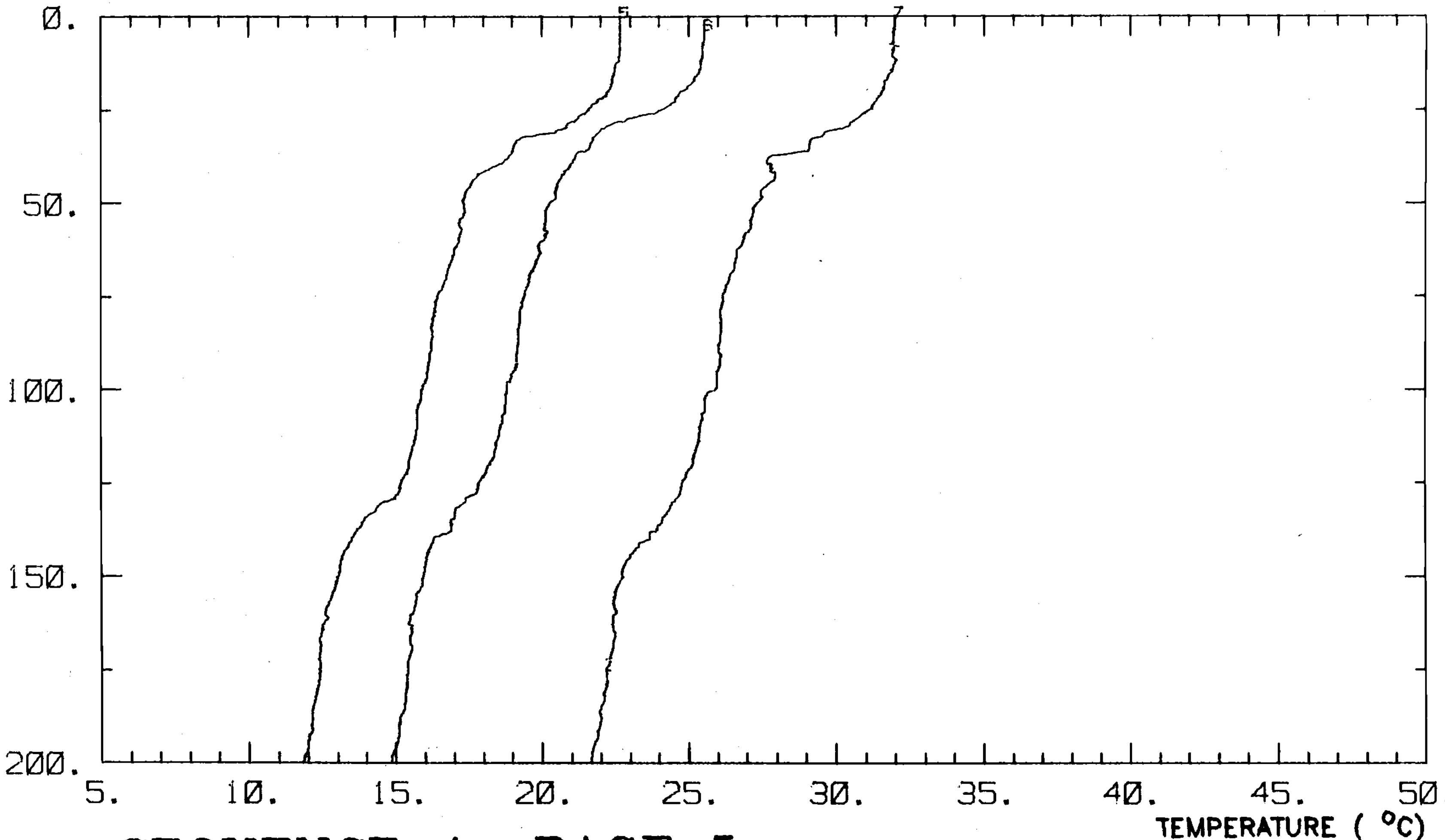
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

11JL82BN



SEQUENCE 4 PAGE 5

START TIME 02:14 GMT 07/11/82

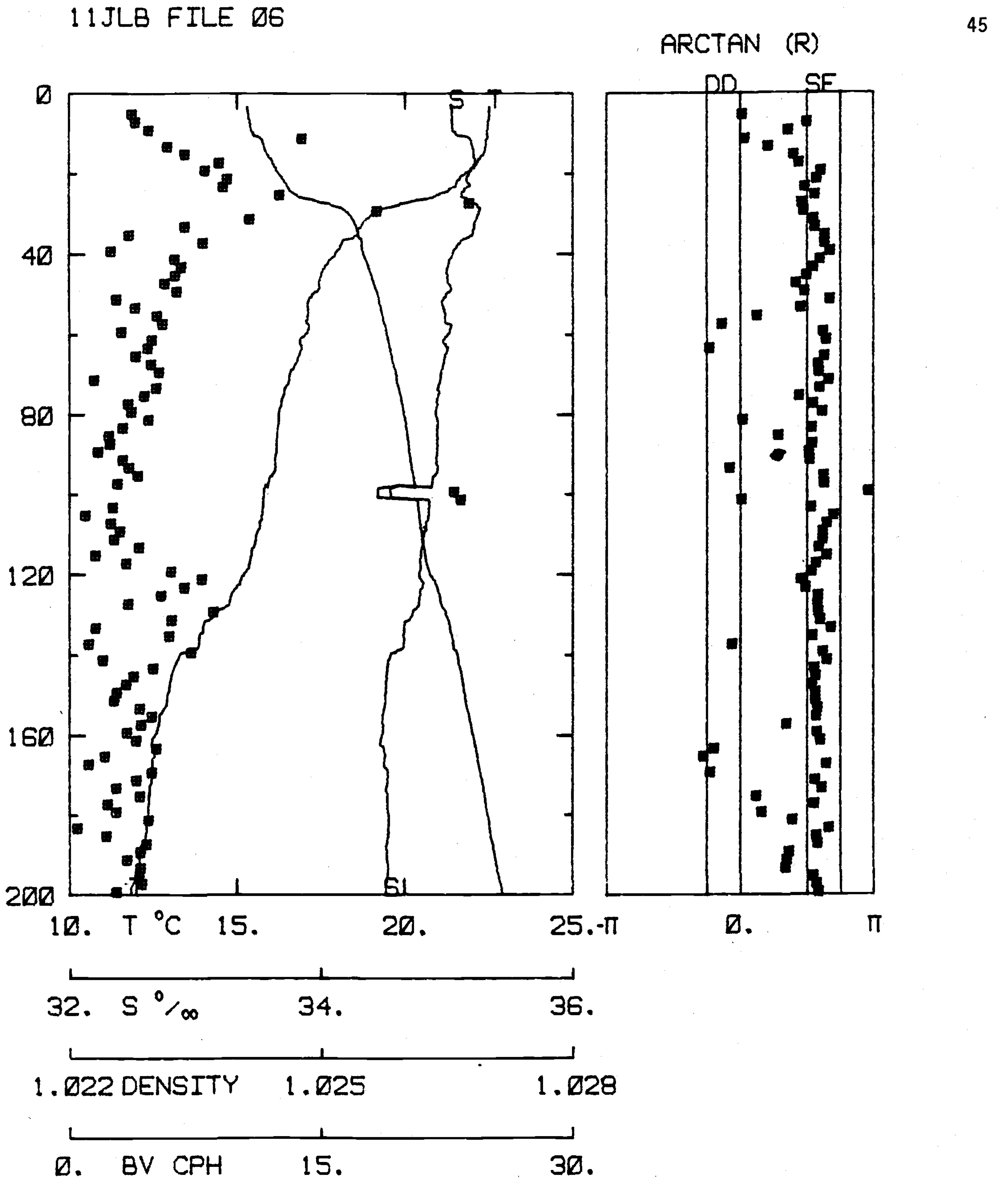
LOCATION 32°11'N 151°44'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


11JLB FILE Ø6
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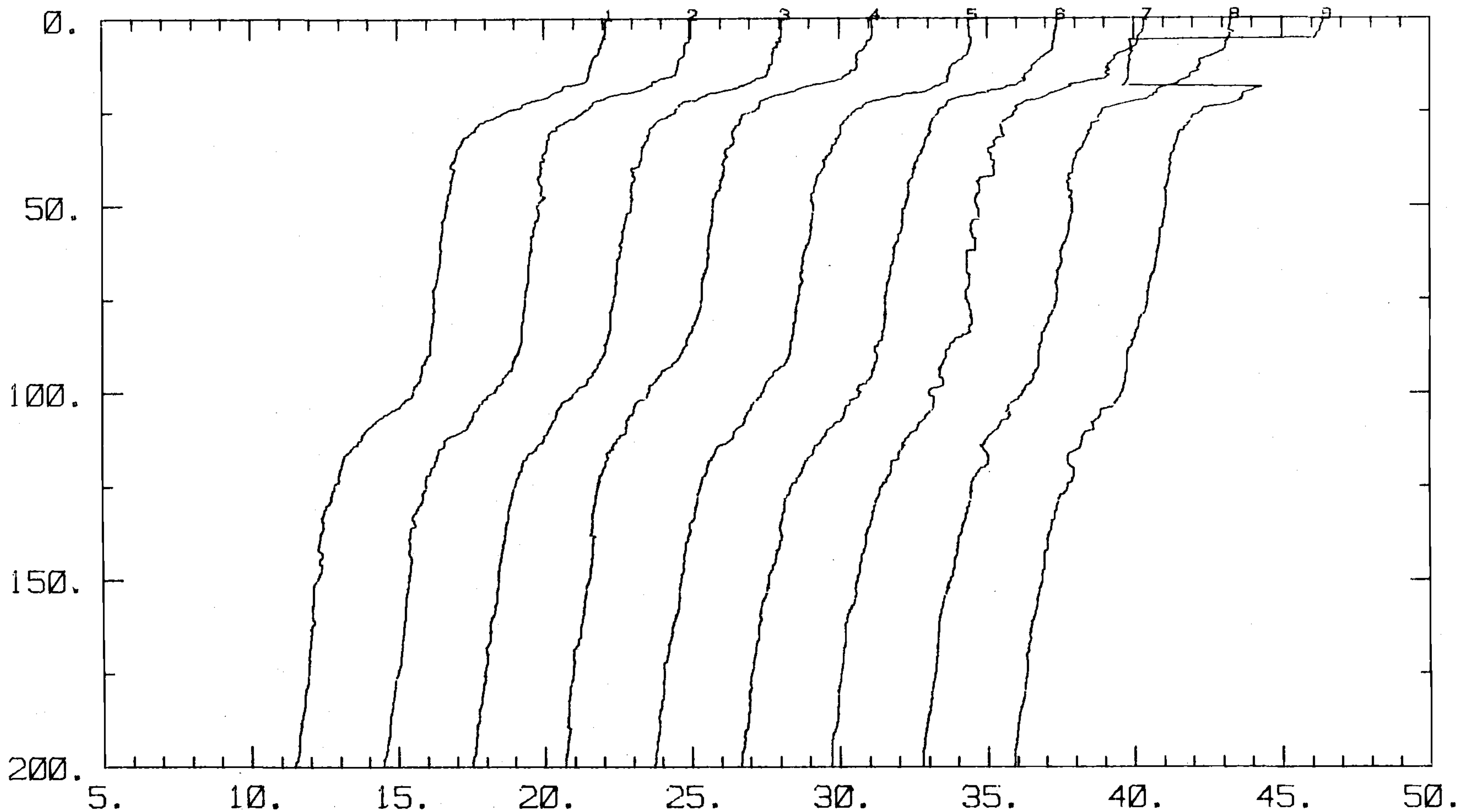
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
Ø. BV CPH 15. 30.

11JL82CN



SEQUENCE 5 PAGE 1

START TIME 03:48 GMT 07/11/82

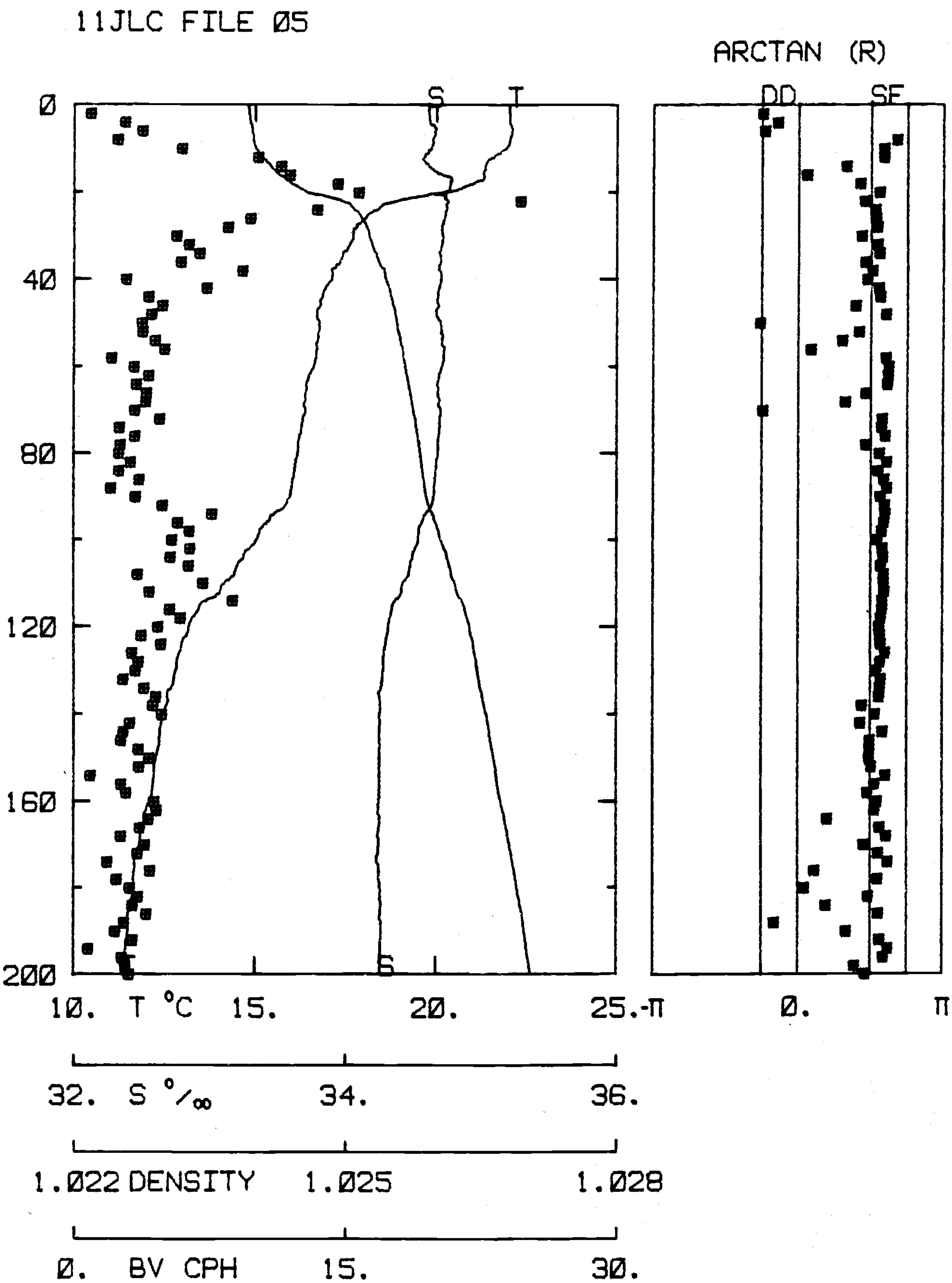
LOCATION 32°17'N 151°45'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 250°

Ship's heading 0°


11JLC FILE Ø5
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10. T °C 15. 20. 25.
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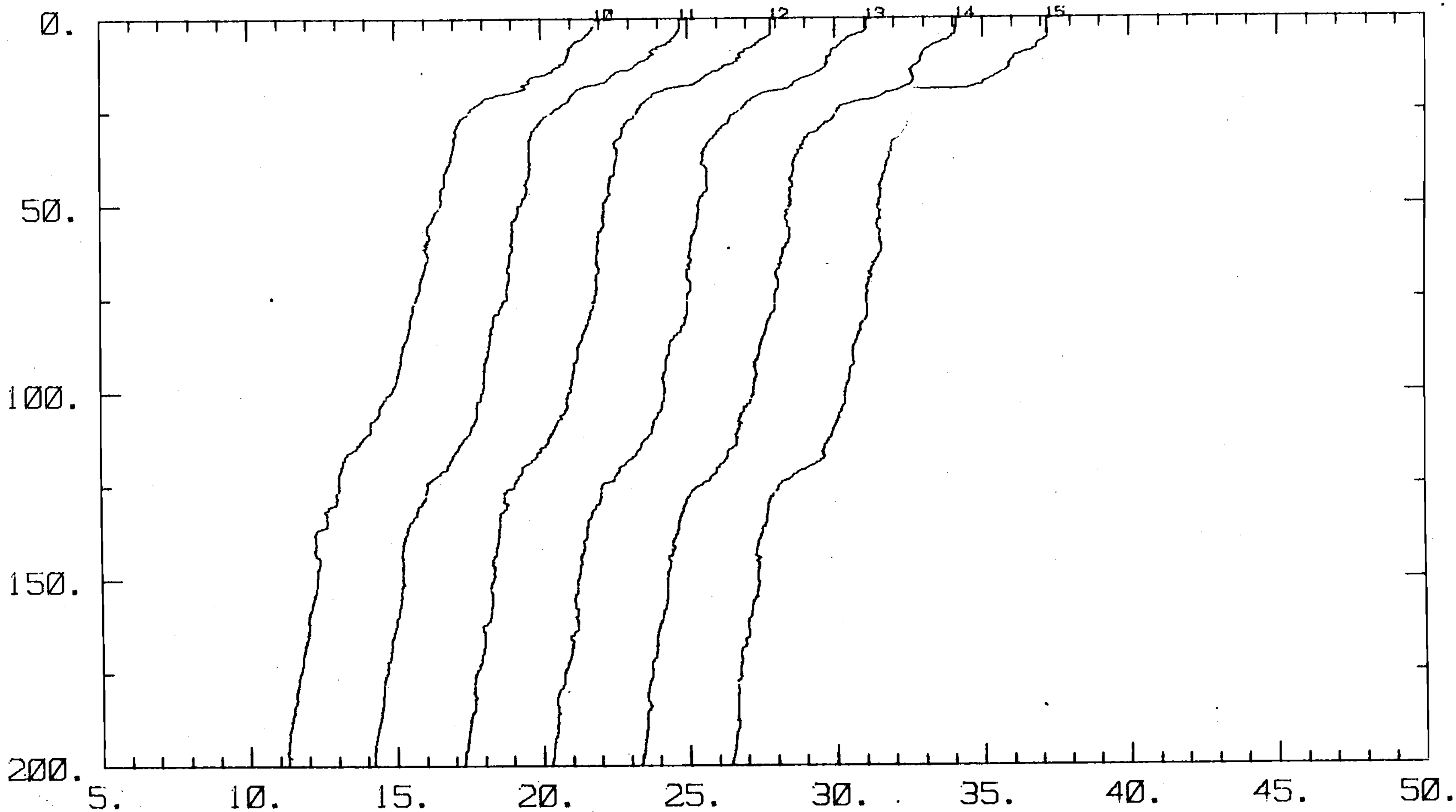
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

11JL82CN



48

SEQUENCE 5 PAGE 2

START TIME 04:43 GMT 07/11/82

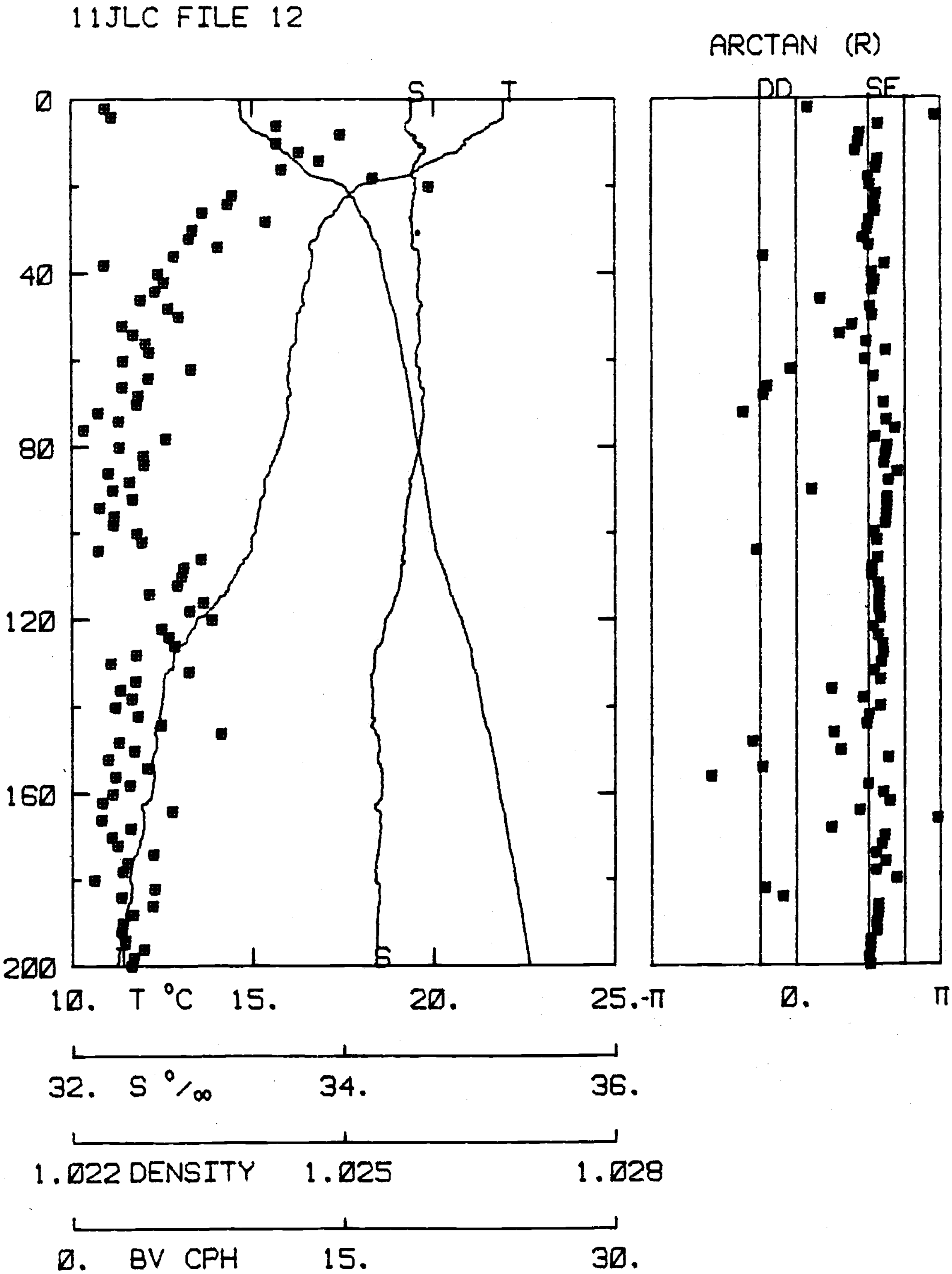
LOCATION 32°21'N 151°46'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 250°

Ship's heading 0°



11JLC FILE 12
ARCTAN (R)
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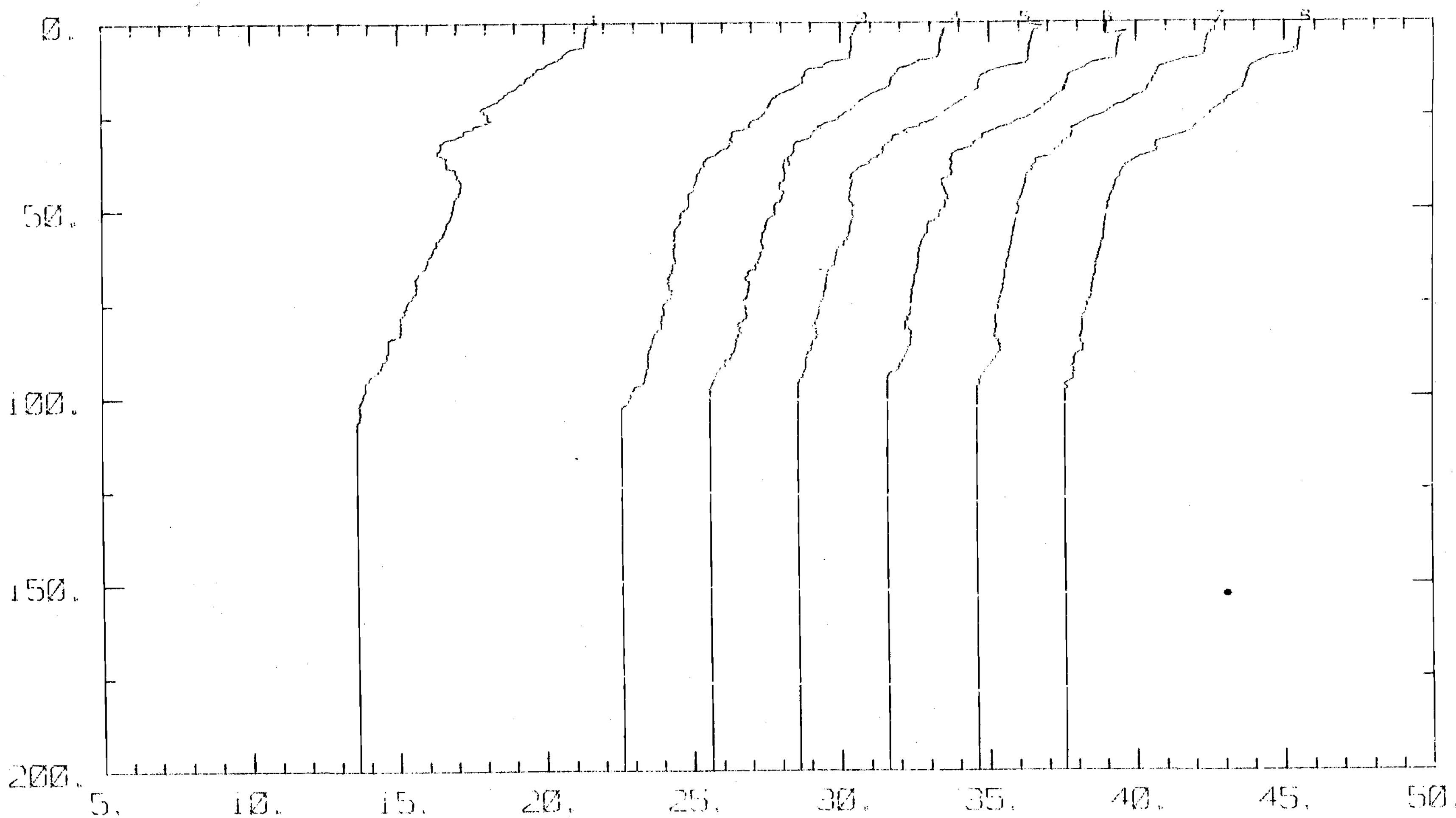
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

12JL82AM



SEQUENCE 6 PAGE 1

START TIME 00:06 GMT 07/12/82

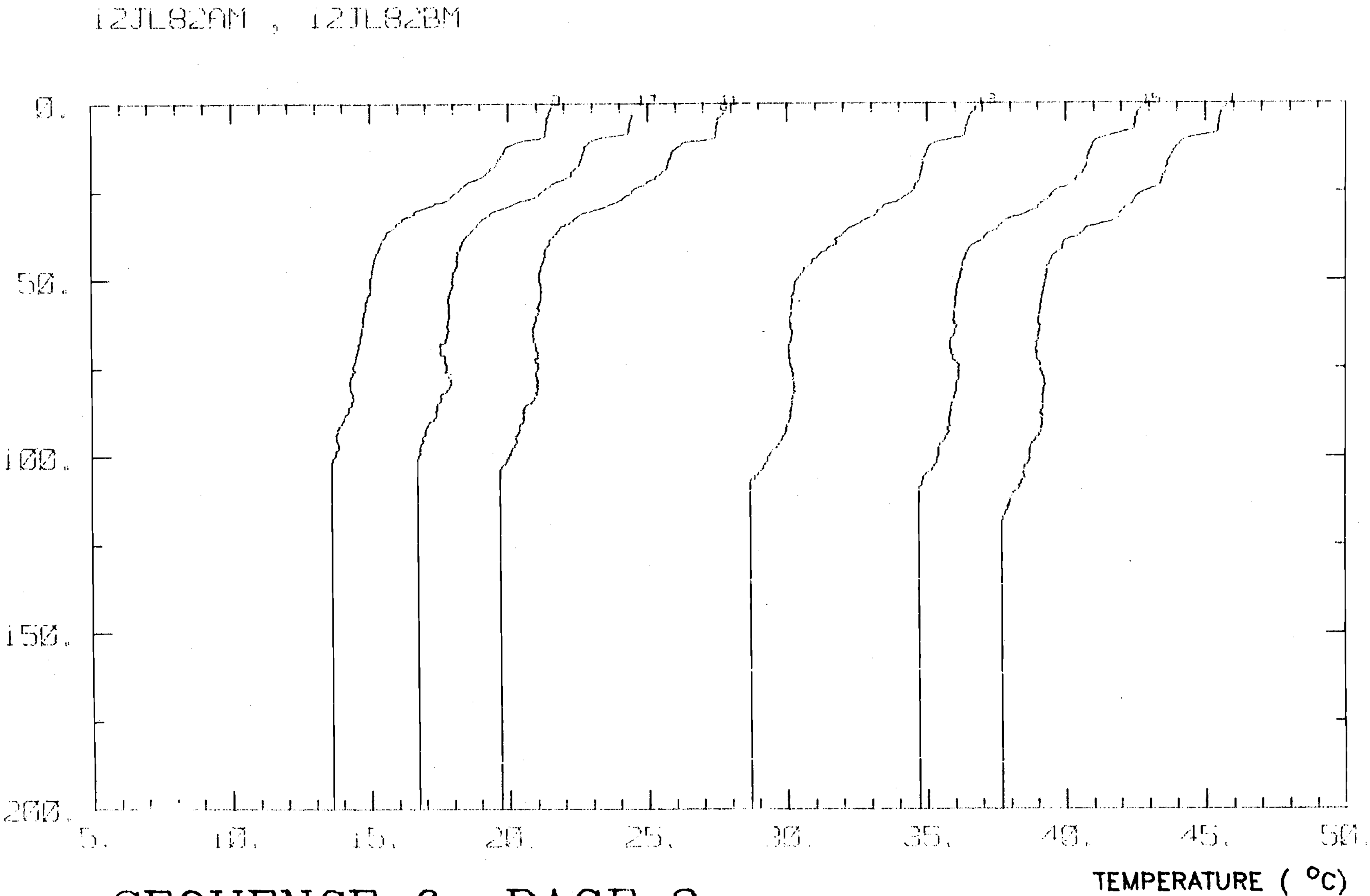
LOCATION 33°57'N 151°50'W

Profile spacing 800m

WIND SPEED 6. m/s

DIRECTION 250°

Ship's heading 0°



SEQUENCE 6 PAGE 2

START TIME 01:01 GMT 07/12/82

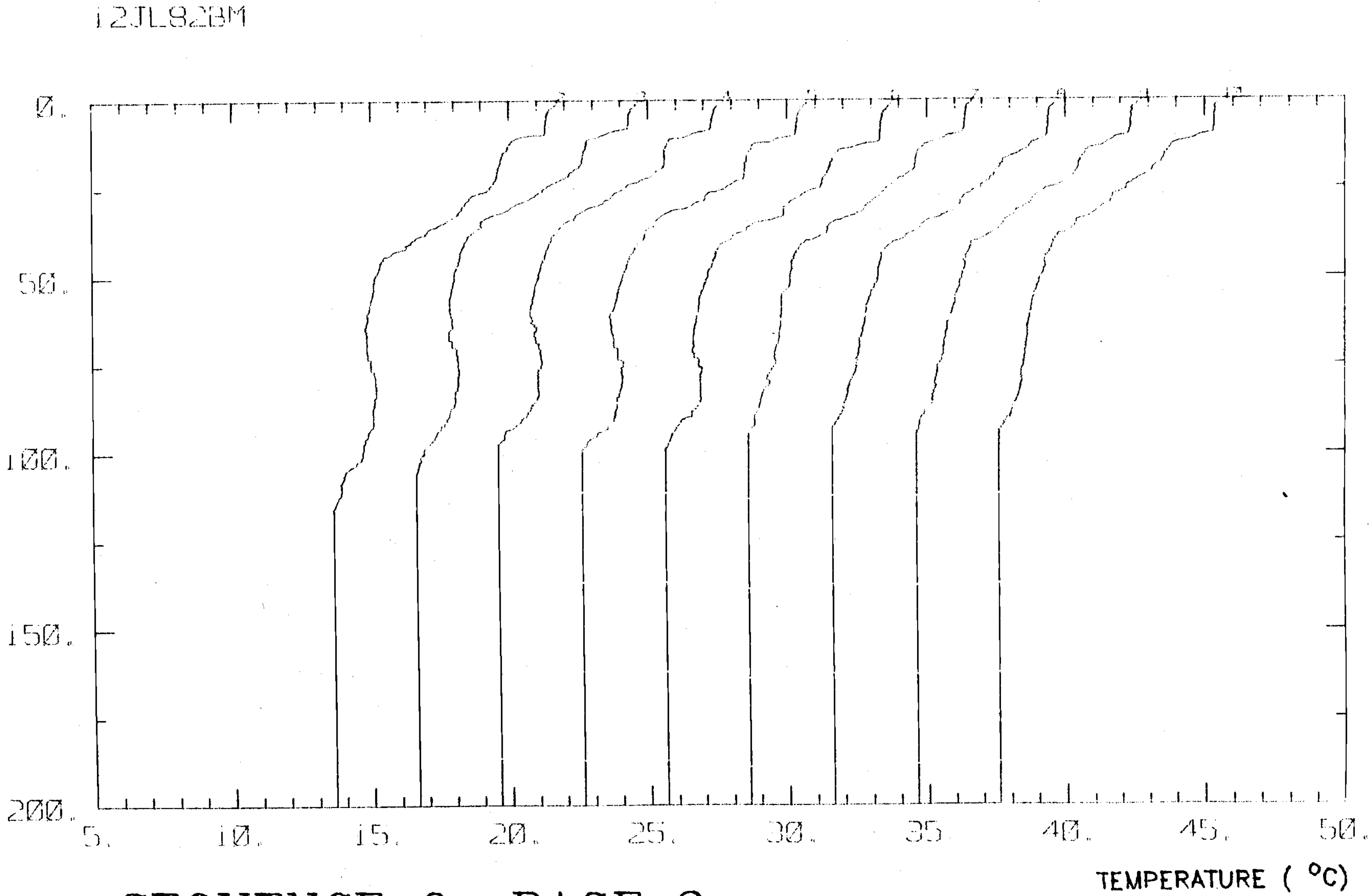
LOCATION 34°01'N 151°50'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 250°

Ship's heading 0°



SEQUENCE 6 PAGE 3

START TIME 02:00 GMT 07/12/82

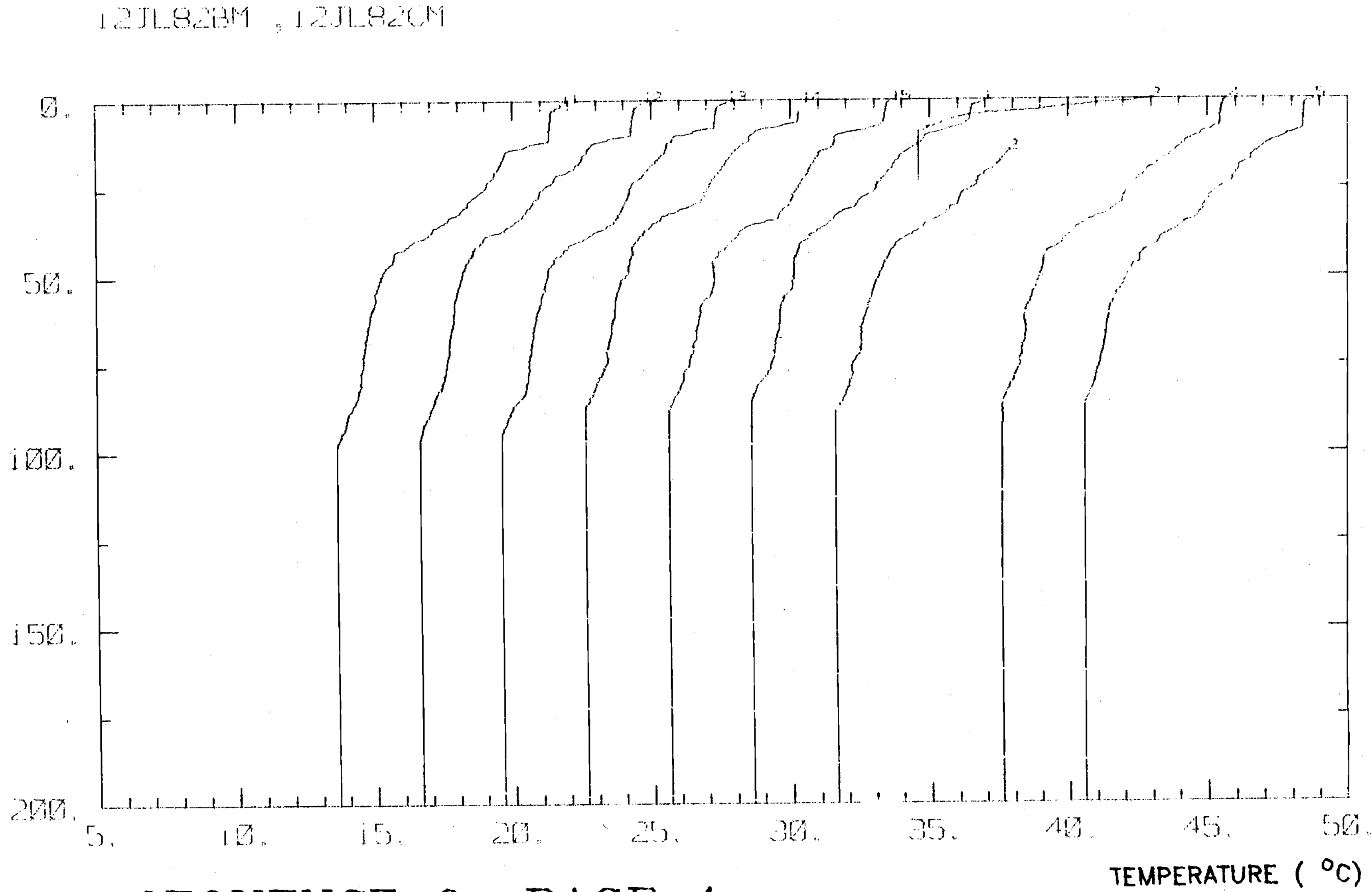
LOCATION 34°05'N 151°50'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 250°

Ship's heading 0°



56

SEQUENCE 6 PAGE 4

START TIME 02:54 GMT 07/12/82

LOCATION 34°09'N 151°50'W

Profile spacing 900m

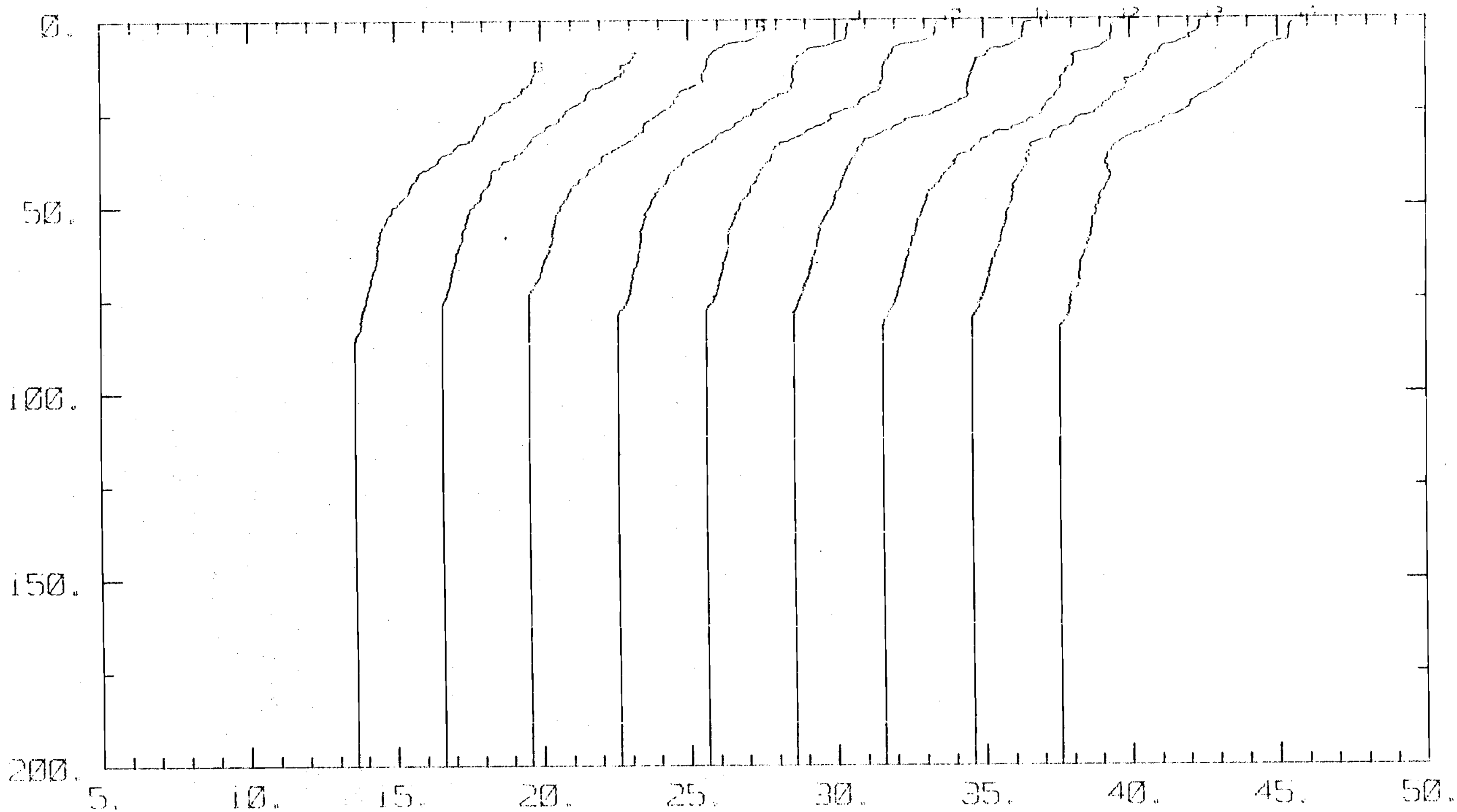
WIND SPEED 6. m/s

DIRECTION 250°

Ship's heading 0°

12JL82CM

58



SEQUENCE 6 PAGE 5

START TIME 03:48 GMT 07/12/82

LOCATION 34°13'N 151°50'W

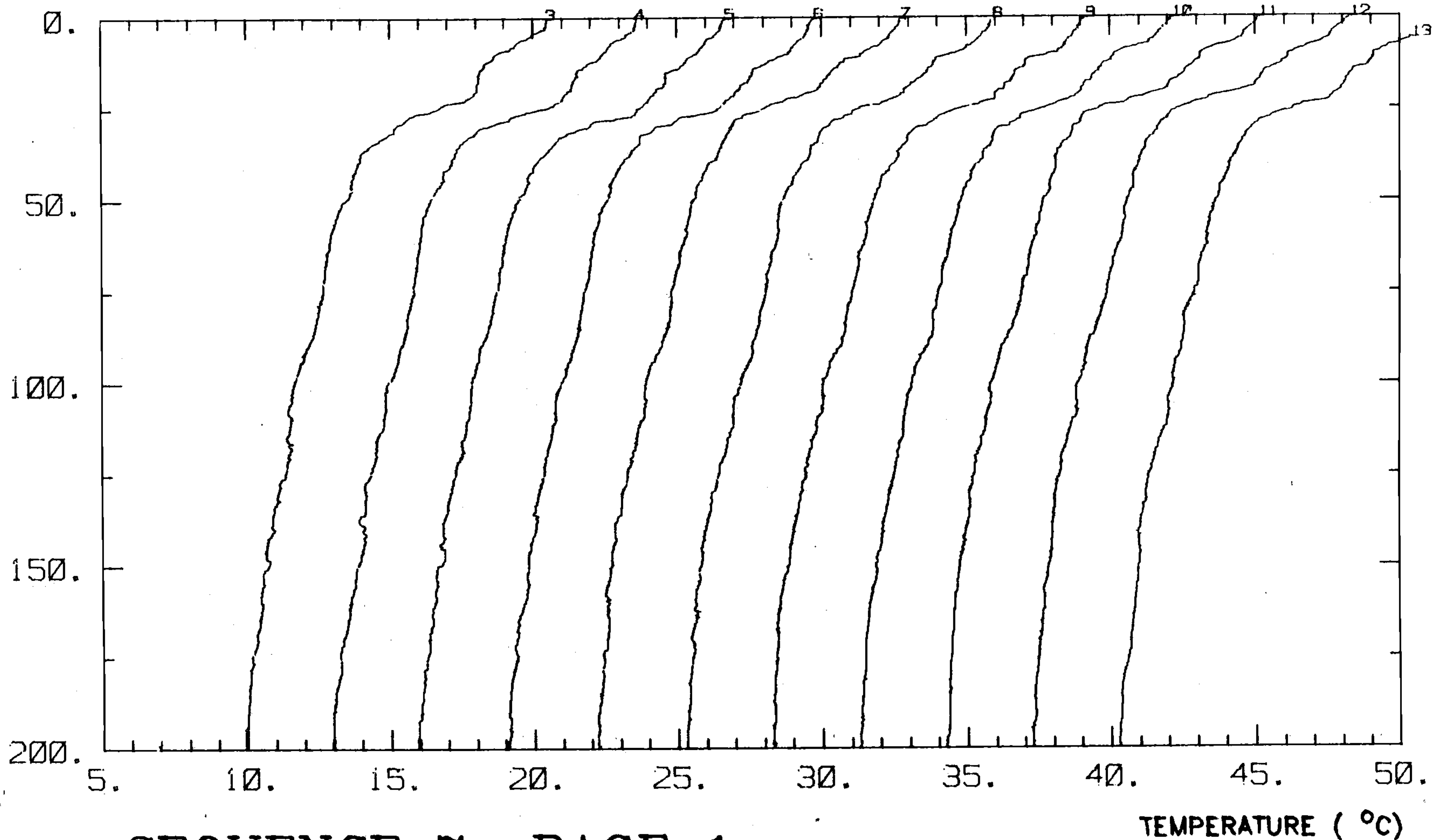
Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 250°

Ship's heading 0°

12JL82EN



SEQUENCE 7 PAGE 1

START TIME 22:54 GMT 07/12/82

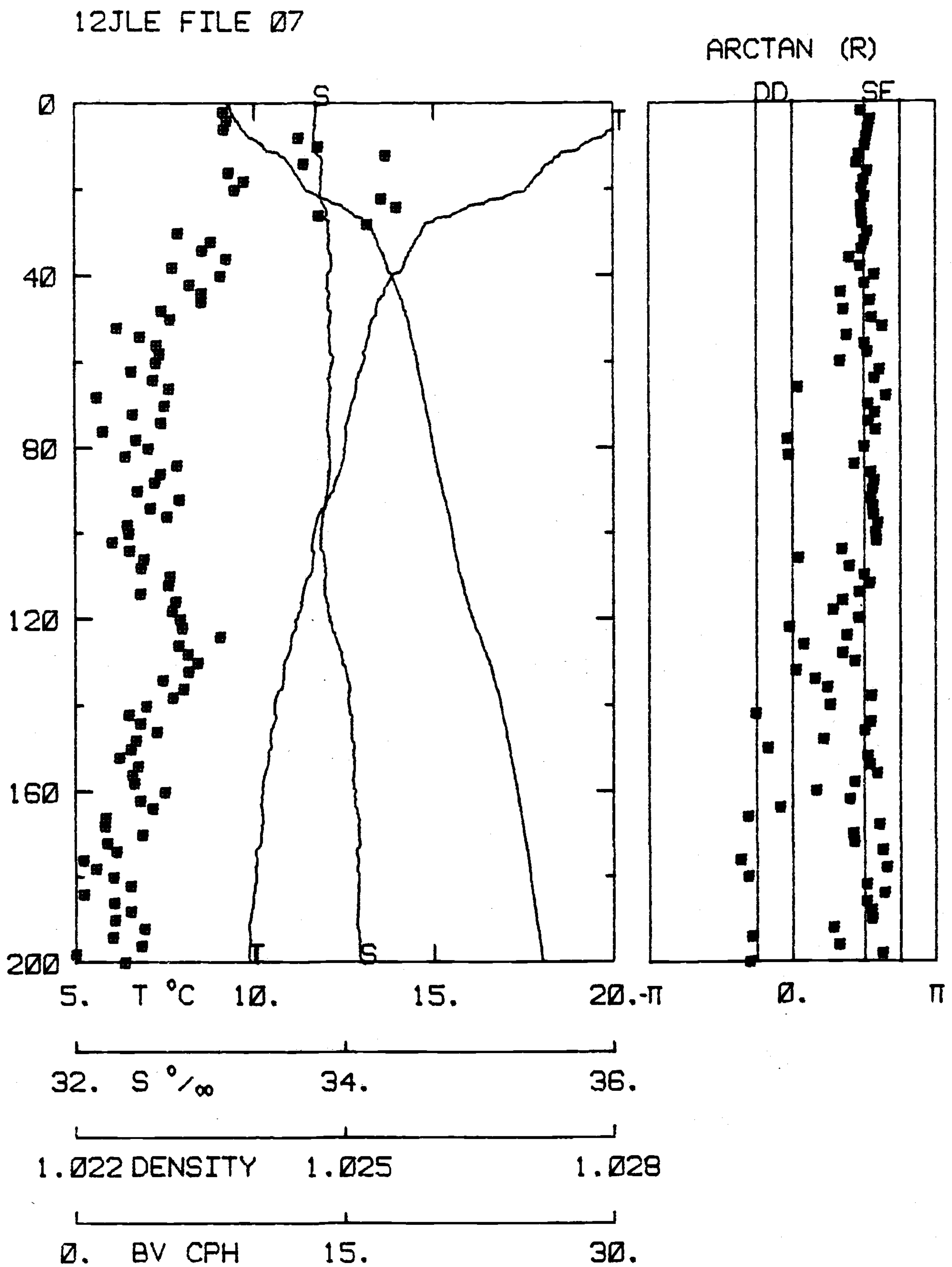
LOCATION 35°53'N 151°52'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


12JLE FILE Ø7
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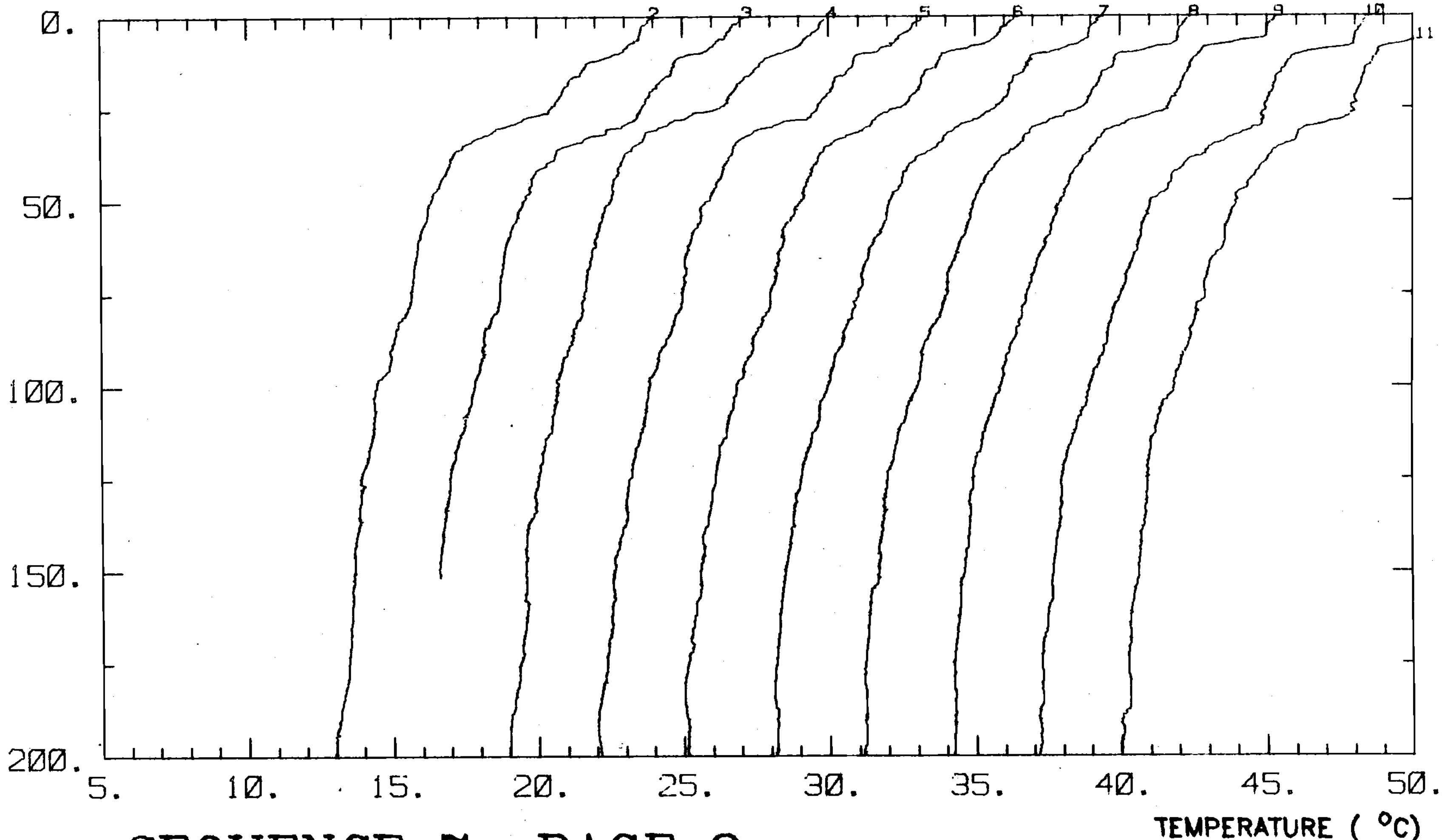
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

13JL82AN



62

SEQUENCE 7 PAGE 2

START TIME 00:00 GMT 07/13/82

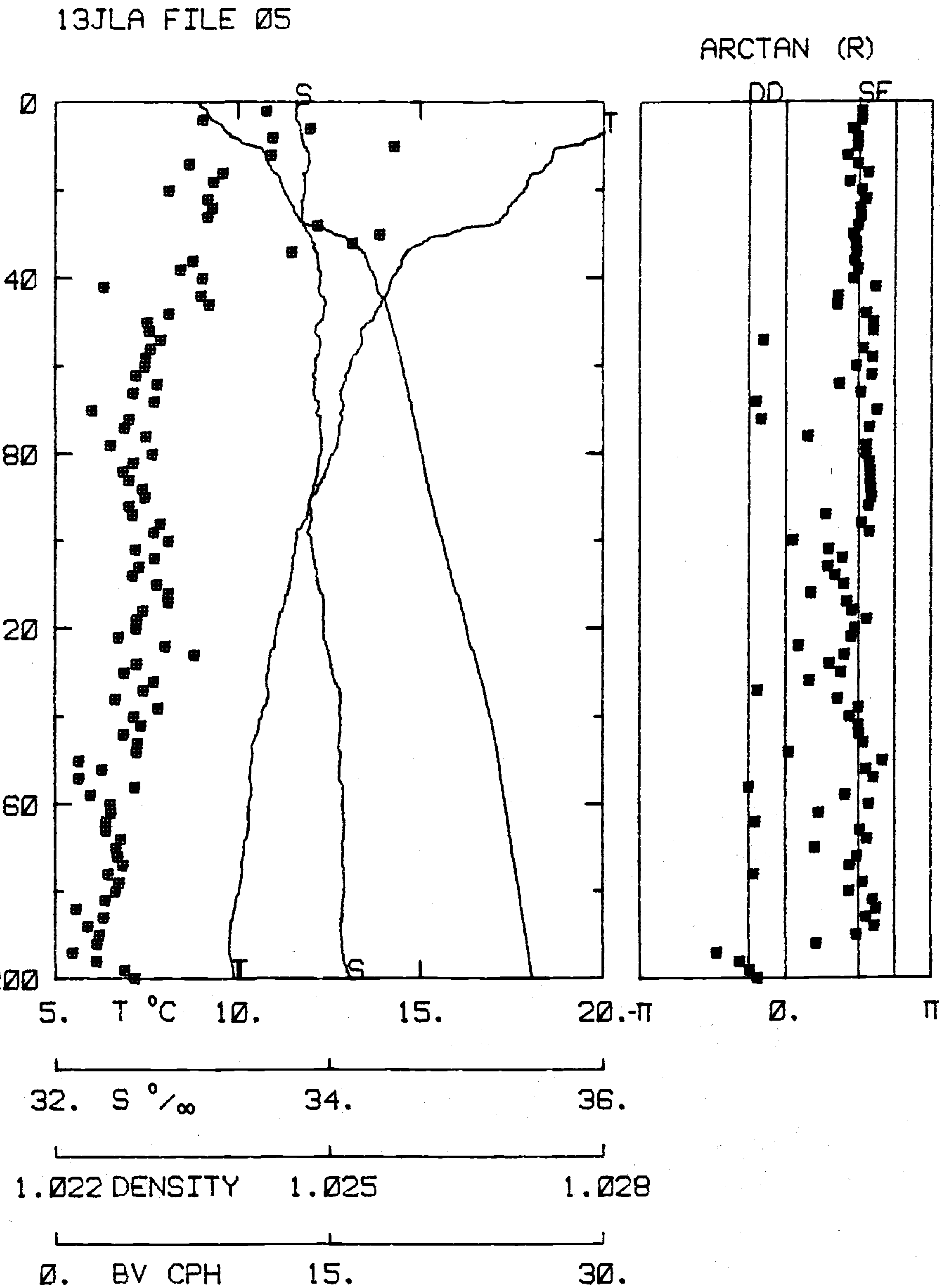
LOCATION 35°57'N 151°50'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


13JLA FILE Ø5
ARCTAN (R)
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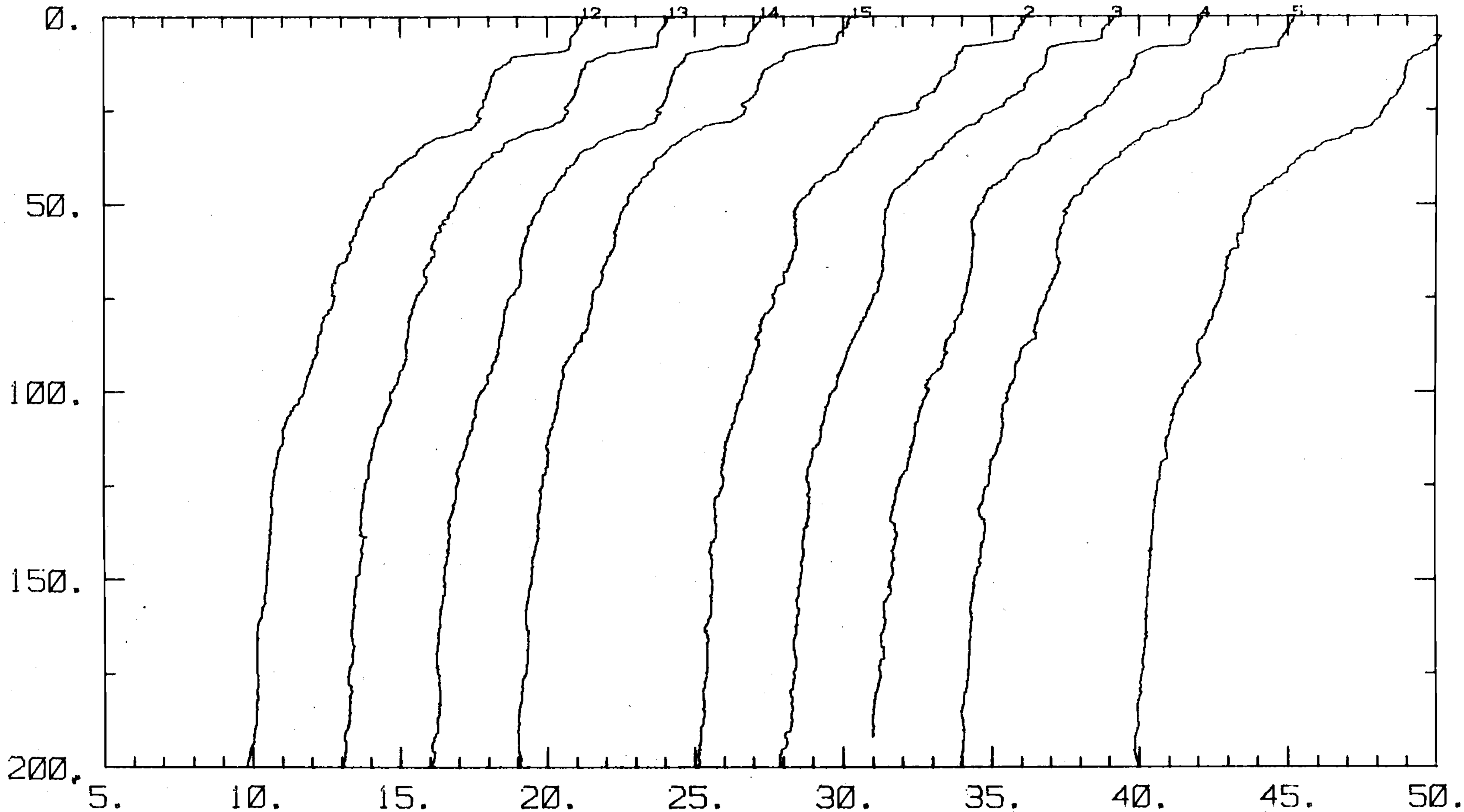
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

13JL82AN , 13JL82BN



SEQUENCE 7 PAGE 3

START TIME 01:06 GMT 07/13/82

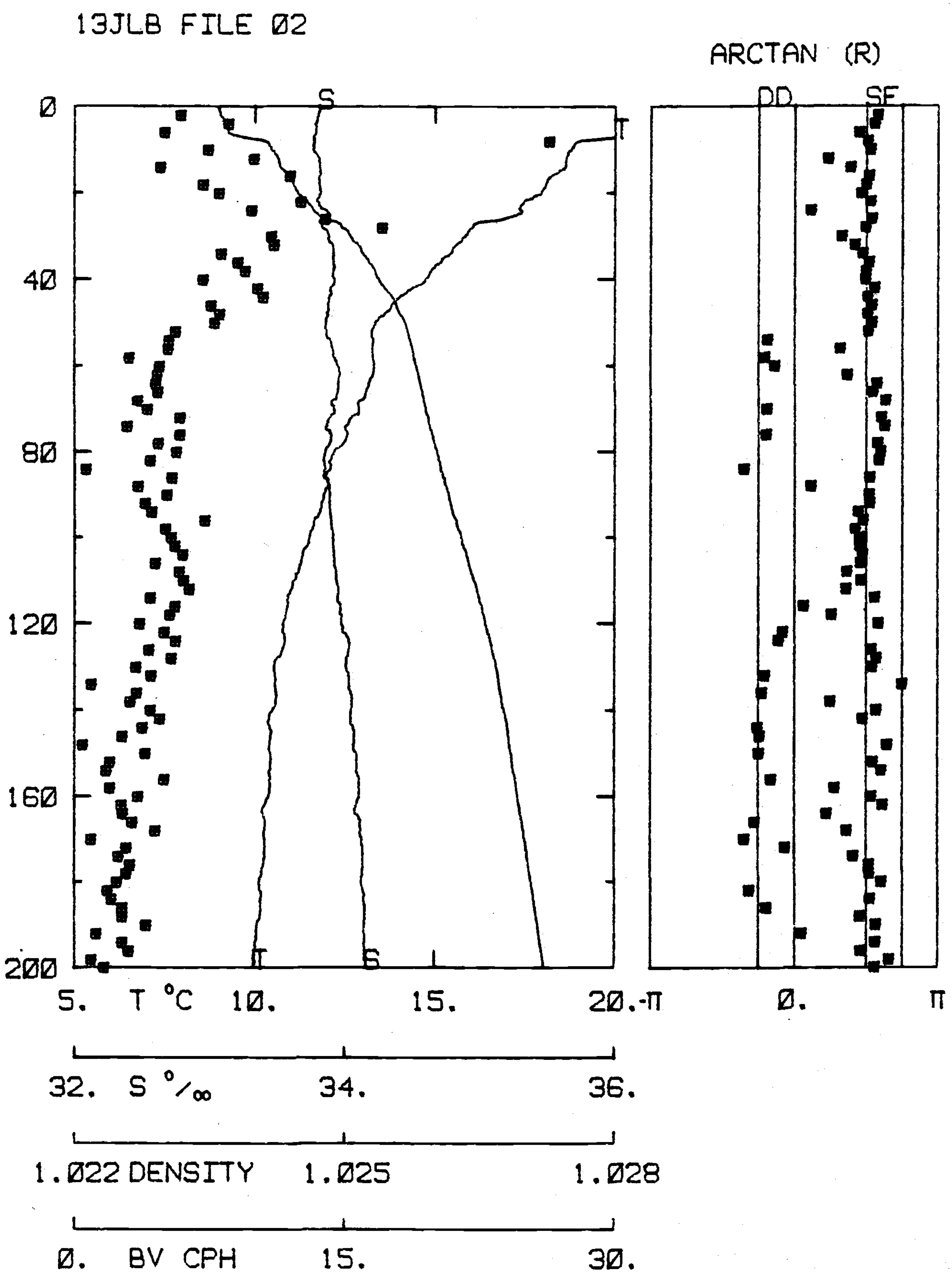
LOCATION 36°01'N 151°49'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°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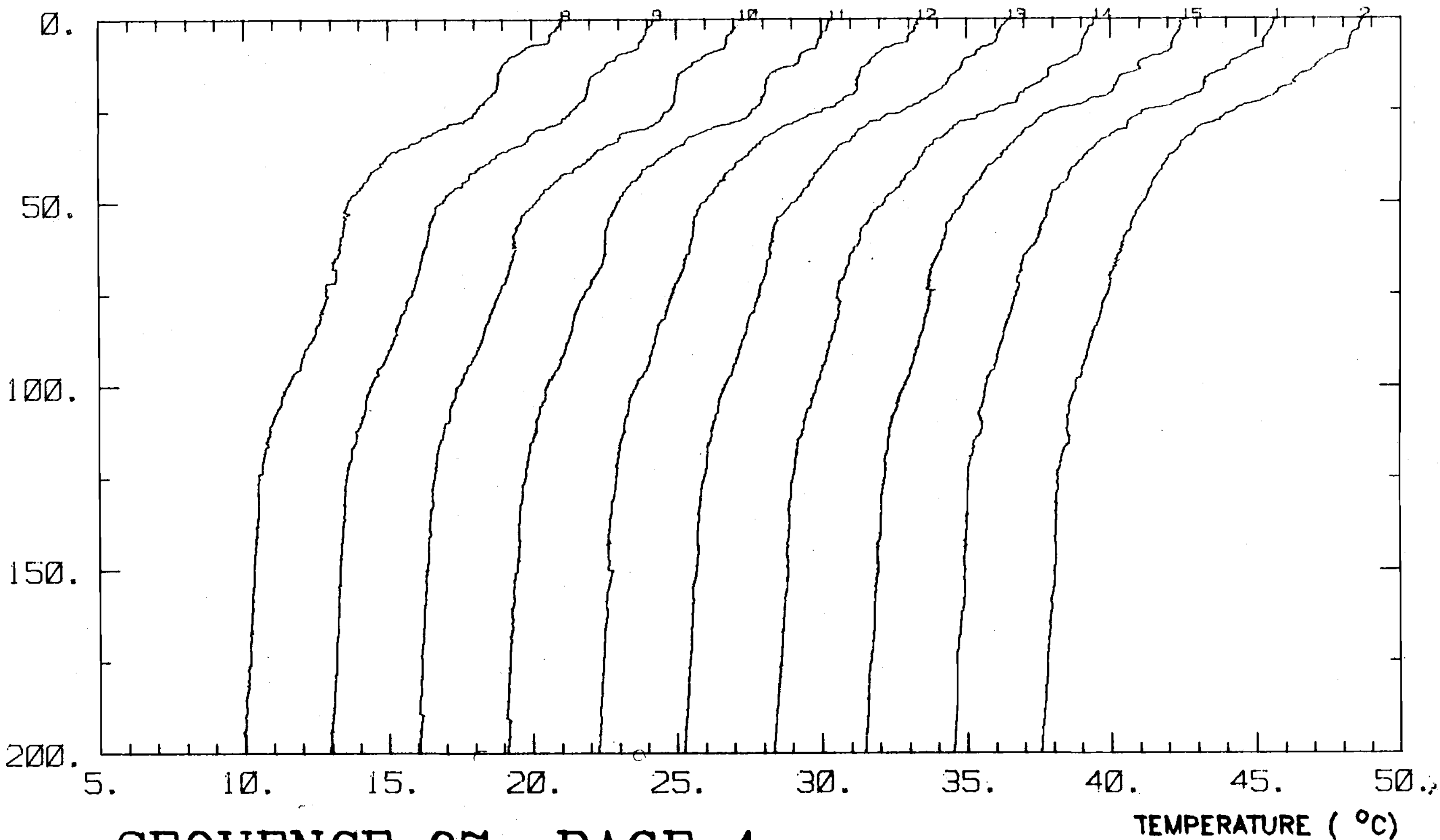
13JL82BN , 13JL82CN



99

SEQUENCE 07 PAGE 4

START TIME 02:12 GMT 07/13/82

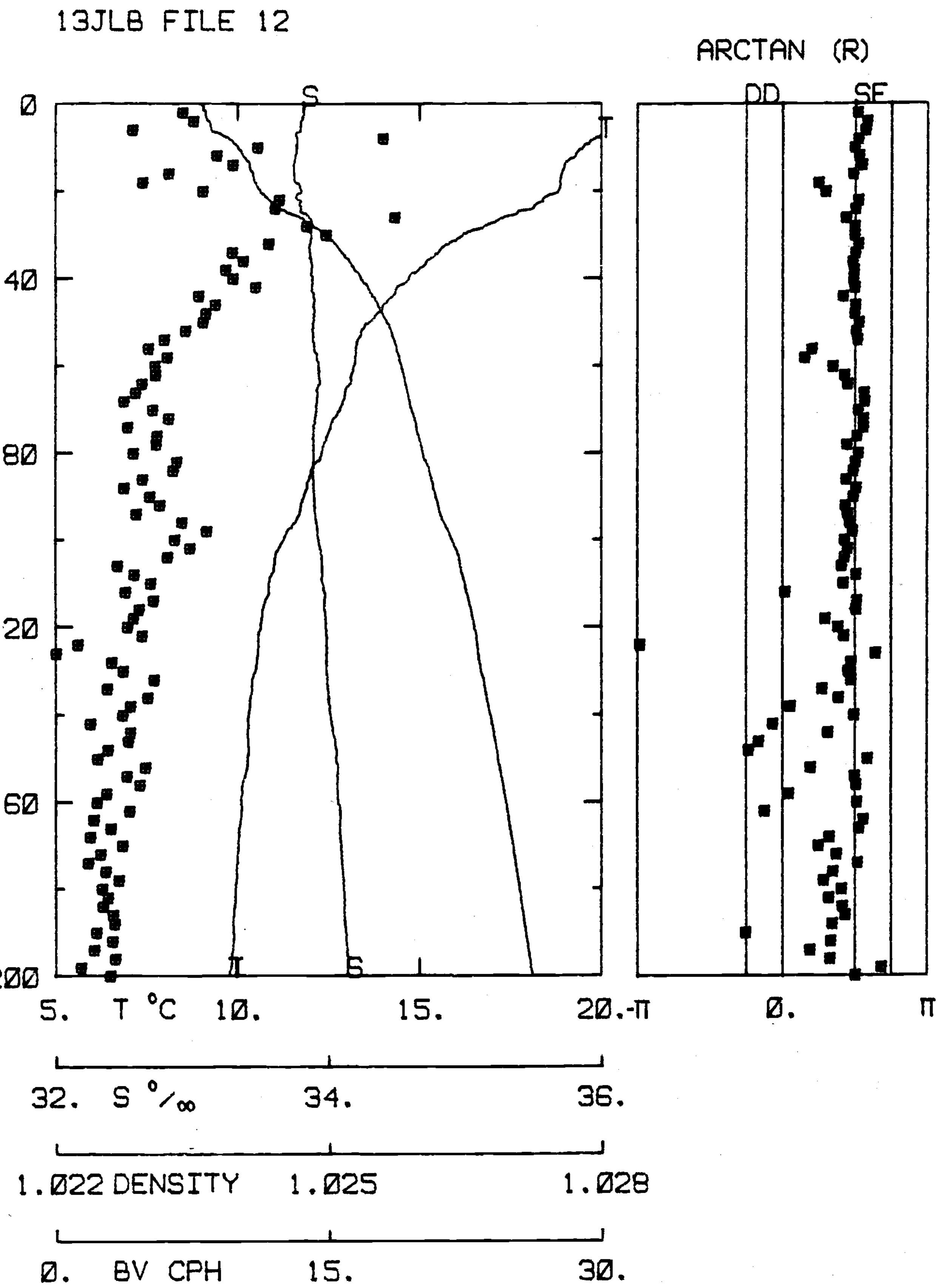
LOCATION 36°05'N 151°49'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°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ARCTAN (R)
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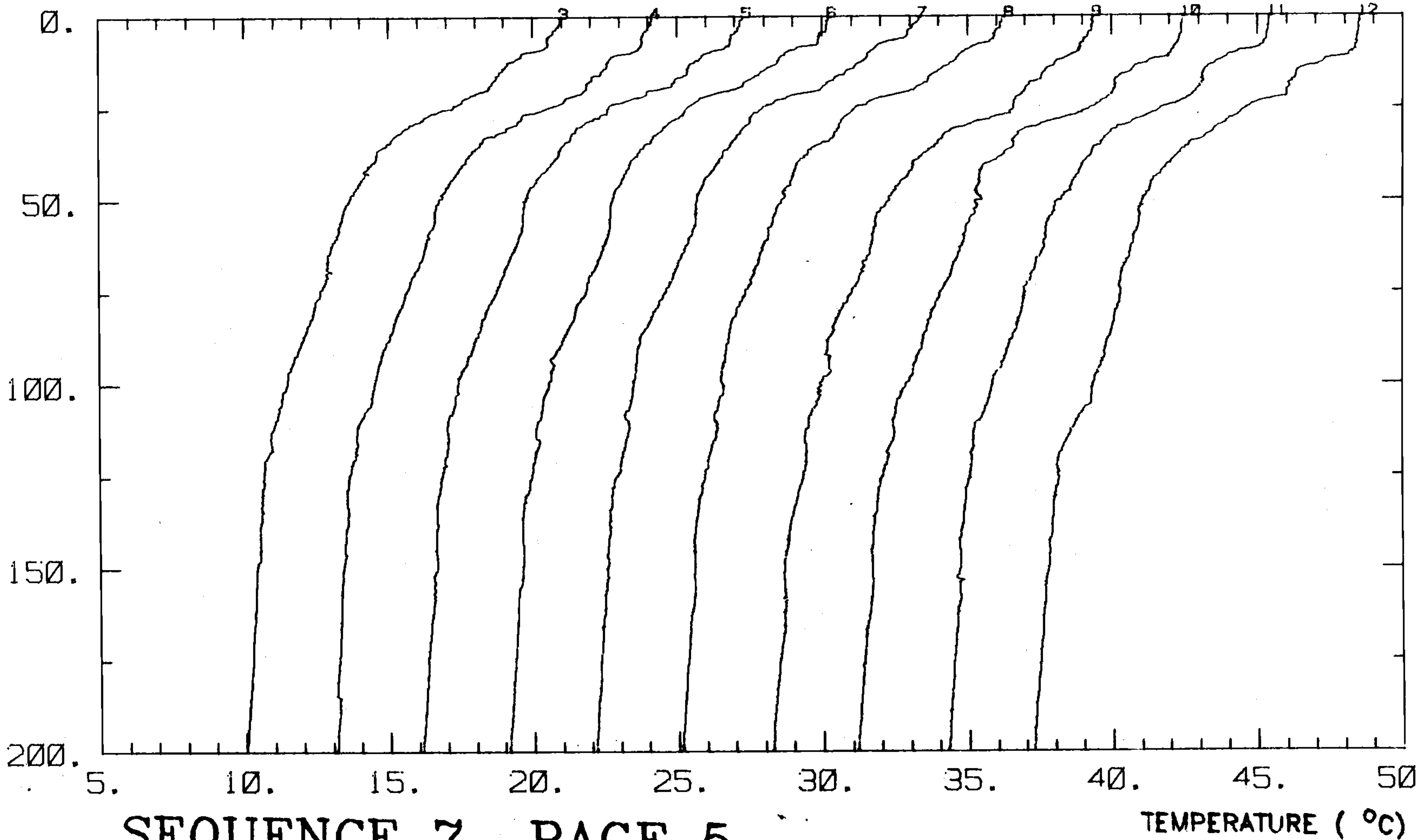
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

13JL82CN



SEQUENCE 7 PAGE 5

START TIME 03:12 GMT 07/13/82

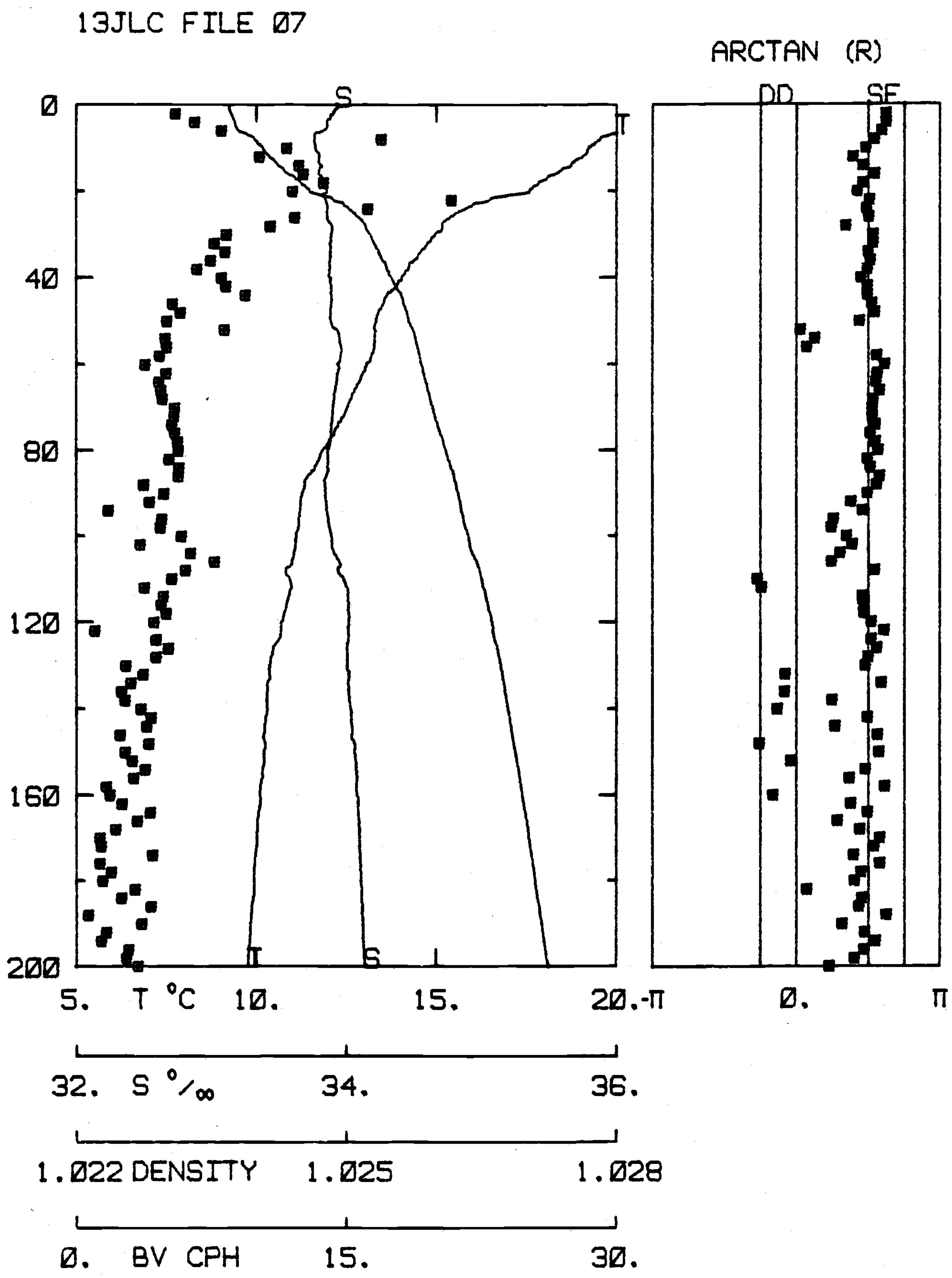
LOCATION 36°09'N 151°49'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°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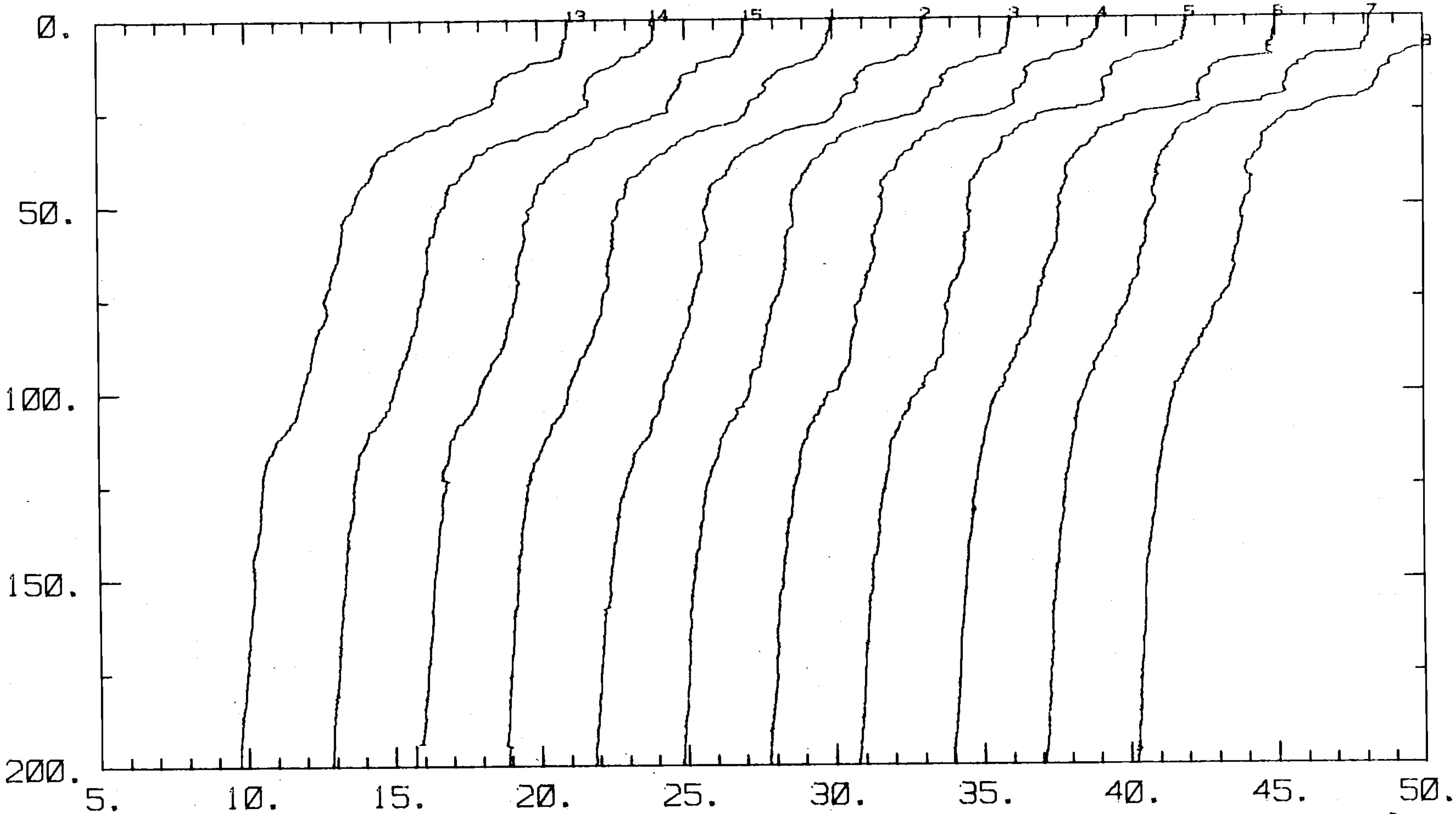
13JL82CN , 13JL82DN



70

SEQUENCE 7 PAGE 6

START TIME 04:13 GMT 07/13/82

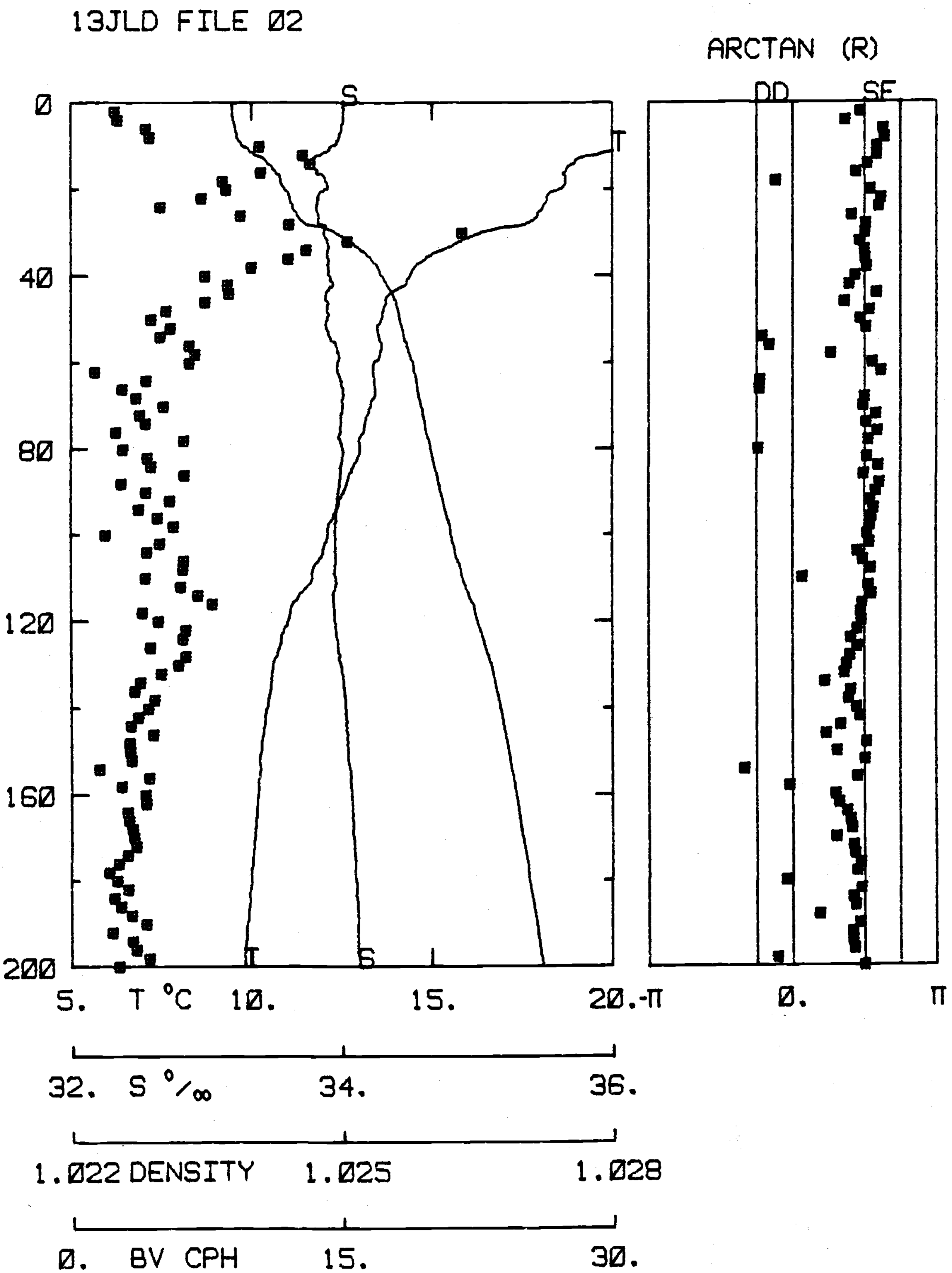
LOCATION 36°13'N 151°49'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°


13JLD FILE Ø2
ARCTAN (R)
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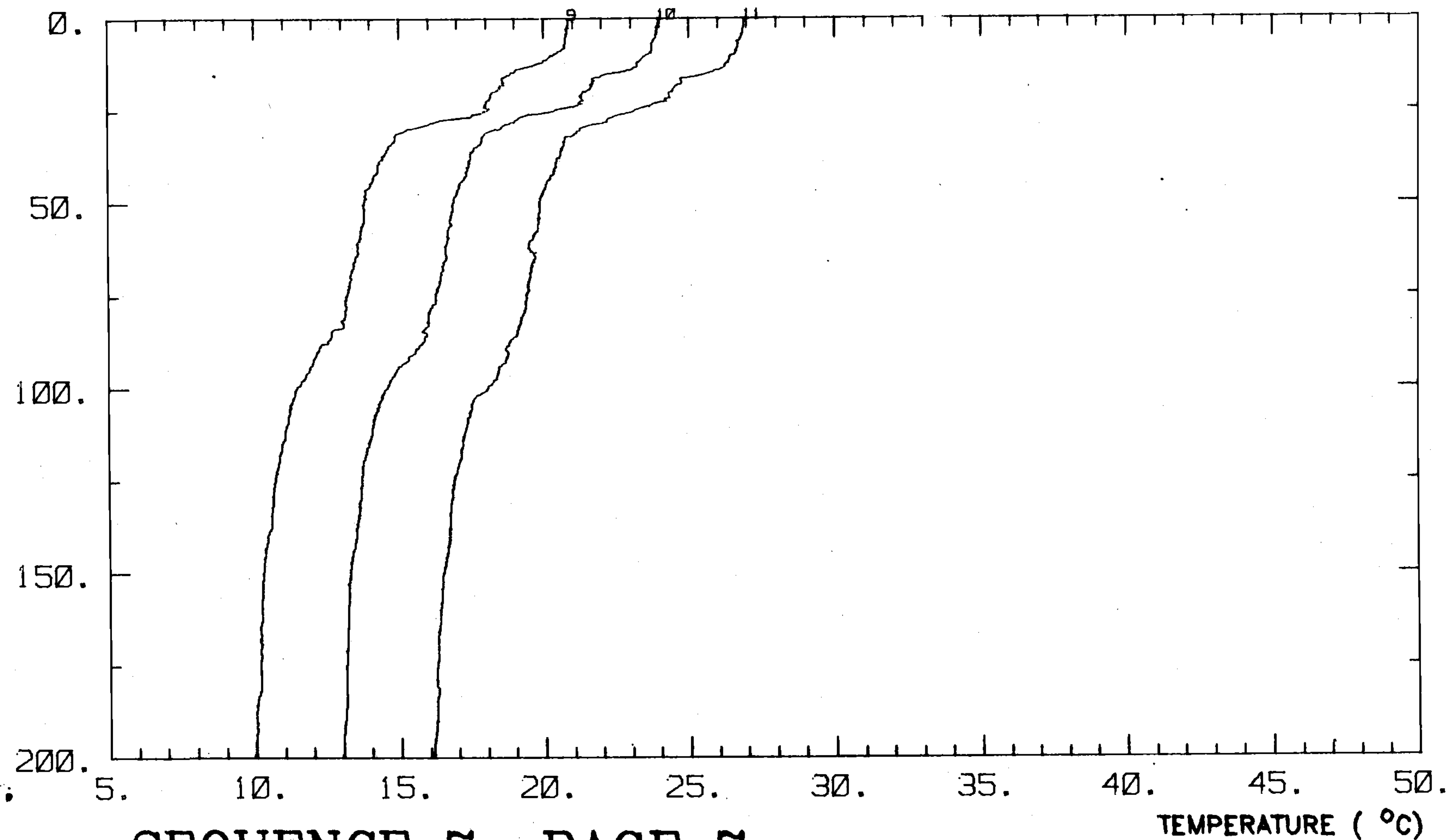
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

13JL82DN



72

SEQUENCE 7 PAGE 7

START TIME 05:19 GMT 07/13/82

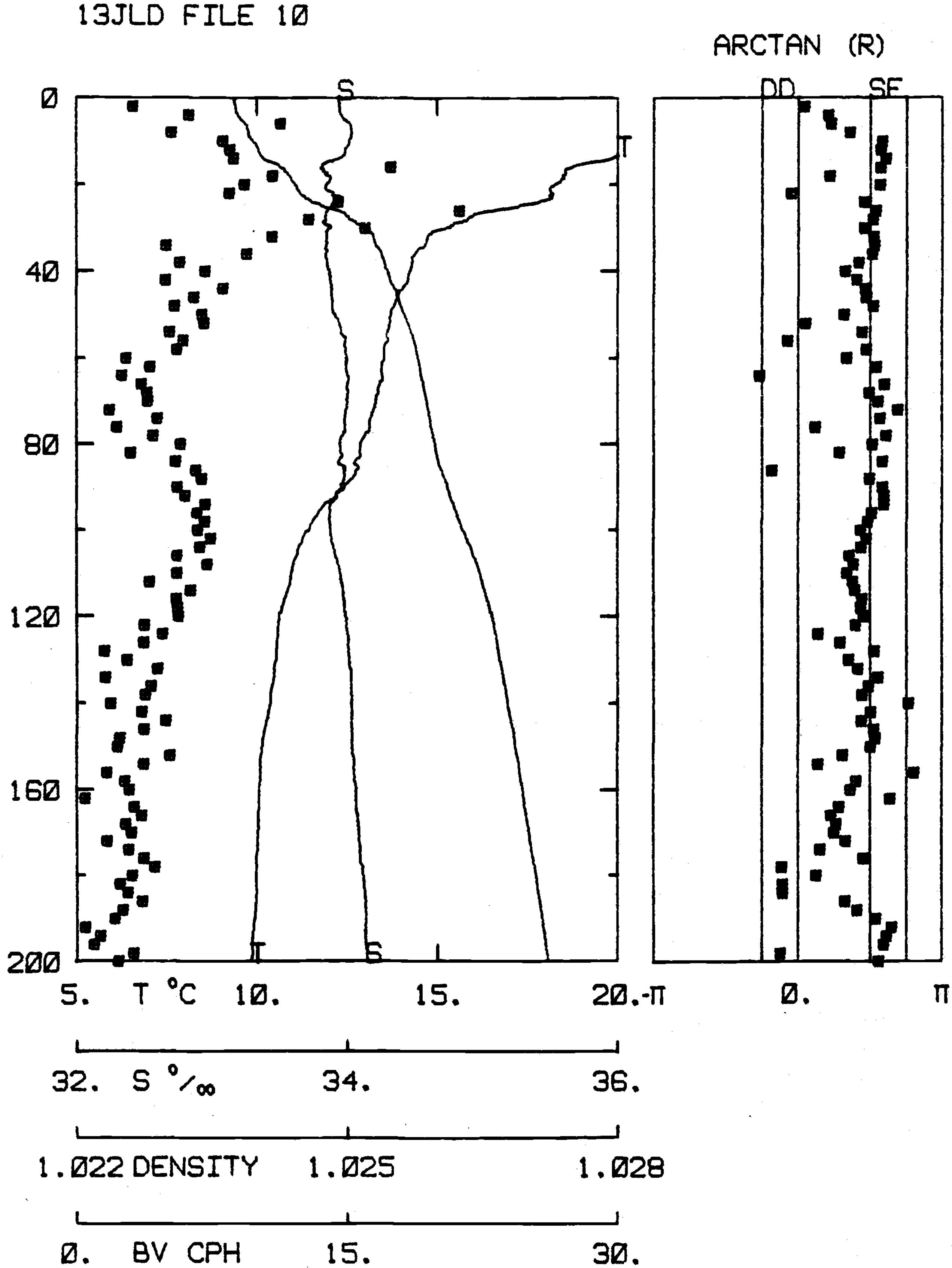
LOCATION 36°17'N 151°48'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 280°

Ship's heading 0°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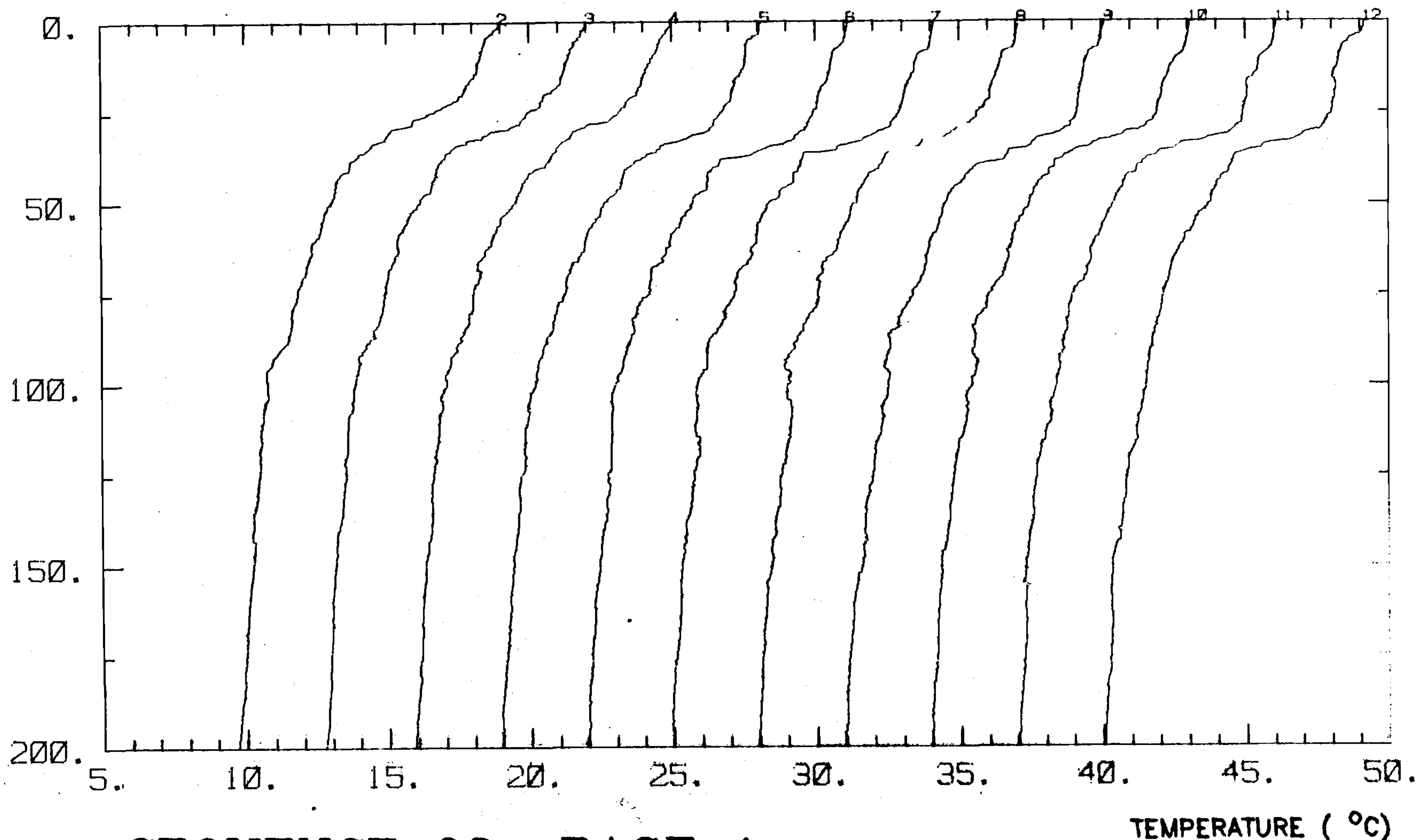
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

13JL82EN



SEQUENCE 08 PAGE 1

START TIME 22:35 GMT 07/13/82

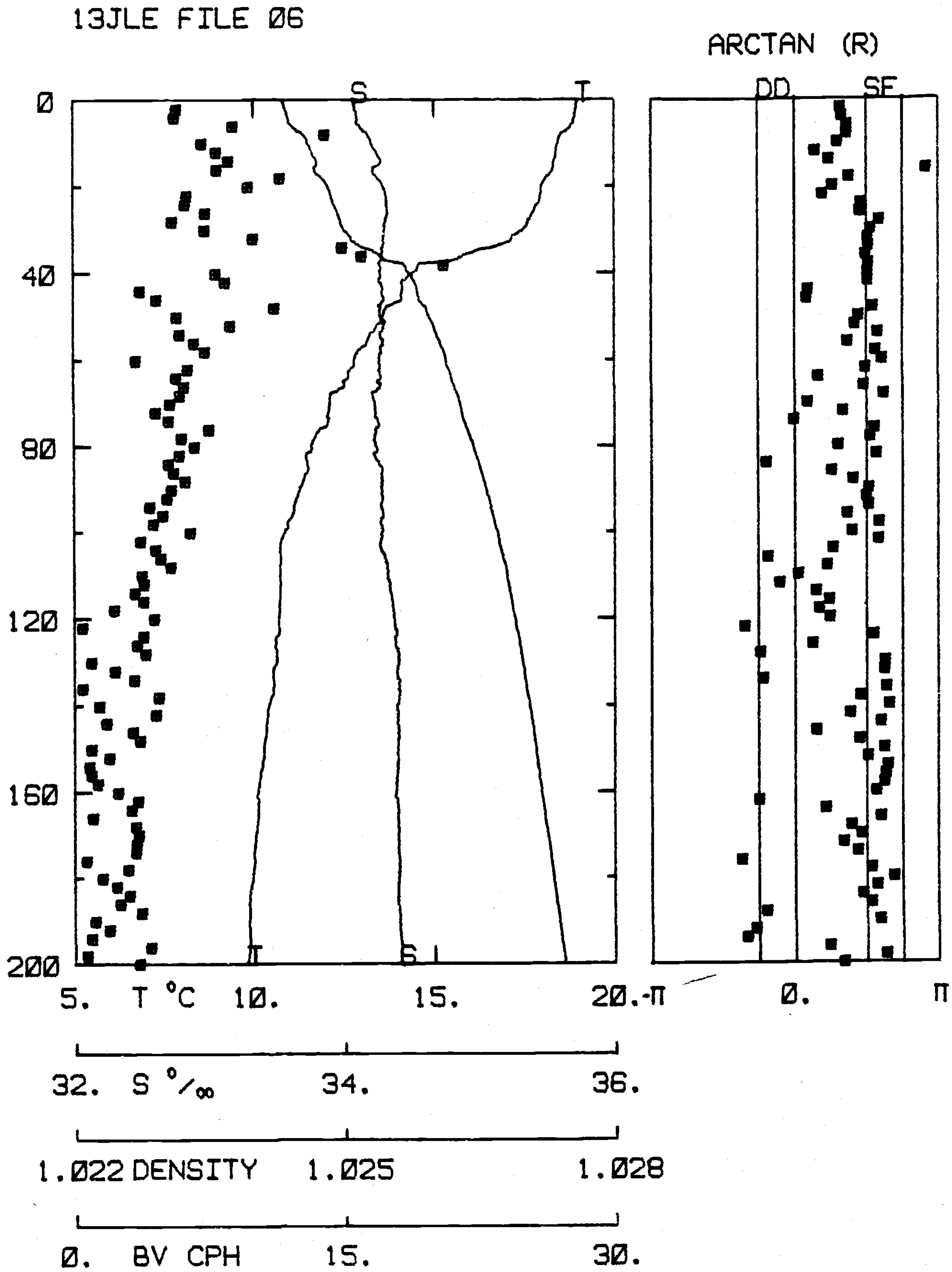
LOCATION 37°43'N 151°49'W

Profile spacing 900m

WIND SPEED 9. m/s

DIRECTION 340°

Ship's heading 0°


13JLE FILE Ø6
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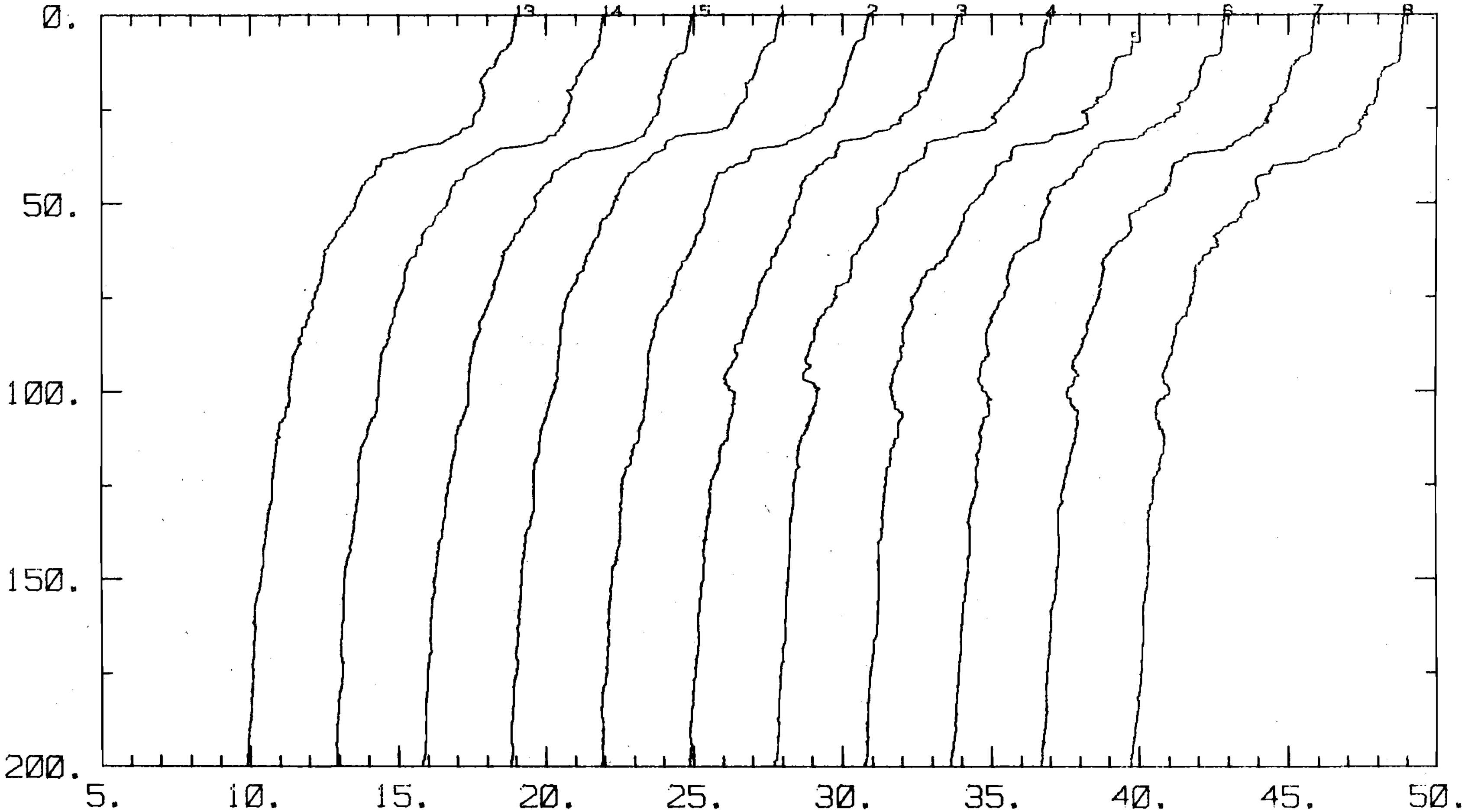
-π Ø. π
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

13JL82EN , 14JL82AN



SEQUENCE 08 PAGE 2

START TIME 23:42 GMT 07/13/82

LOCATION 37°48'N 151°49'W

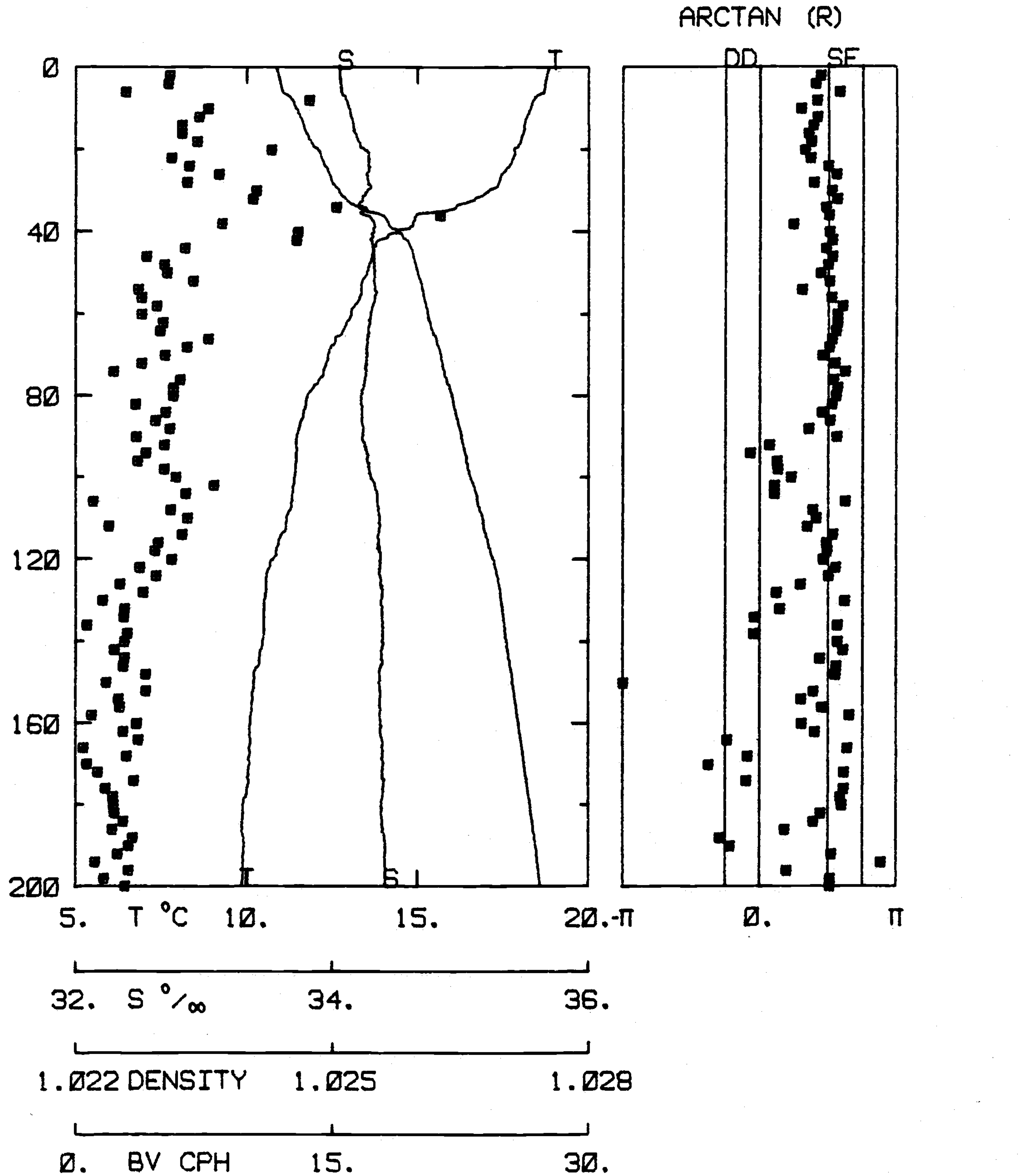
Profile spacing 900m

WIND SPEED 9. m/s

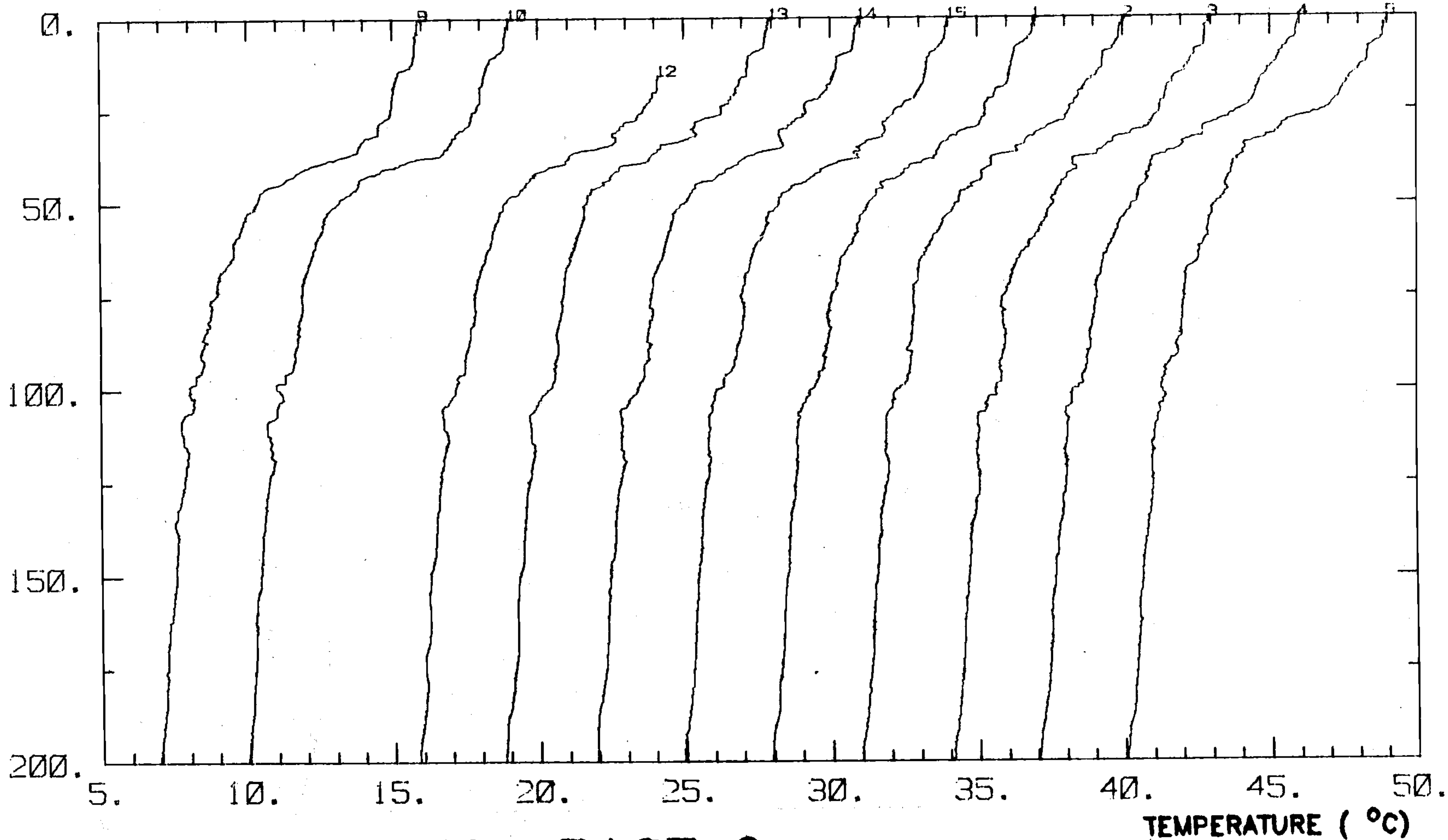
DIRECTION 340°

Ship's heading 0°

14JLA FILE 02



14JL82AN , 14JL82BN



SEQUENCE 08 PAGE 3

START TIME 00:48 GMT 07/14/82

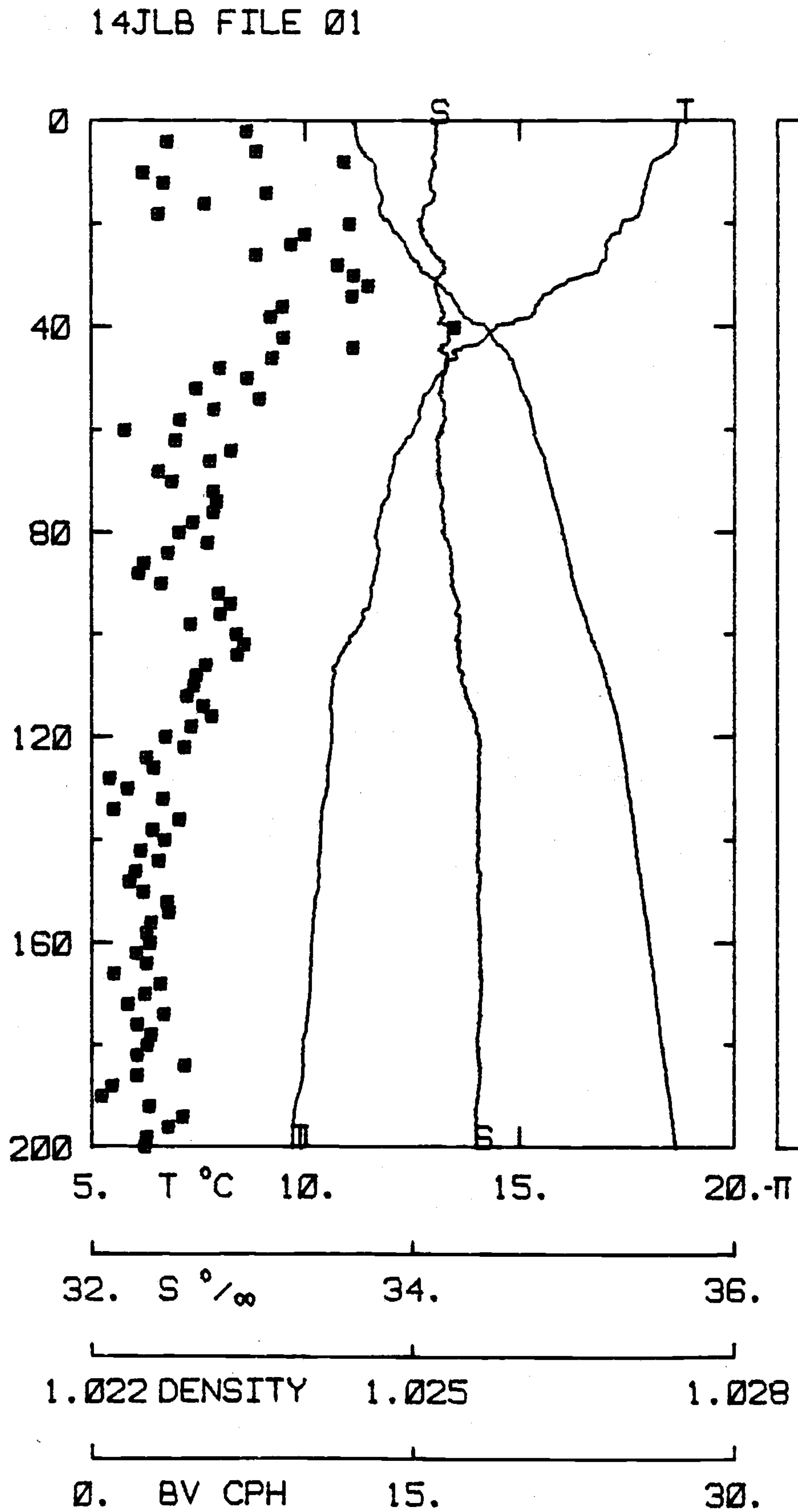
LOCATION 37°52'N 151°49'W

Profile spacing 900m

WIND SPEED 9. m/s

DIRECTION 340°

Ship's heading 0°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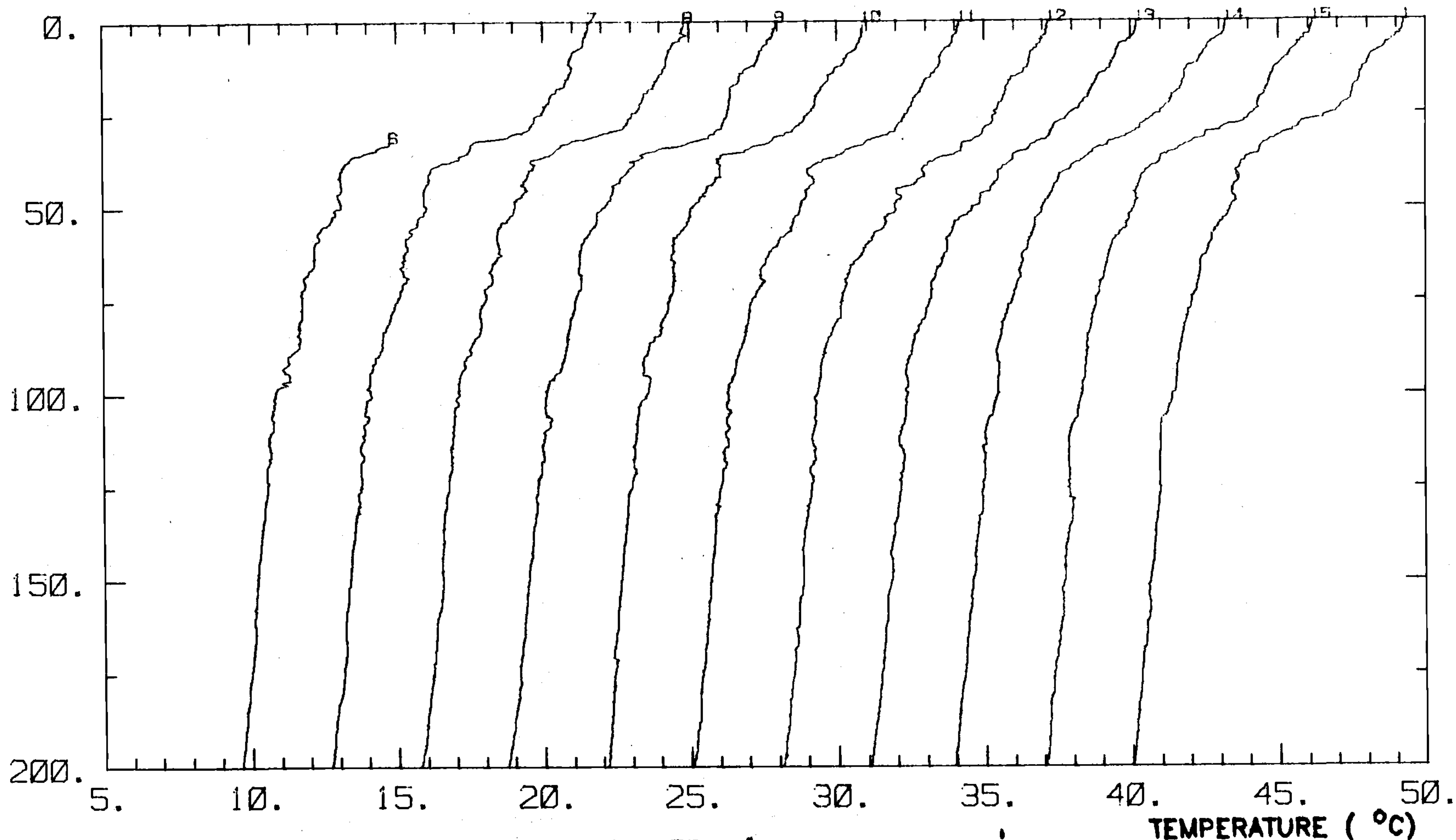
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

14JL82BN , 14JL82CN



08

SEQUENCE 08 PAGE 4

START TIME 02:00 GMT 07/14/82

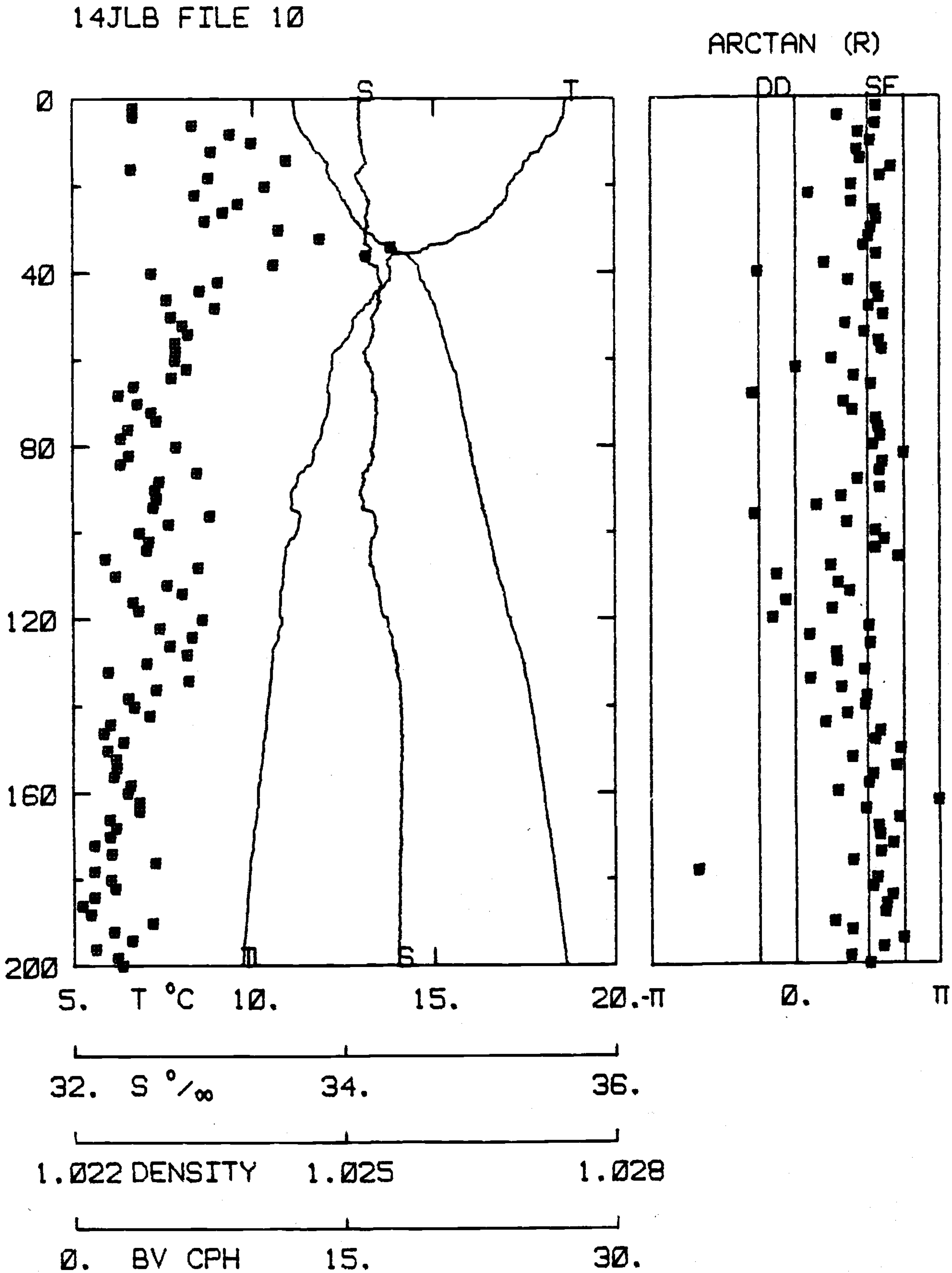
LOCATION 37°56'N 151°49'W

Profile spacing 900m

WIND SPEED 9. m/s

DIRECTION 340°

Ship's heading 0°


14JLB FILE 10
ARCTAN (R)
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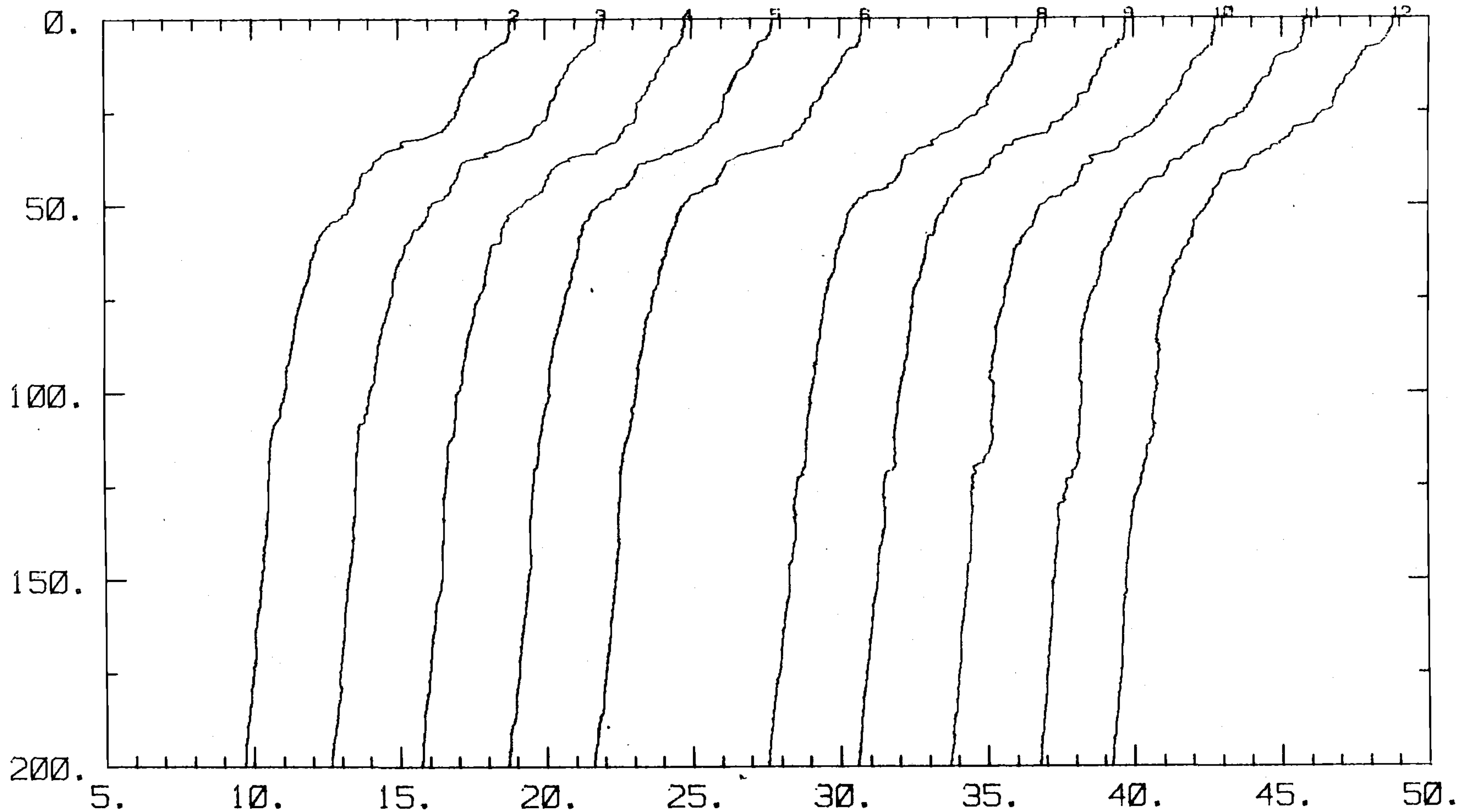
-π 0. π
32. S °/∞ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

i4JL82CN



82

SEQUENCE 08 PAGE 5

START TIME 03:06 GMT 07/14/82

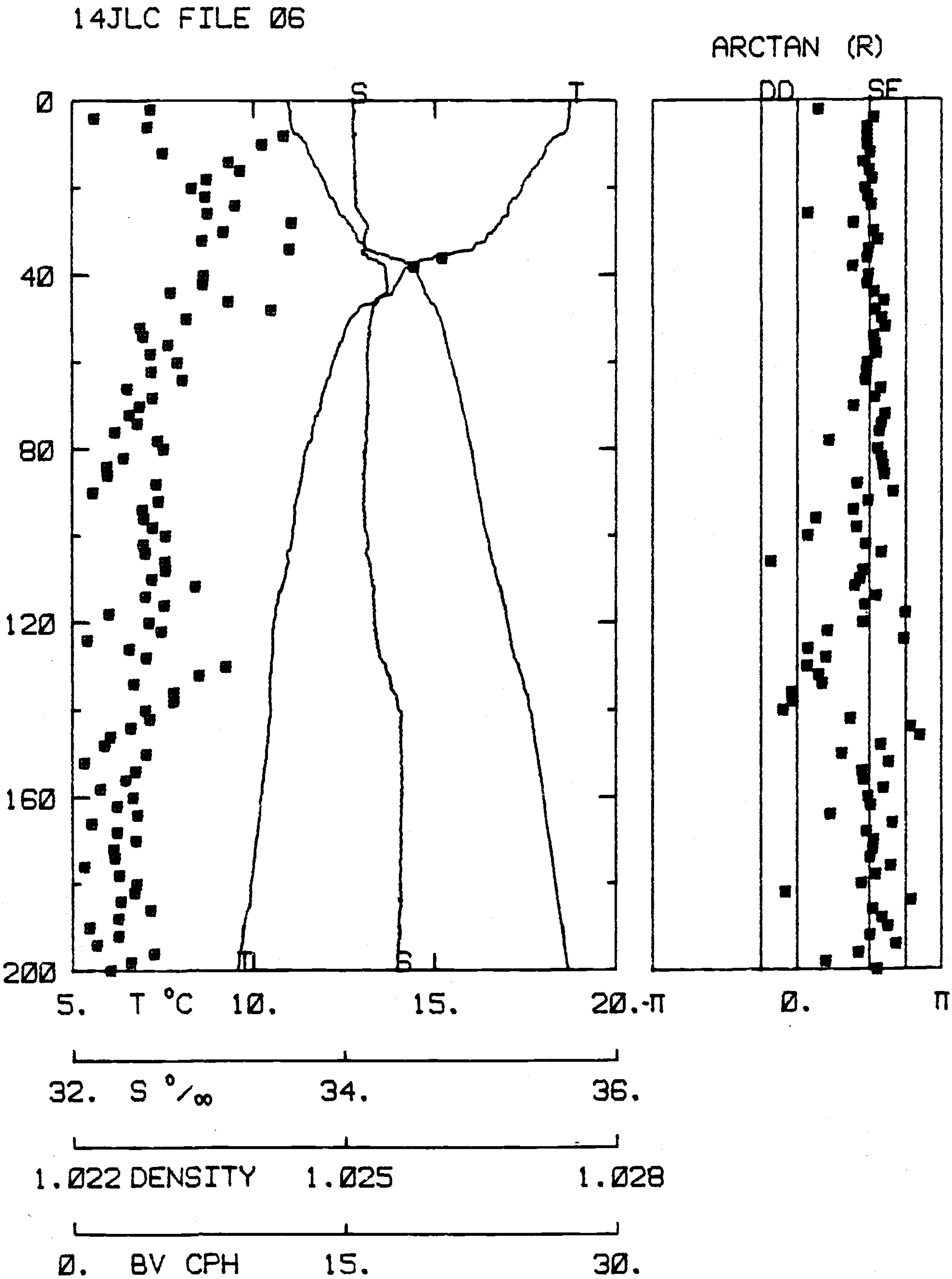
LOCATION 38°00'N 151°49'W

Profile spacing 900m

WIND SPEED 9. m/s

DIRECTION 340°

Ship's heading 0°


14JLC FILE Ø6
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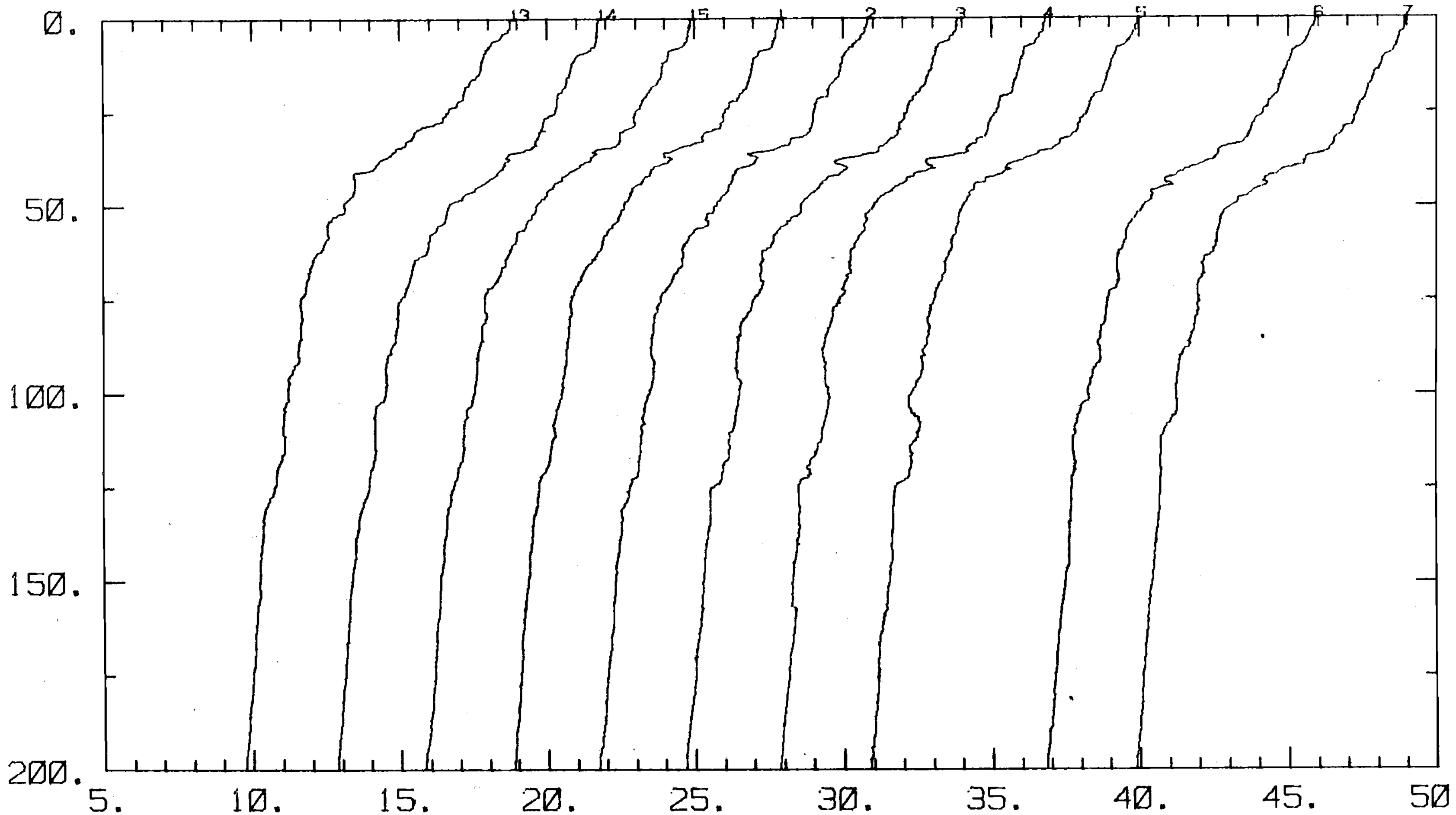
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

14JL82CN , 14JL82DN



SEQUENCE 08 PAGE 6

START TIME 04:13 GMT 07/14/82

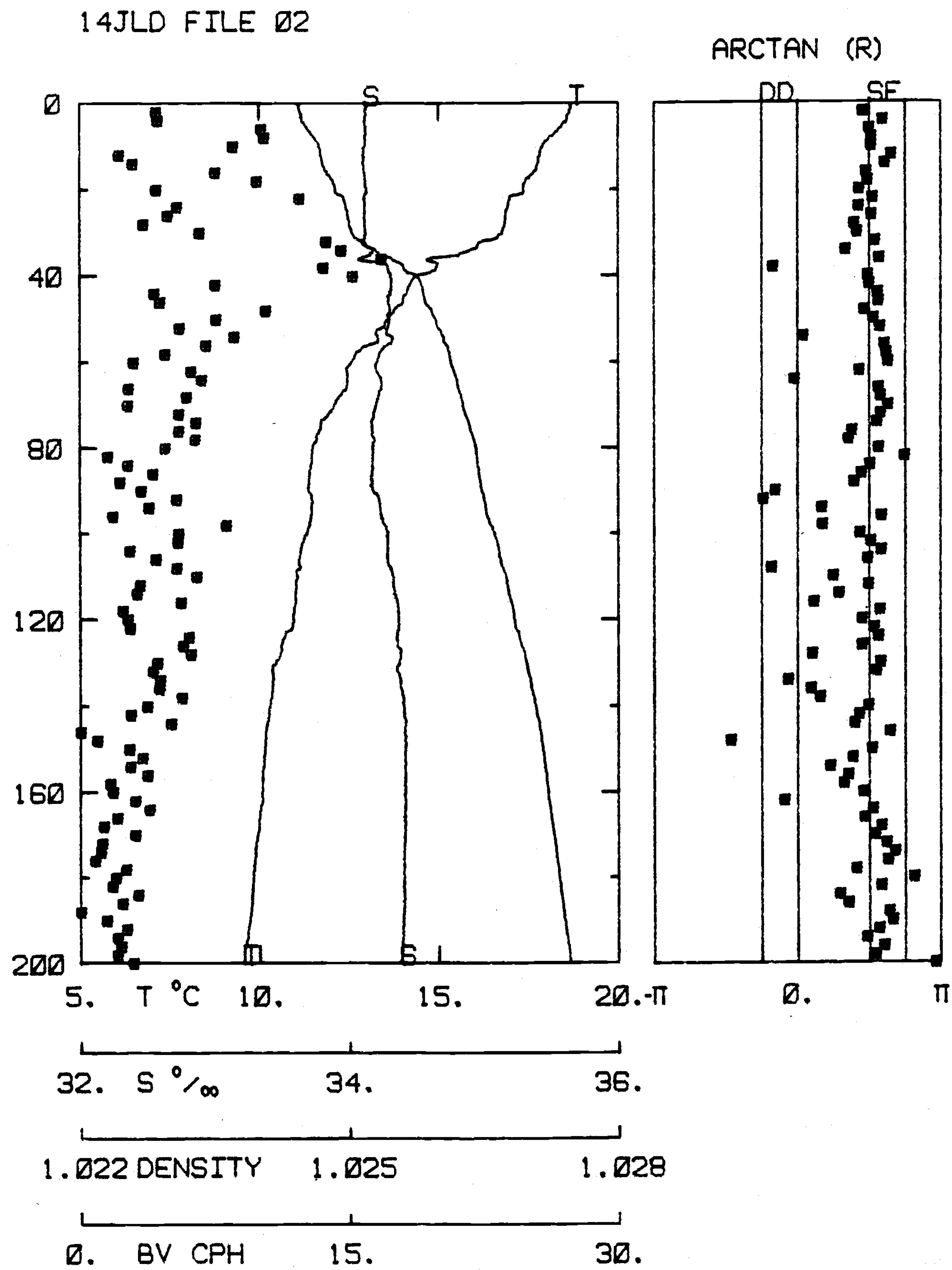
LOCATION 38°04'N 151°49'W

Profile spacing 900m

WIND SPEED 9. m/s

DIRECTION 340°

Ship's heading 0°


14JLD FILE Ø2
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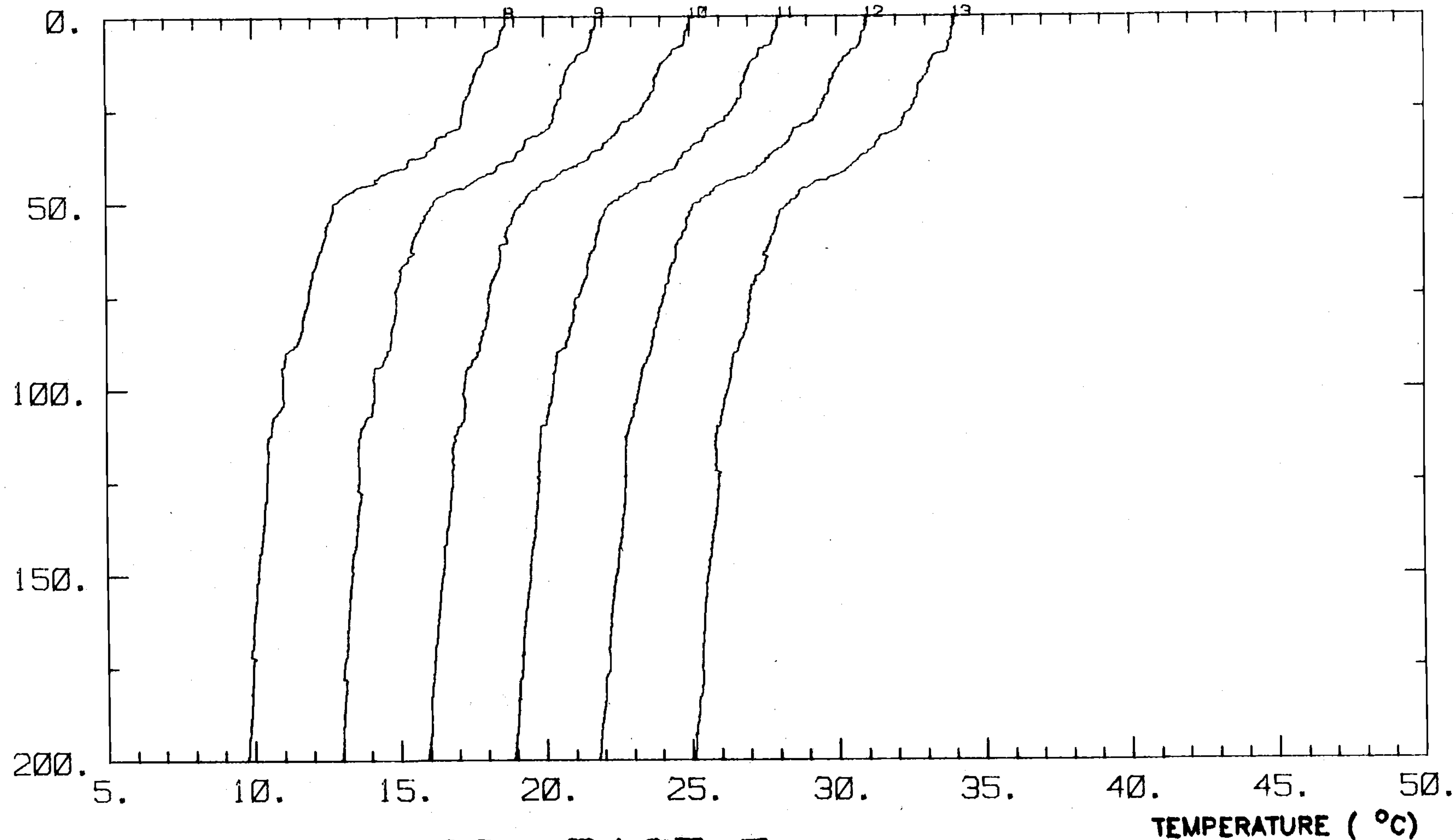
5. T °C 10. 15. 20.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

14JL82DN



SEQUENCE 08 PAGE 7

START TIME 05:19 GMT 07/14/82

LOCATION 38°08'N 151°49'W

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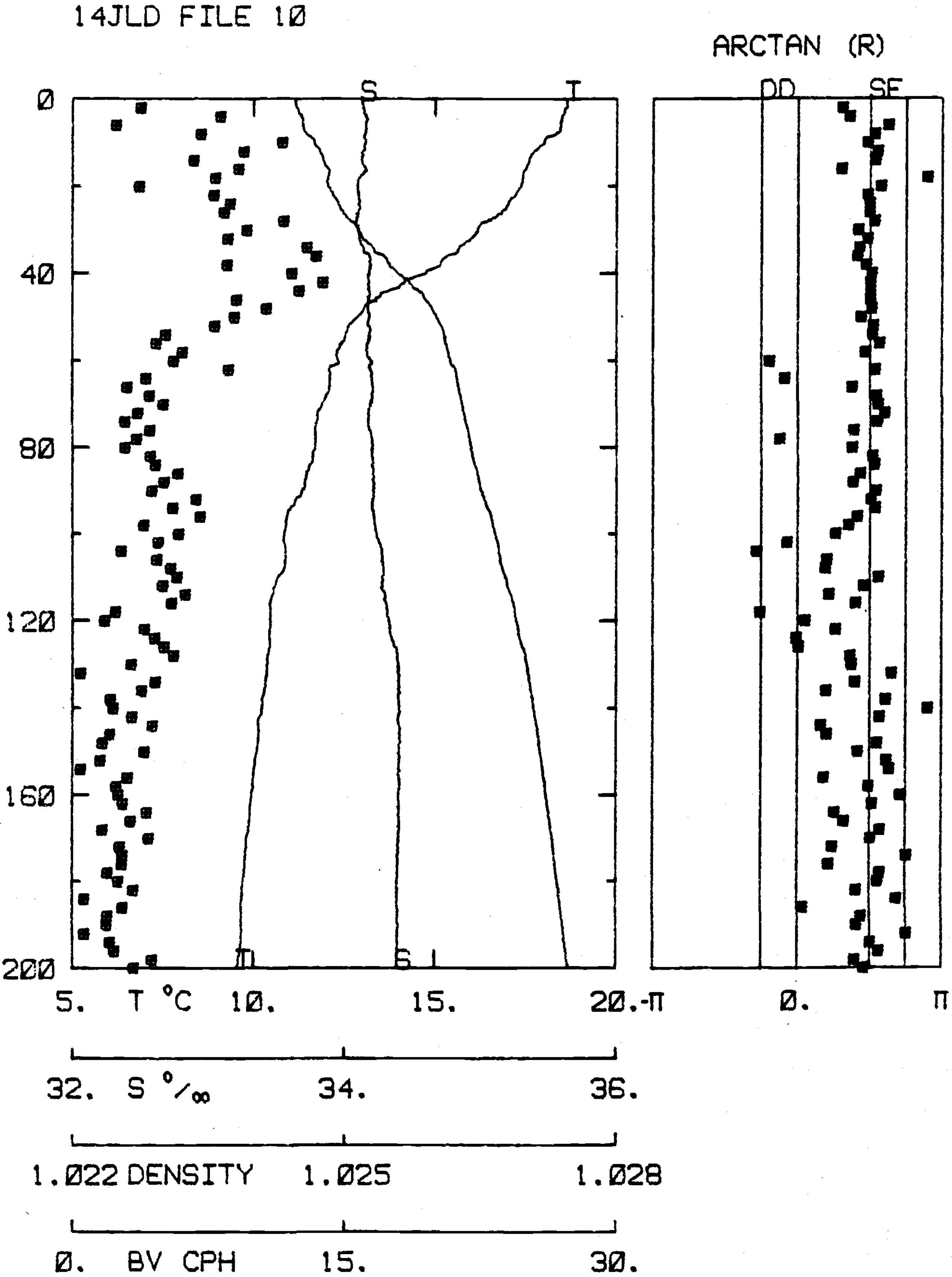
WIND SPEED 9. m/s

" DIRECTION 340°

Ship's heading 0°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BV CPH
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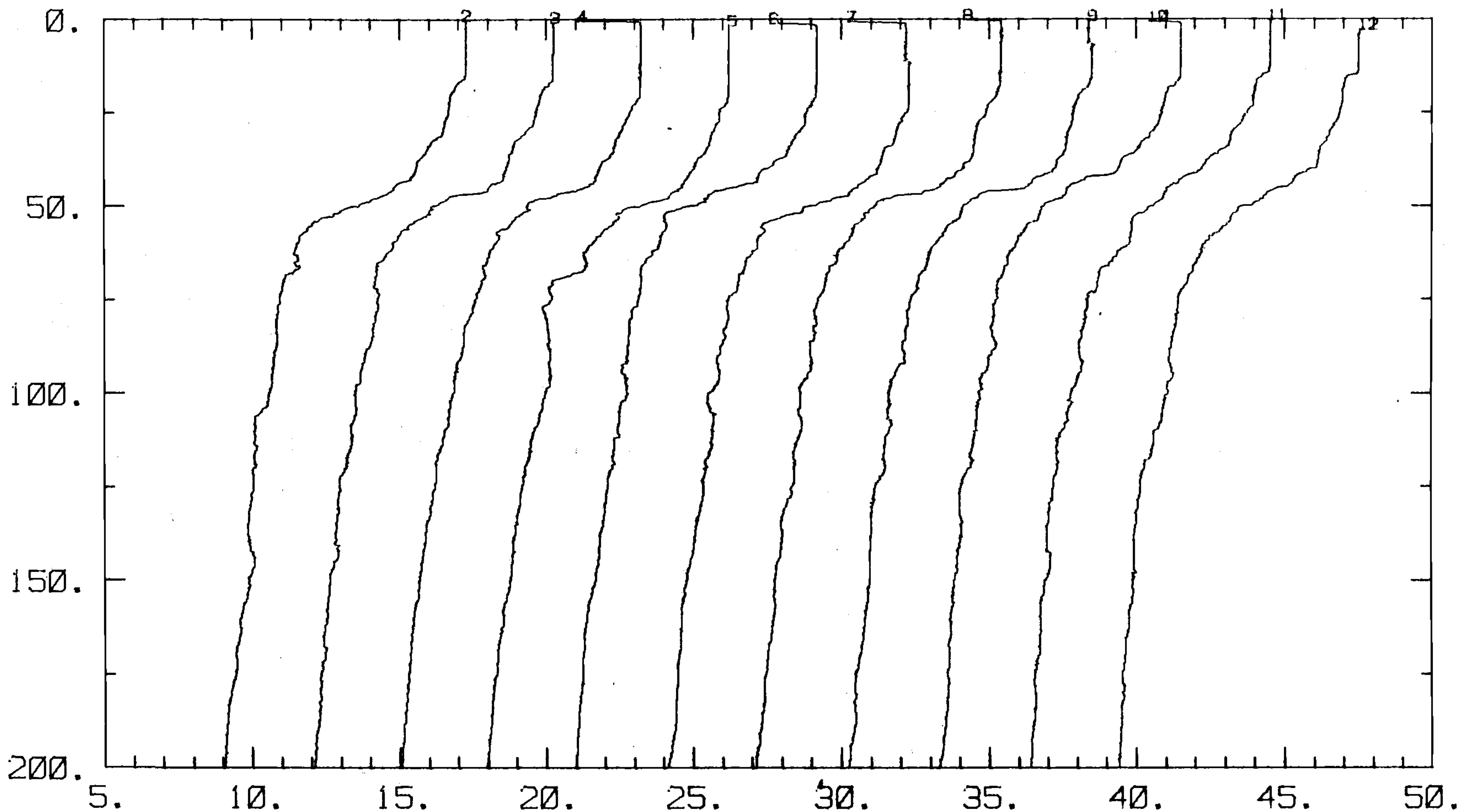
14JL82EN



88

SEQUENCE 9 PAGE 1

START TIME 22:46 GMT 07/14/82

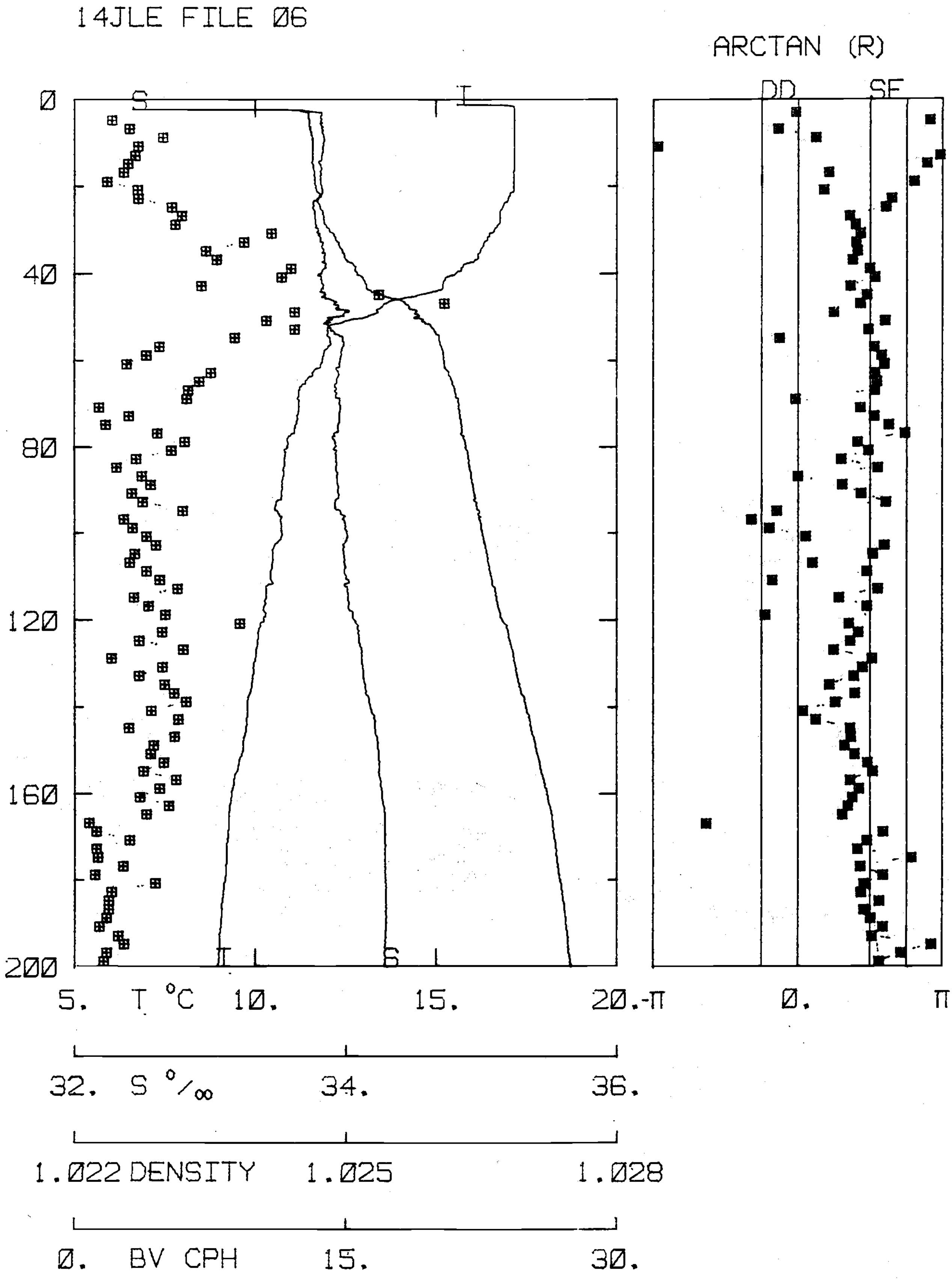
LOCATION 39°36'N 151°52'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 340°

Ship's heading 0°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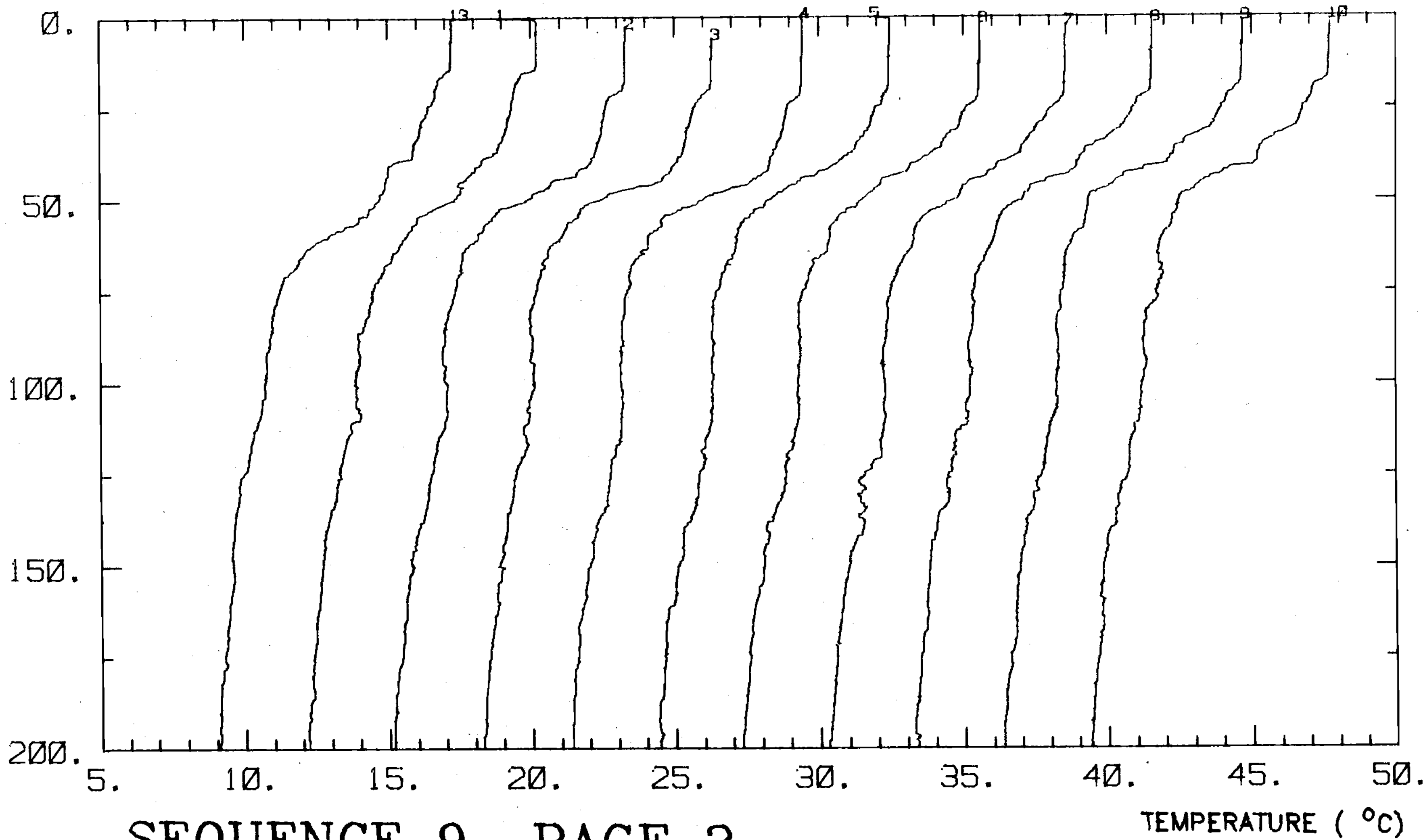
5. T °C 1Ø. 15. 20.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

14JL82EN , 15JL82AN



SEQUENCE 9 PAGE 2

START TIME 00:00 GMT 07/15/82

LOCATION 40°01'N 151°52'W

Profile spacing 800m

WIND SPEED 5. m/s

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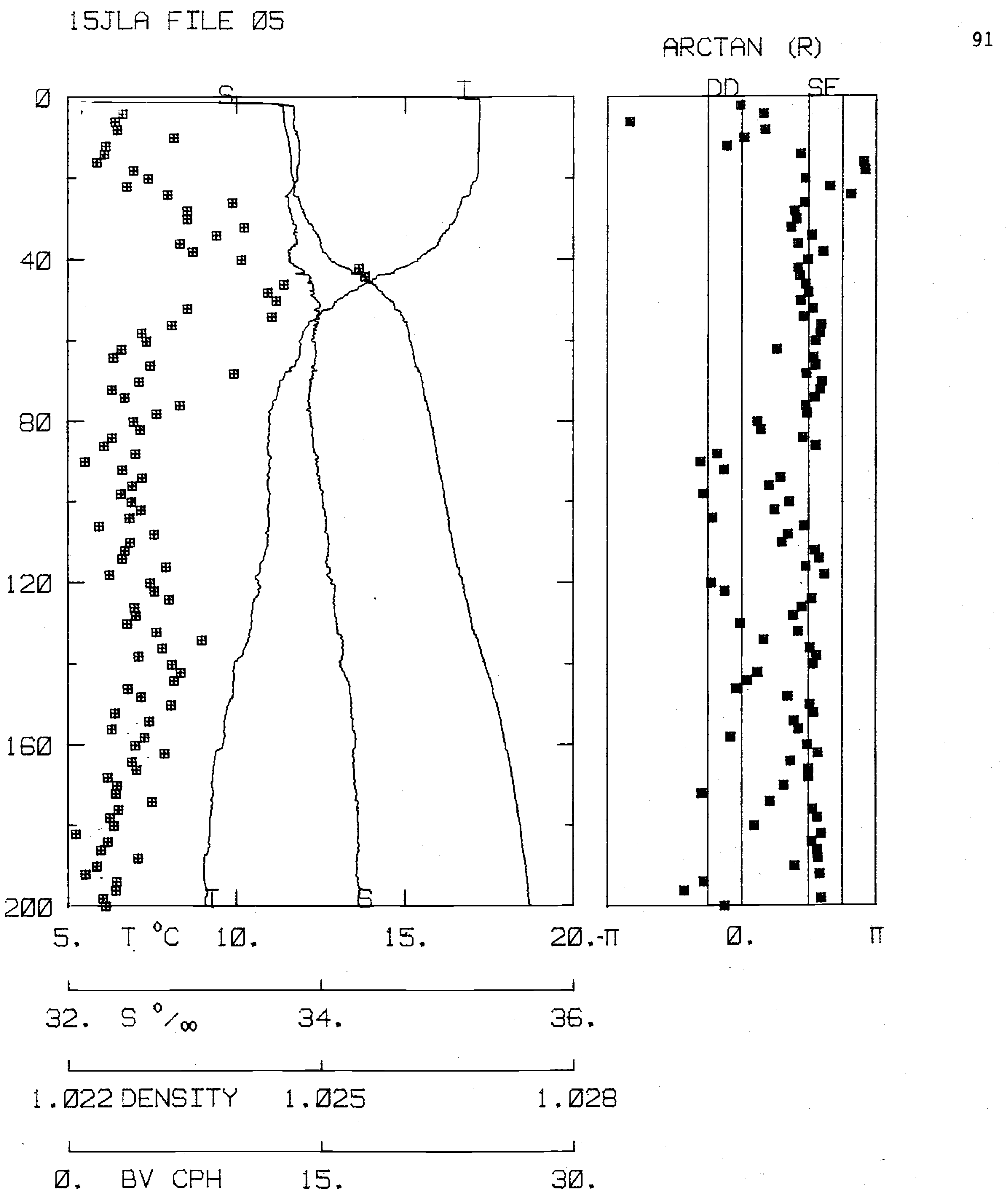
Ship's heading 0°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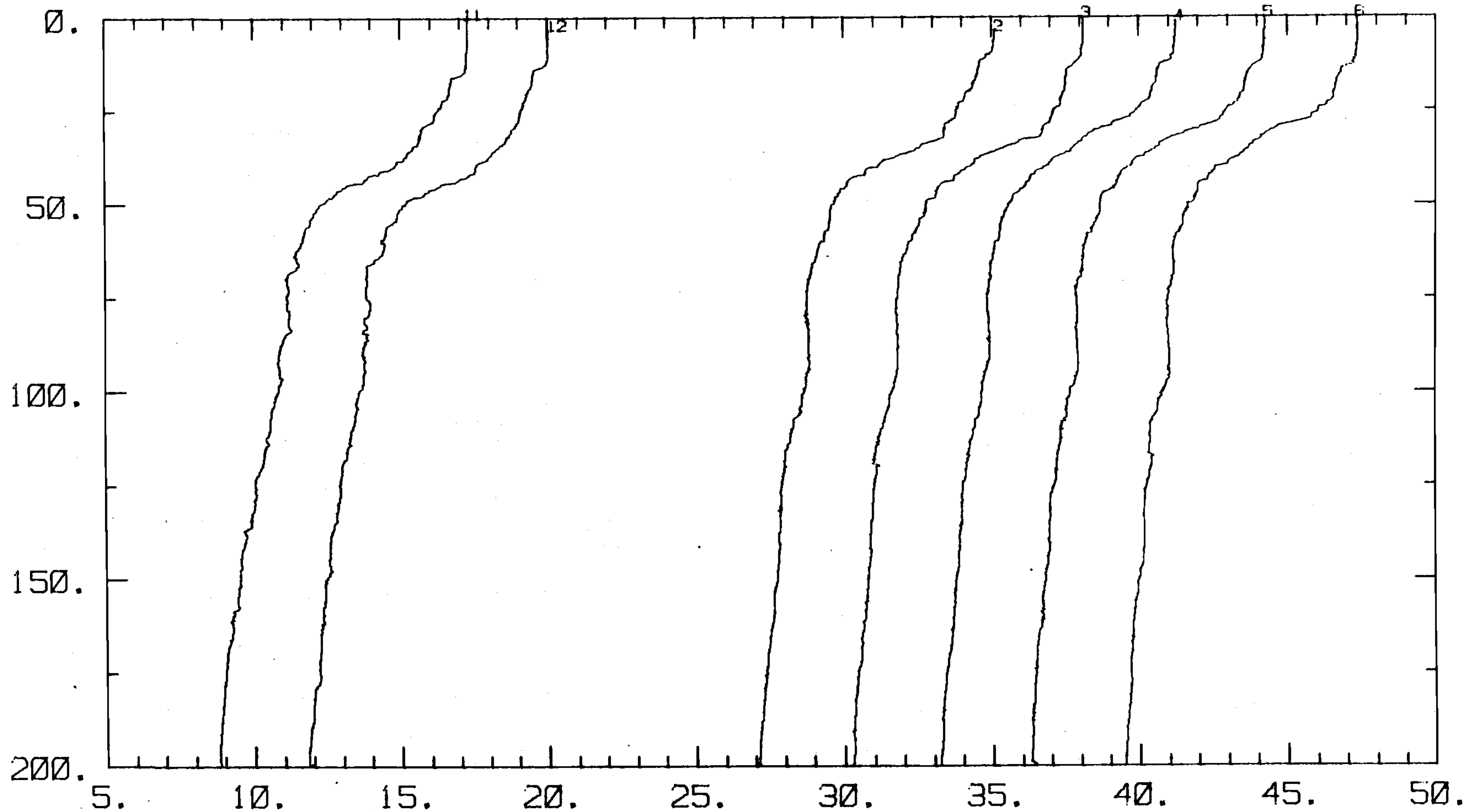
5. T °C 10. 15. 20.
-π Ø. π
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82AN , 15JL82BN



TEMPERATURE (°C)

SEQUENCE 9 PAGE 3

START TIME 01:07 GMT 07/15/82

LOCATION 40°06'N 151°52'W

Profile spacing 800m

WIND SPEED 5. m/s

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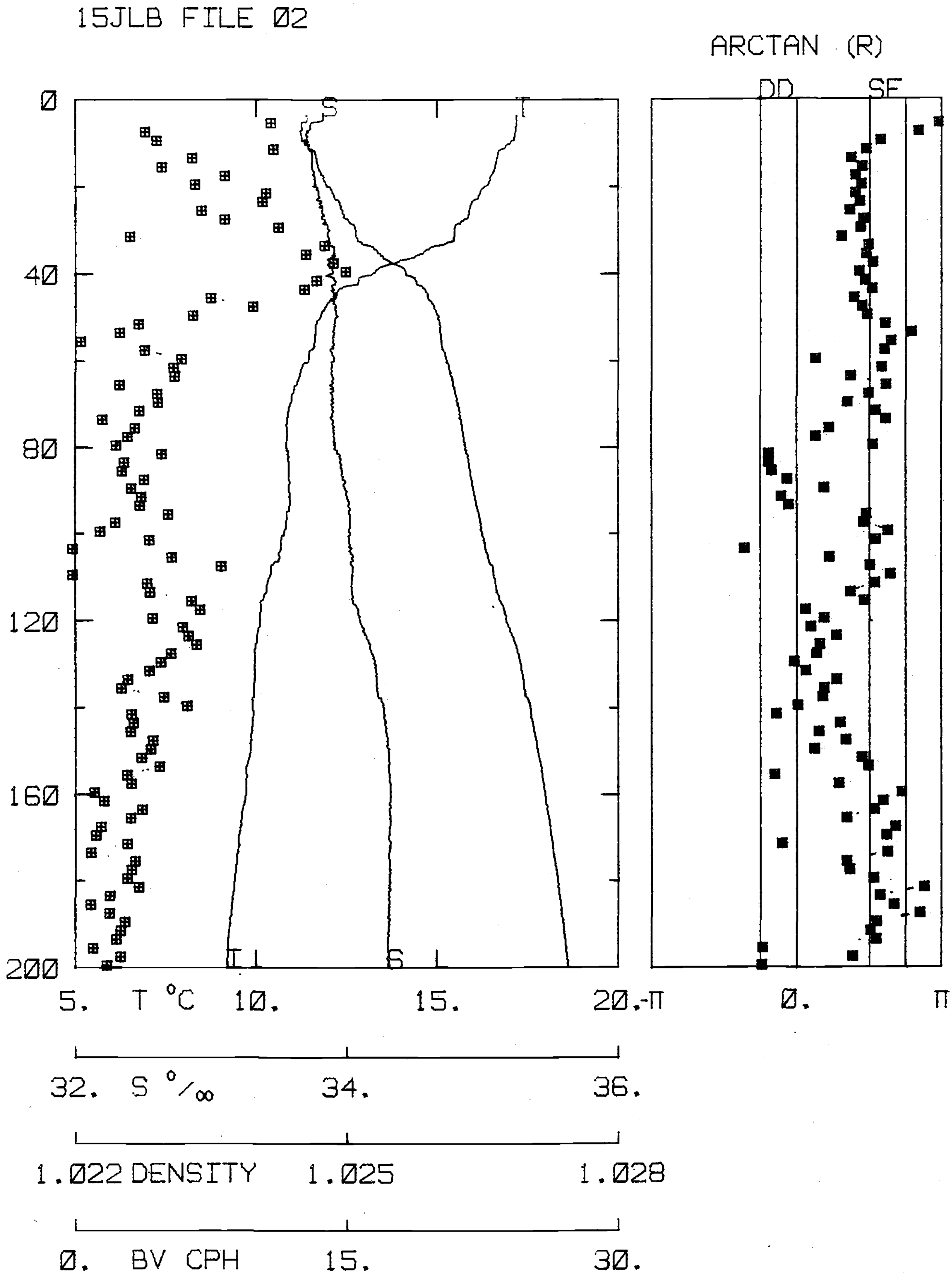
Ship's heading 0°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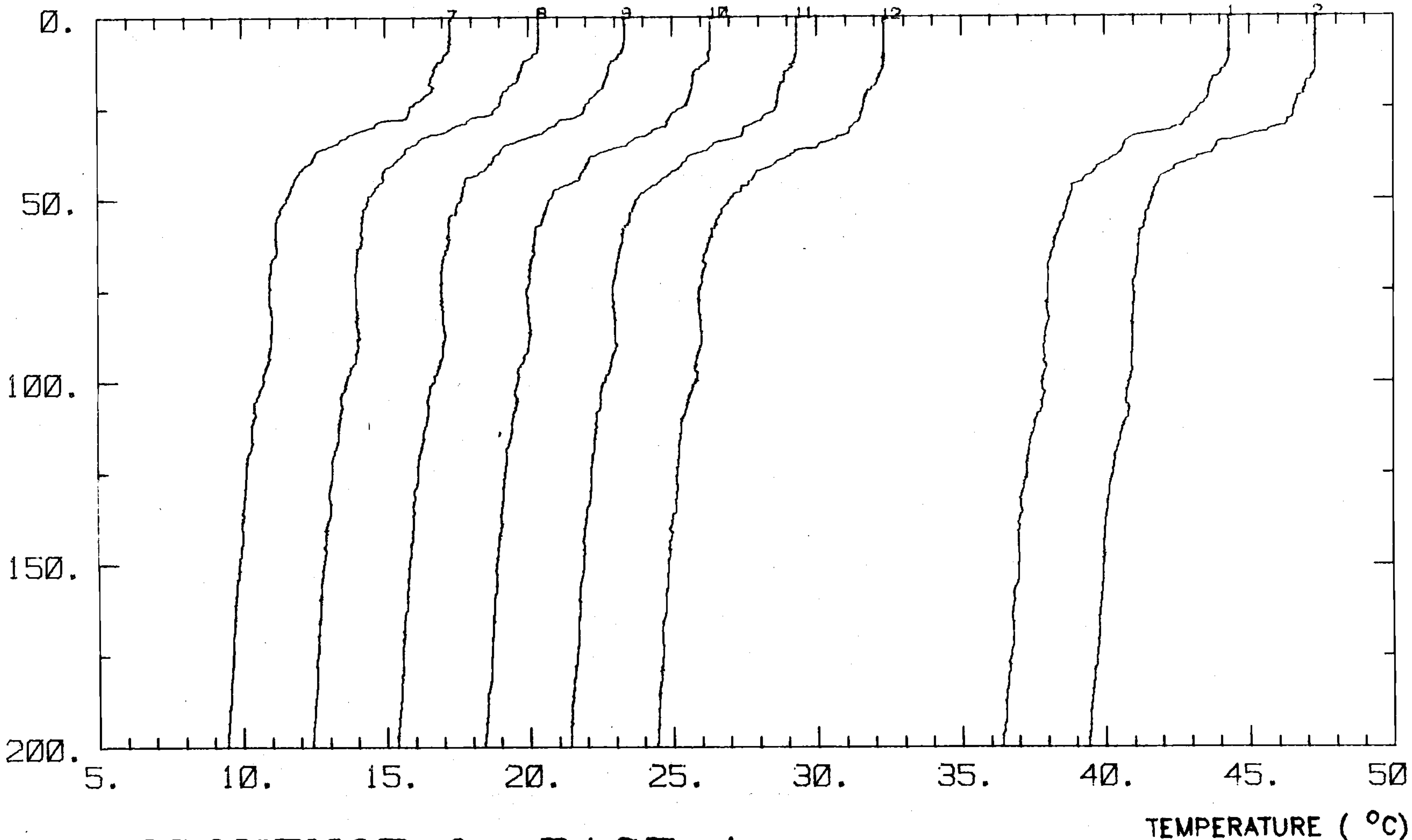
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82BN , 15JL82CN



SEQUENCE 9 PAGE 4

START TIME 02:06 GMT 07/15/82

LOCATION 40°10'N 151°52'W

Profile spacing 800m

WIND SPEED 5. m/s

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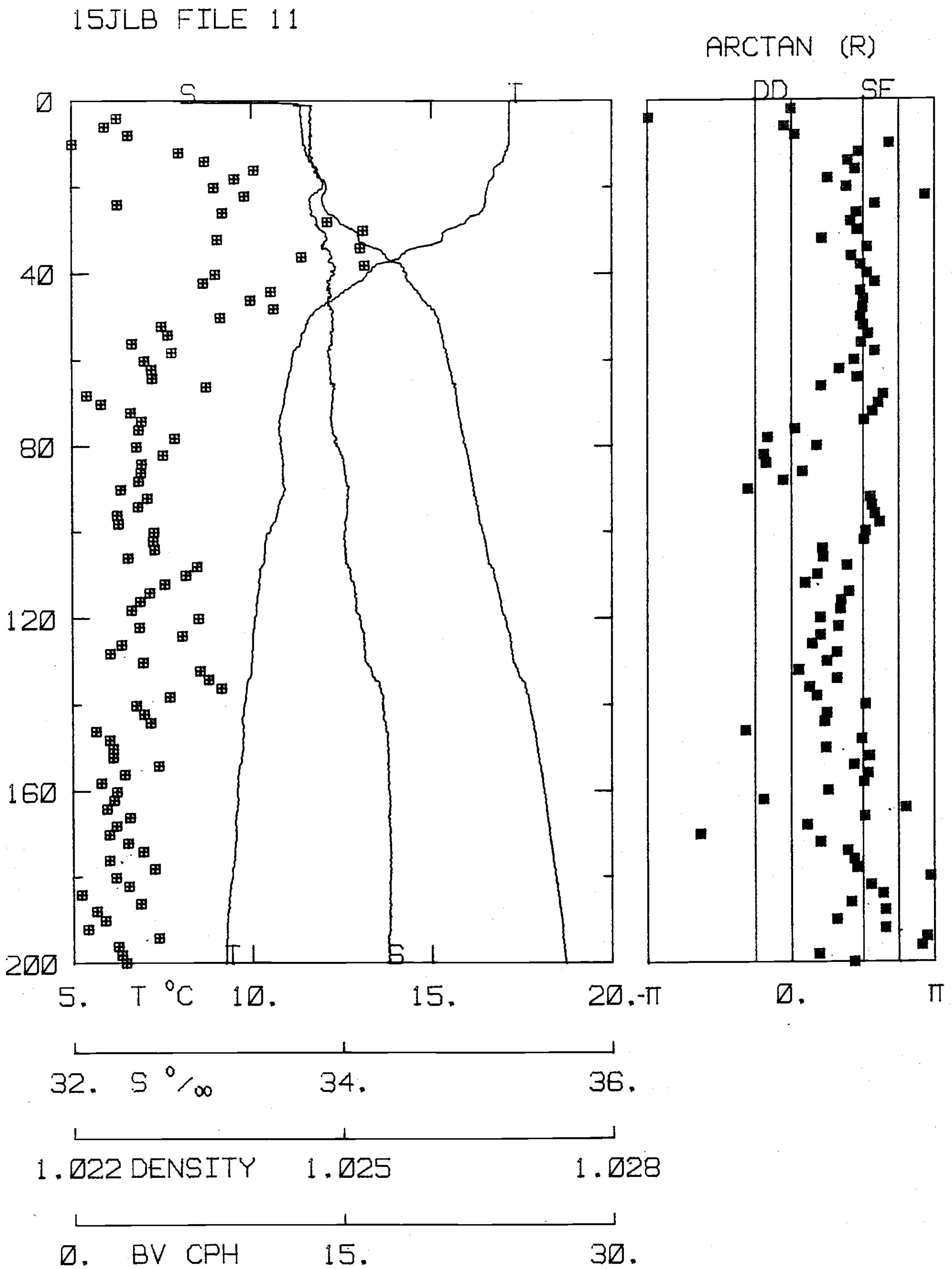
Ship's heading 0°


15JLB FILE 11
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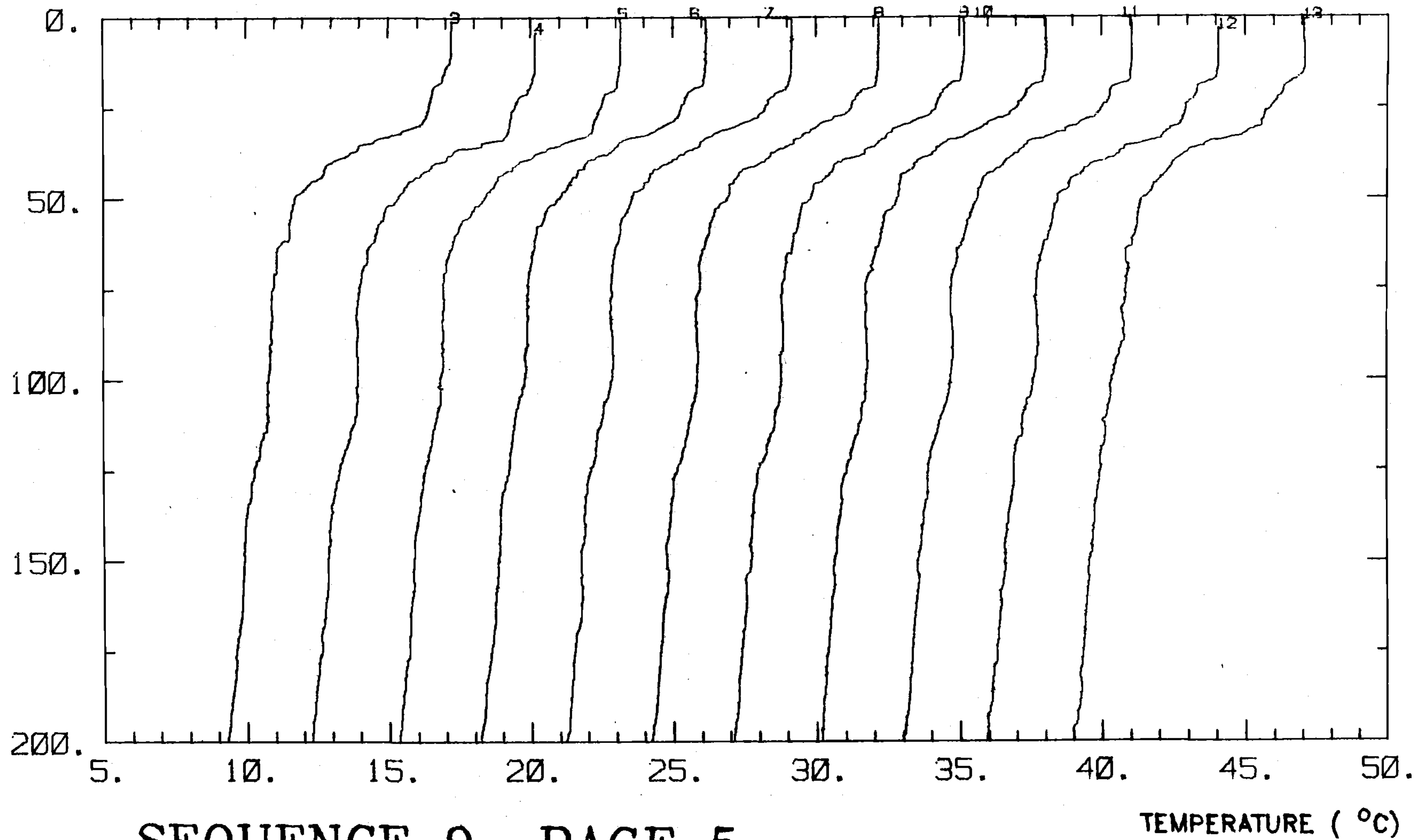
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82CN



SEQUENCE 9 PAGE 5

START TIME 03:12 GMT 07/15/82

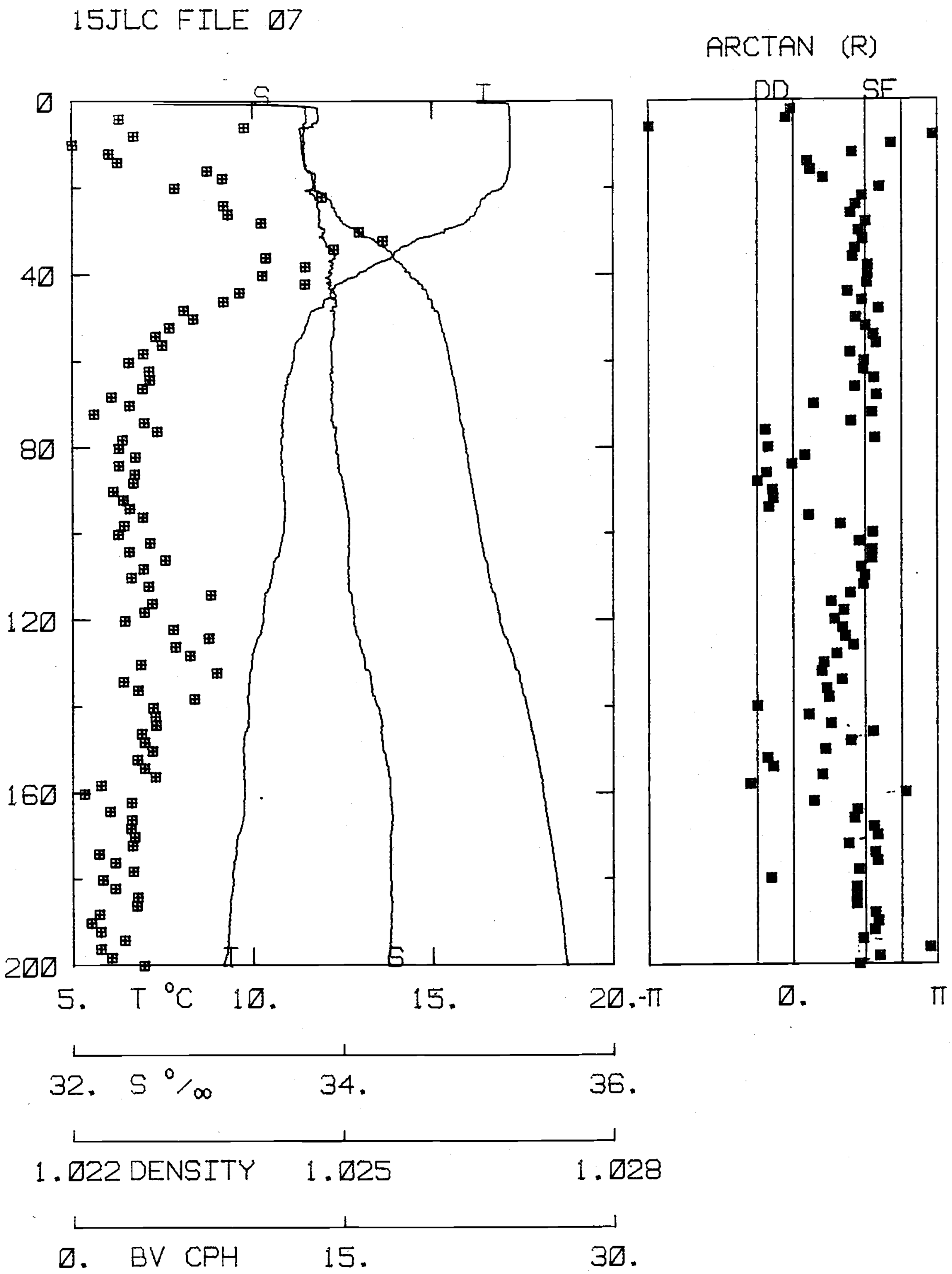
LOCATION 40°14'N 151°52'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 340°

Ship's heading 0°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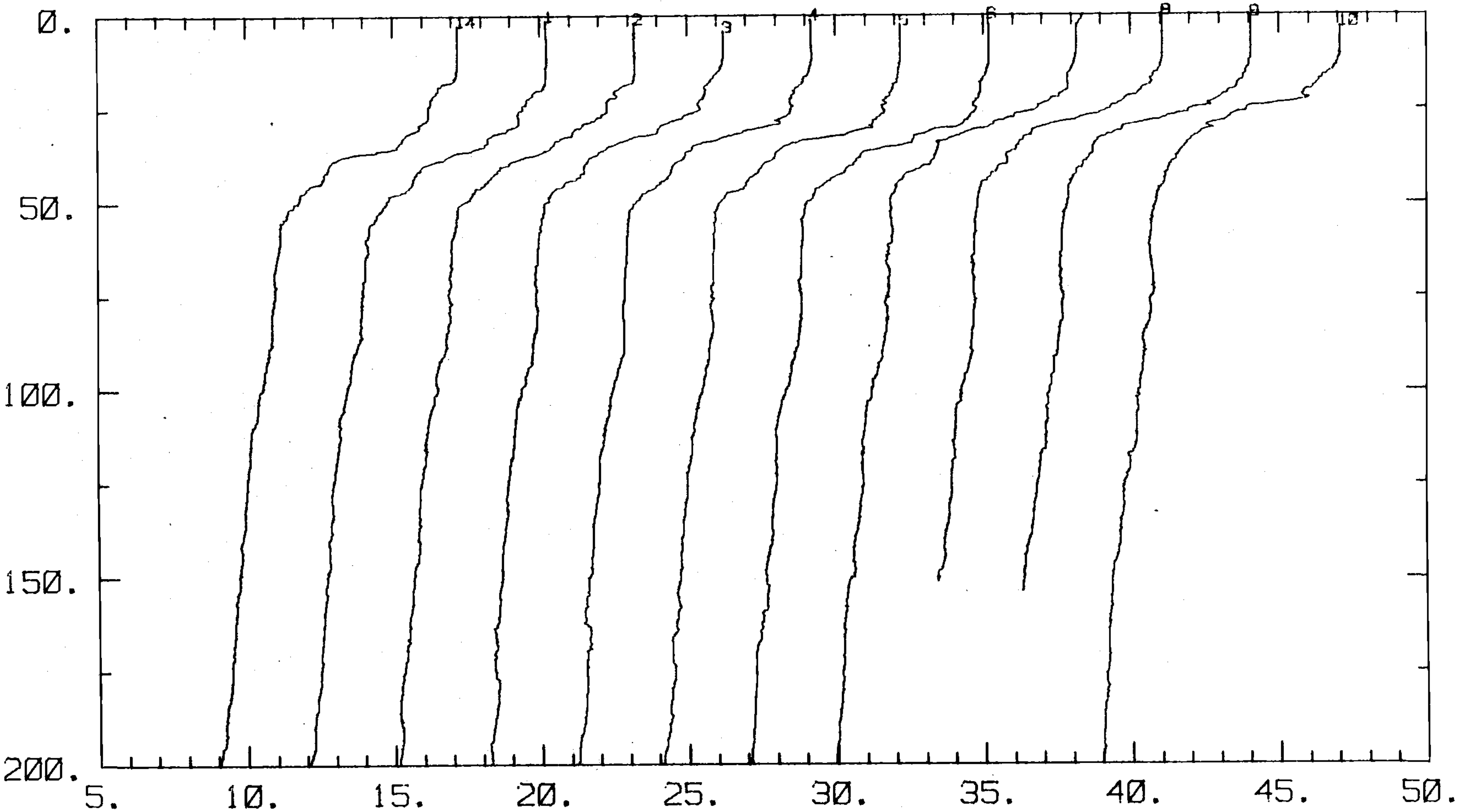
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82CN , 15JL82DN



SEQUENCE 9 PAGE 6

START TIME 04:19 GMT 07/15/82

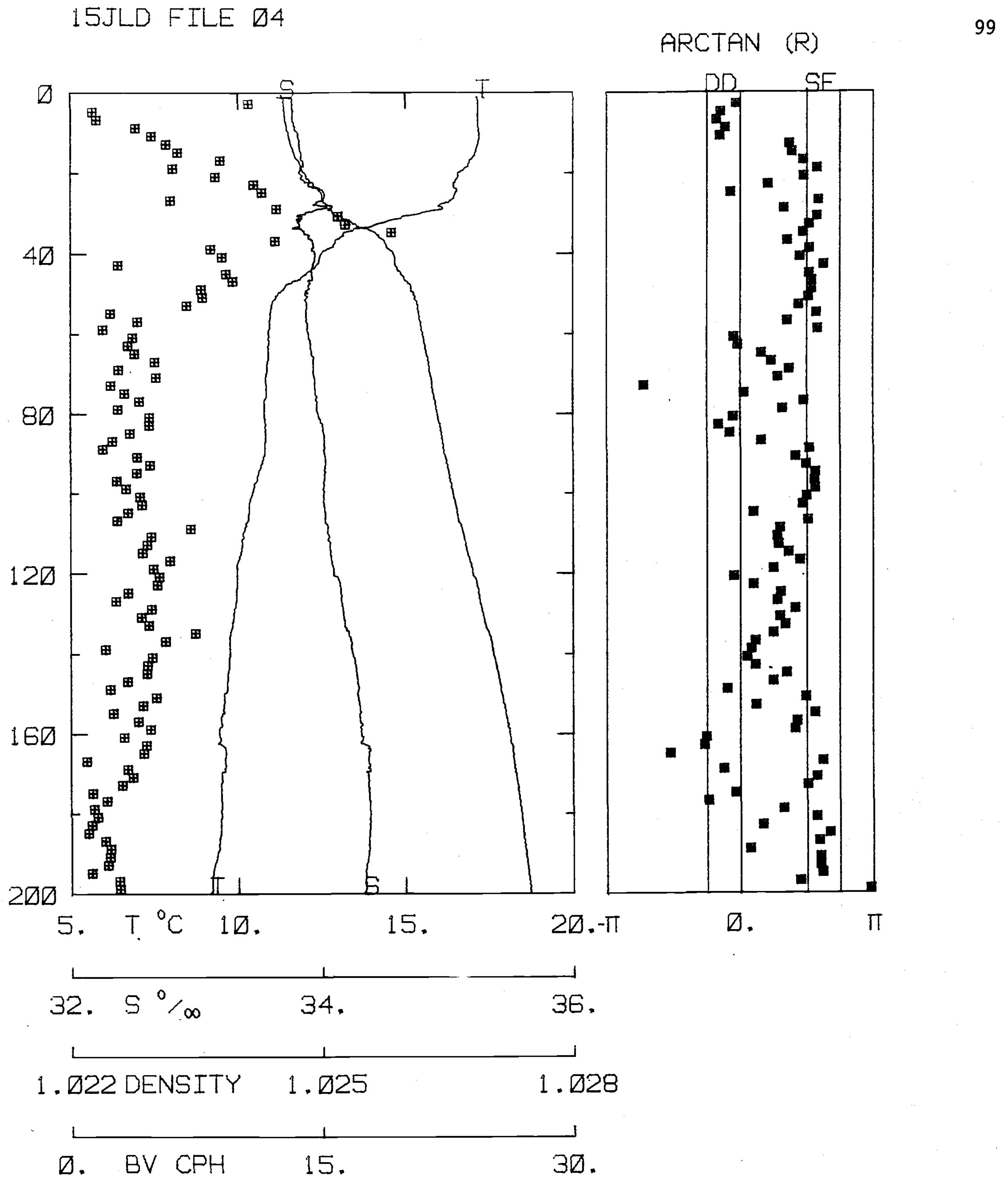
LOCATION 40°18'N 151°53'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 340°

Ship's heading 0°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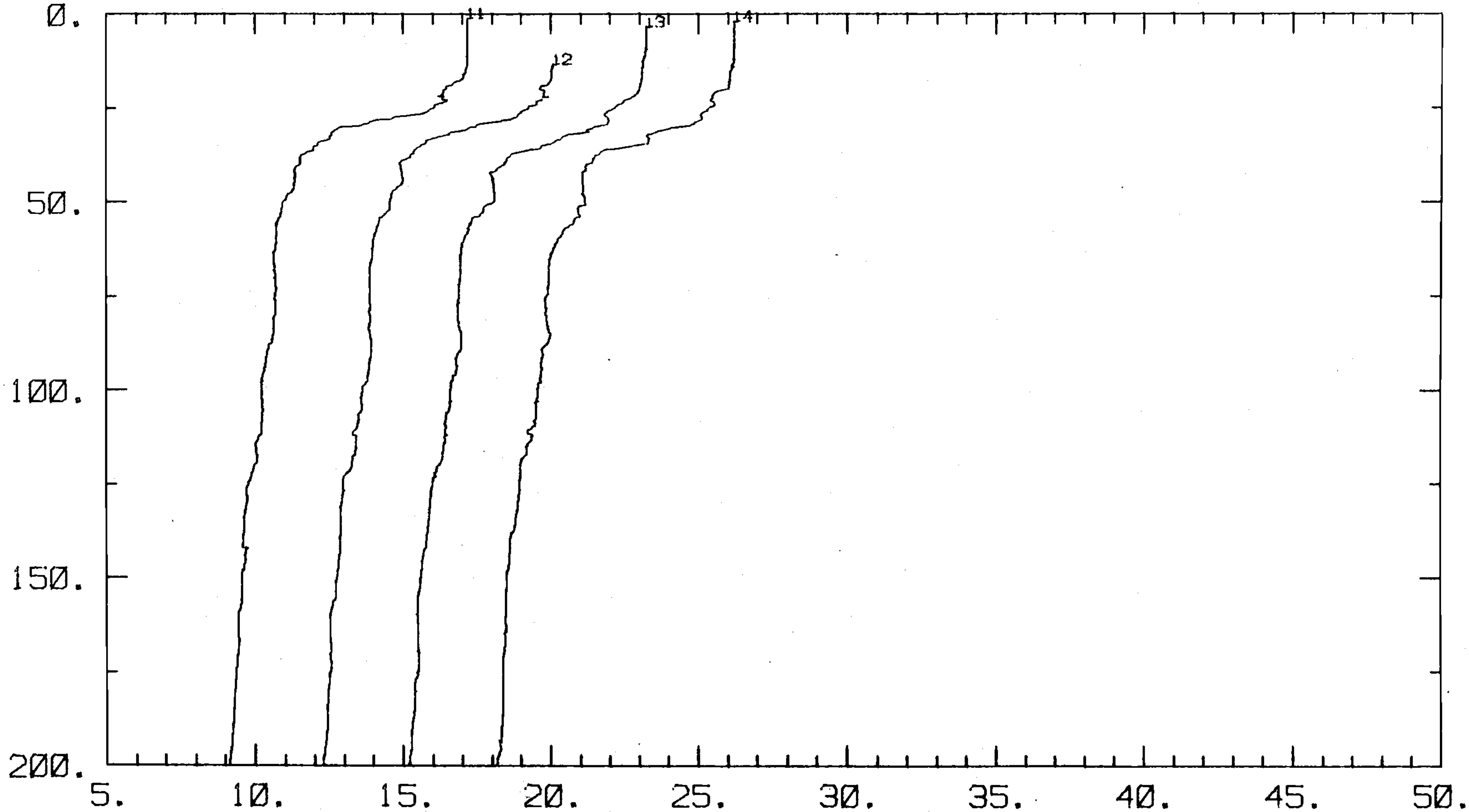
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82DN



TEMPERATURE (°C)

SEQUENCE 9 PAGE 7

START TIME 05:25 GMT 07/15/82

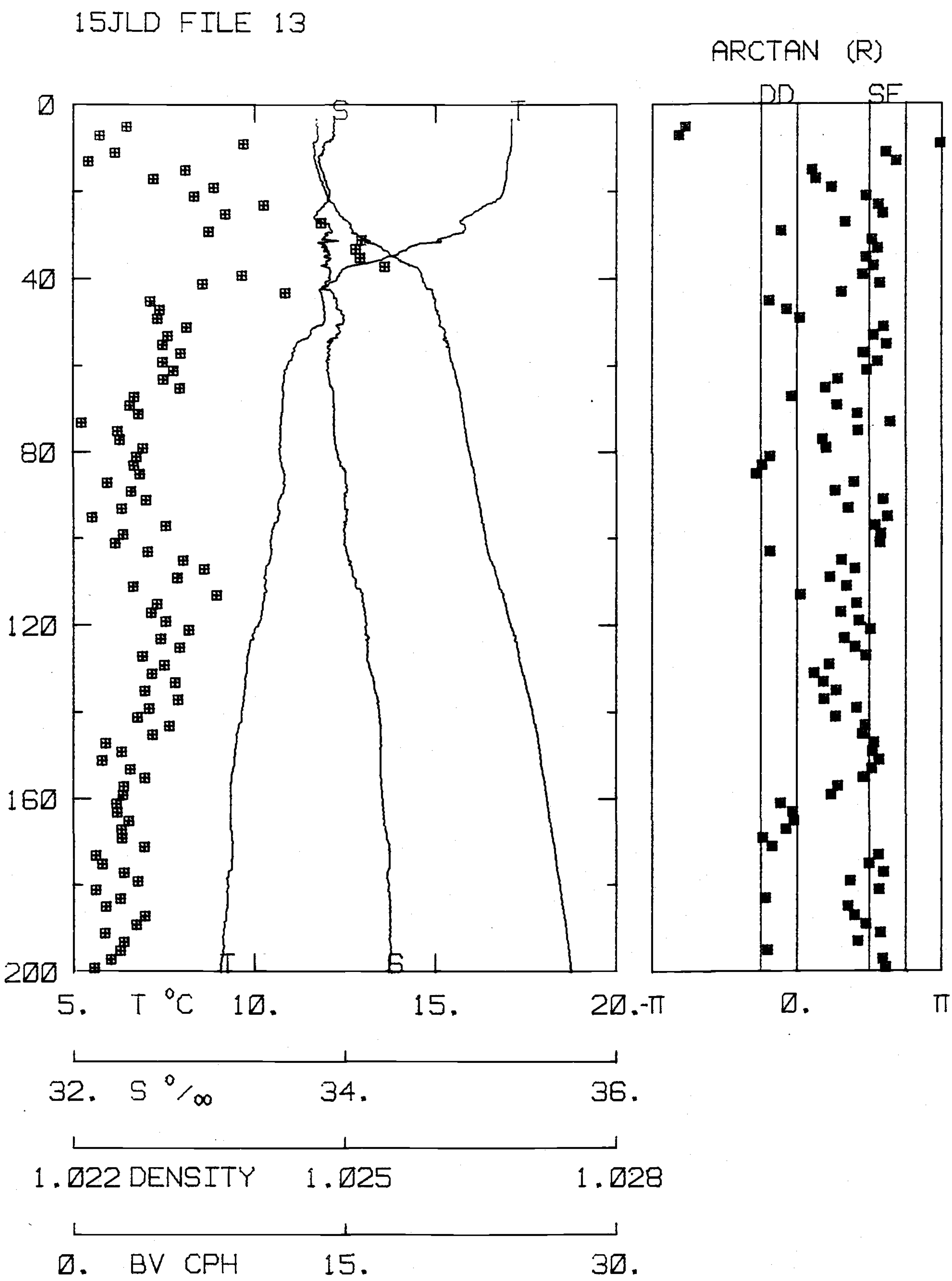
LOCATION 40°22'N 151°53'W

Profile spacing 800m

WIND SPEED 5. m/s

DIRECTION 340°

Ship's heading 0°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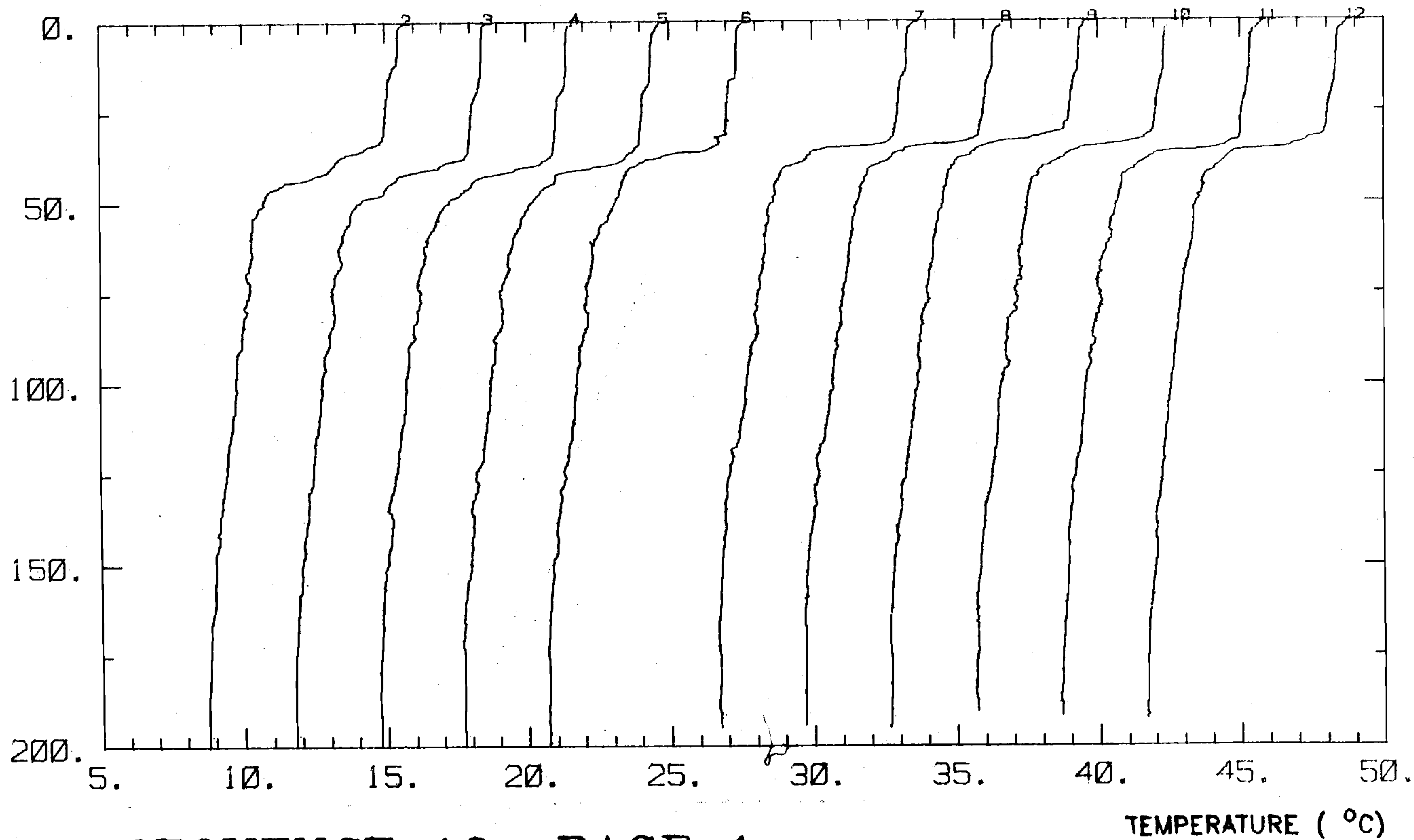
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82EM



102

SEQUENCE 10 PAGE 1

START TIME 22:42 GMT 07/15/82

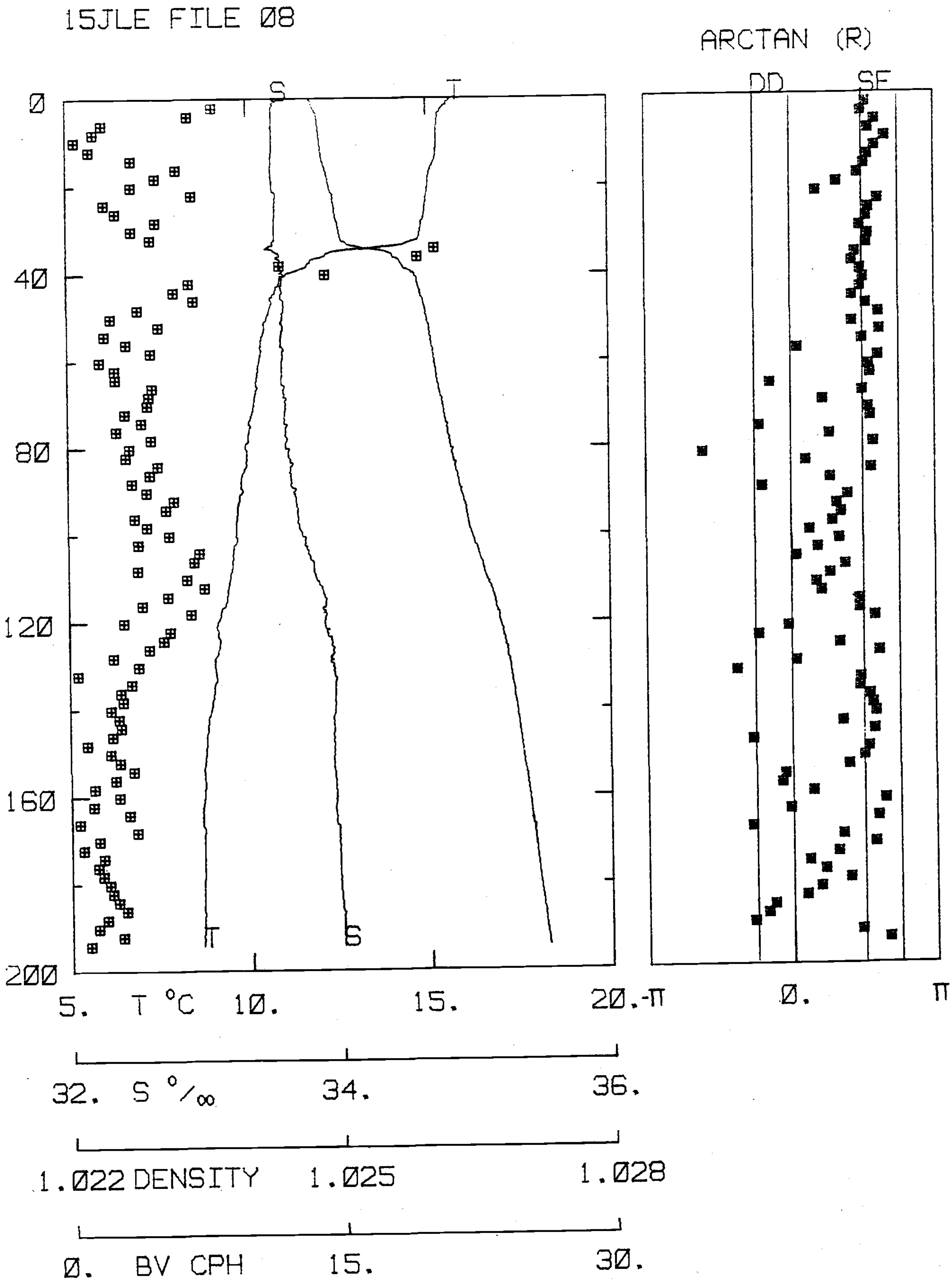
LOCATION 41°30'N 151°59'W

Profile spacing 800m

WIND SPEED 3. m/s

DIRECTION 040°

Ship's heading 0°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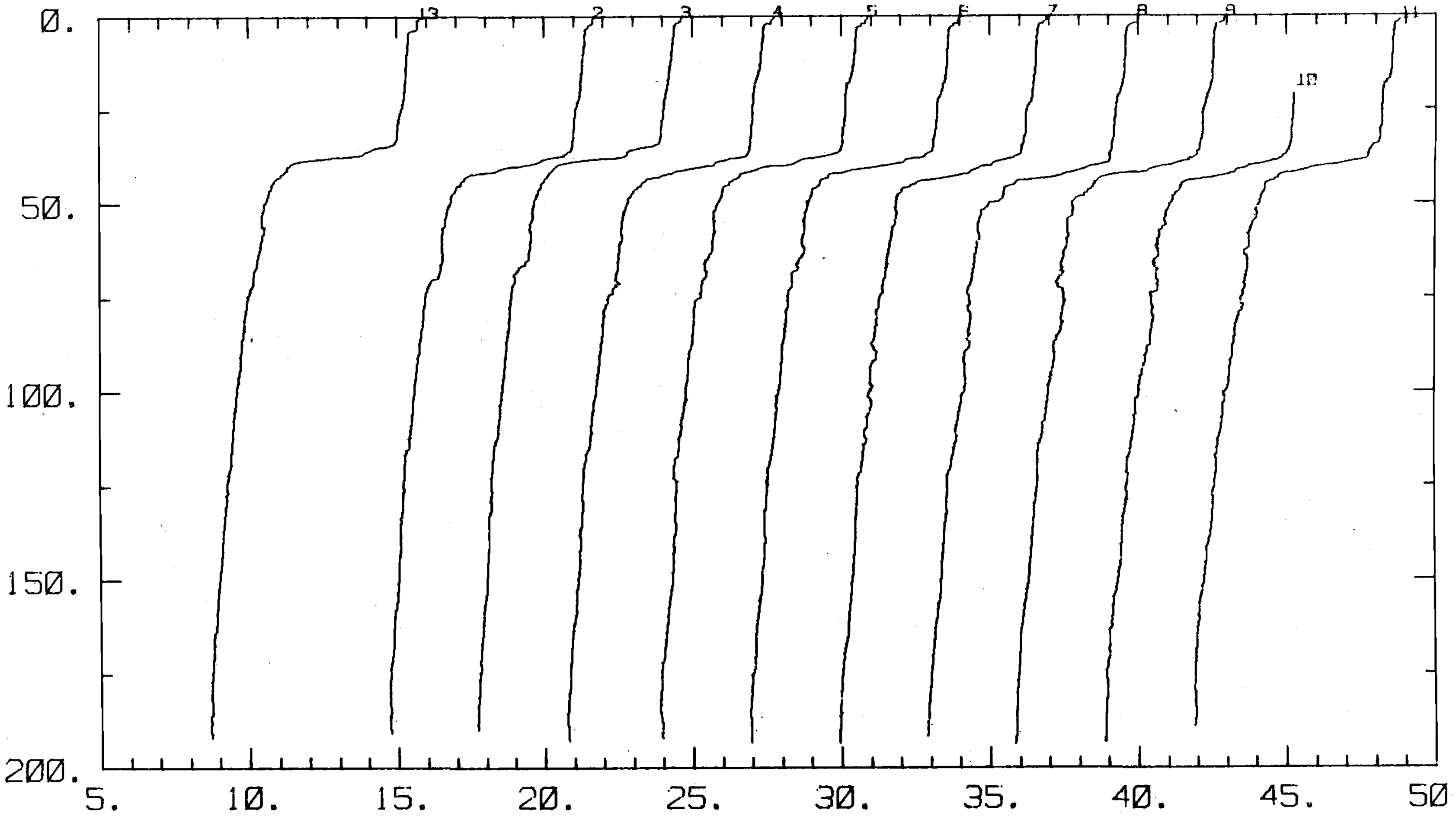
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

15JL82EM , 16JL82AM



104

SEQUENCE 10 PAGE 2

START TIME 23:54 GMT 07/15/82

LOCATION 41°34'N 152°00'W

Profile spacing 800m

WIND SPEED 3. m/s

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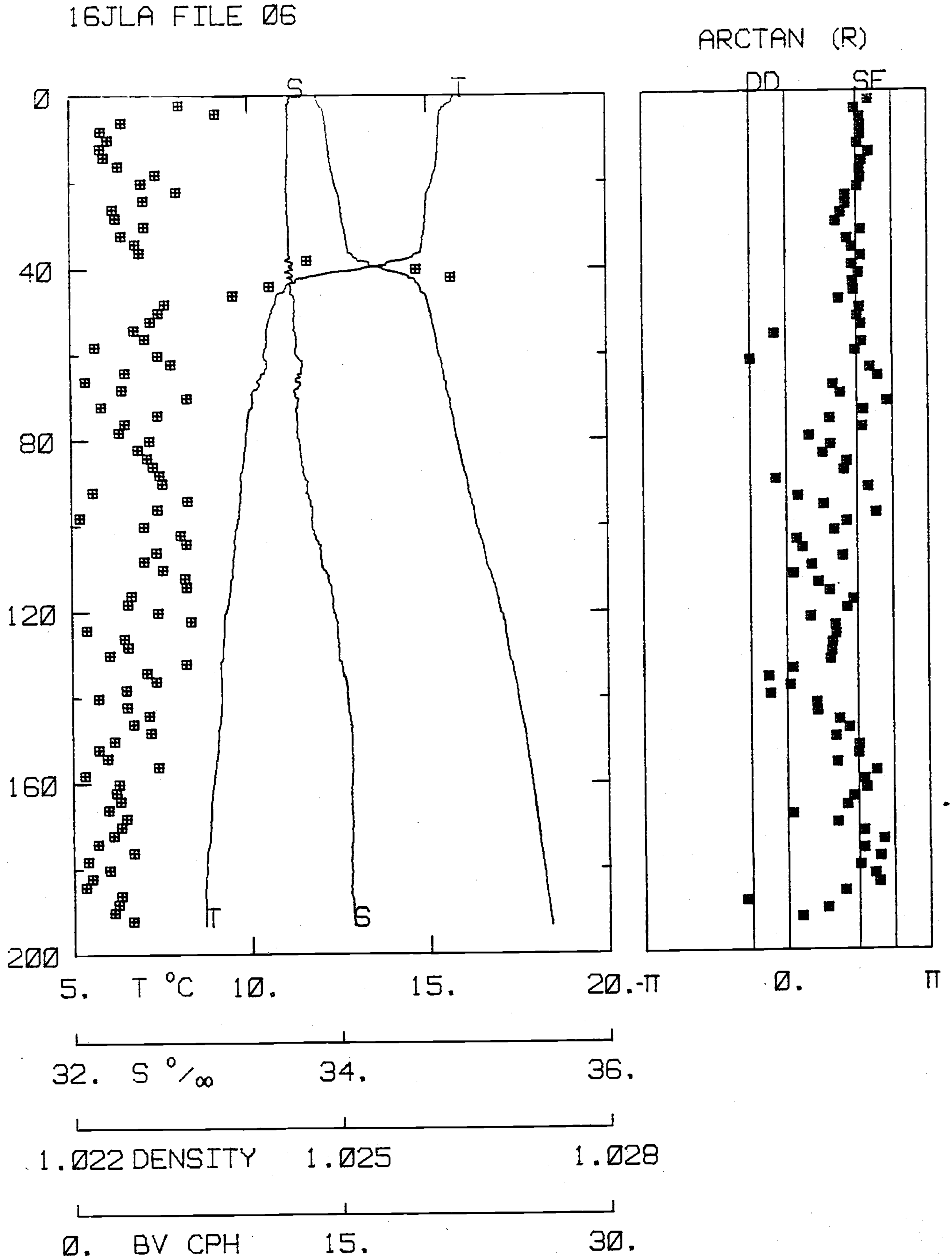
Ship's heading 0°


16JLA FILE 06
ARCTAN (R)
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5. T °C 10. 15. 20.
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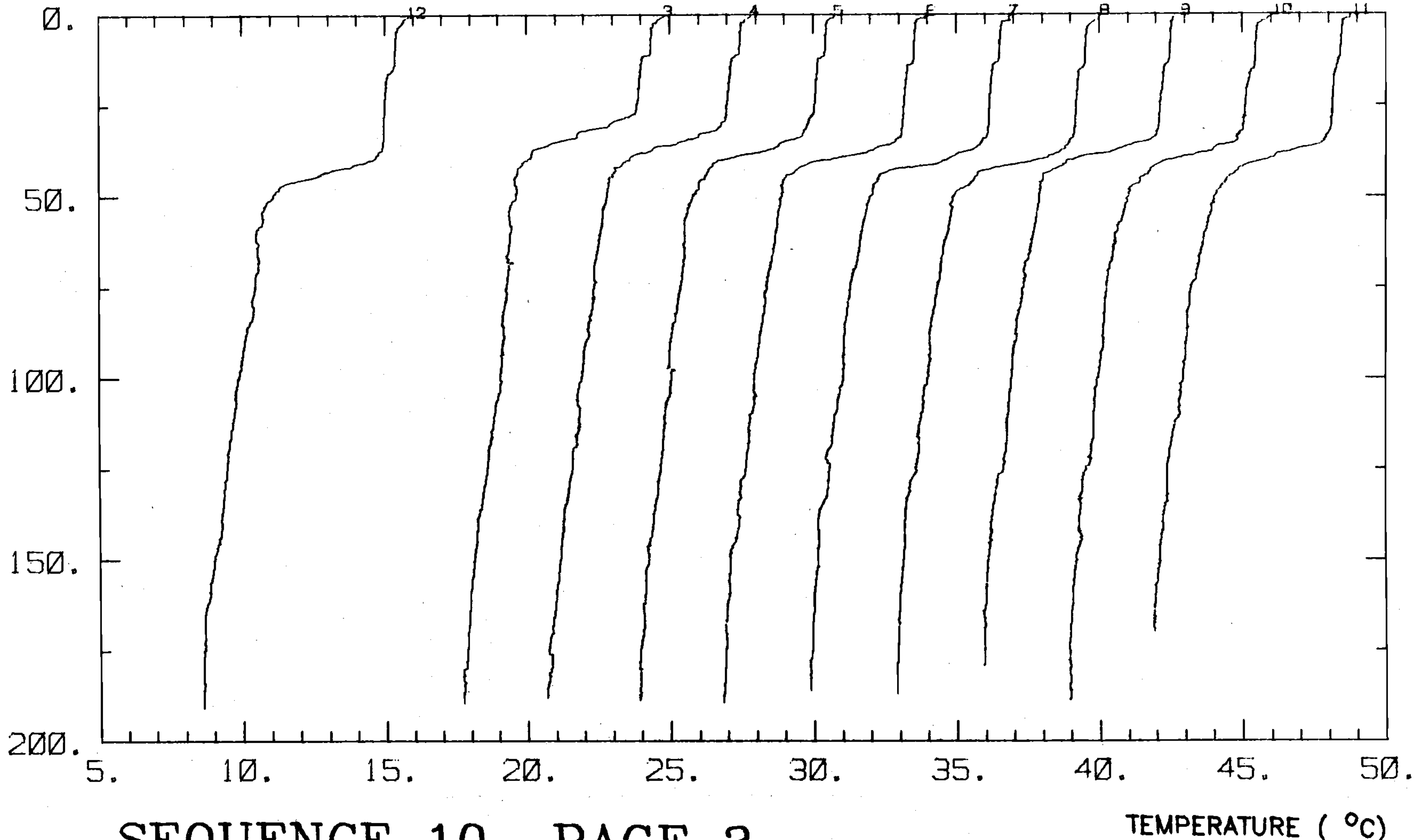
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

16JL82AM , 16JL82BN



106

SEQUENCE 10 PAGE 3

START TIME 01:06 GMT 07/16/82

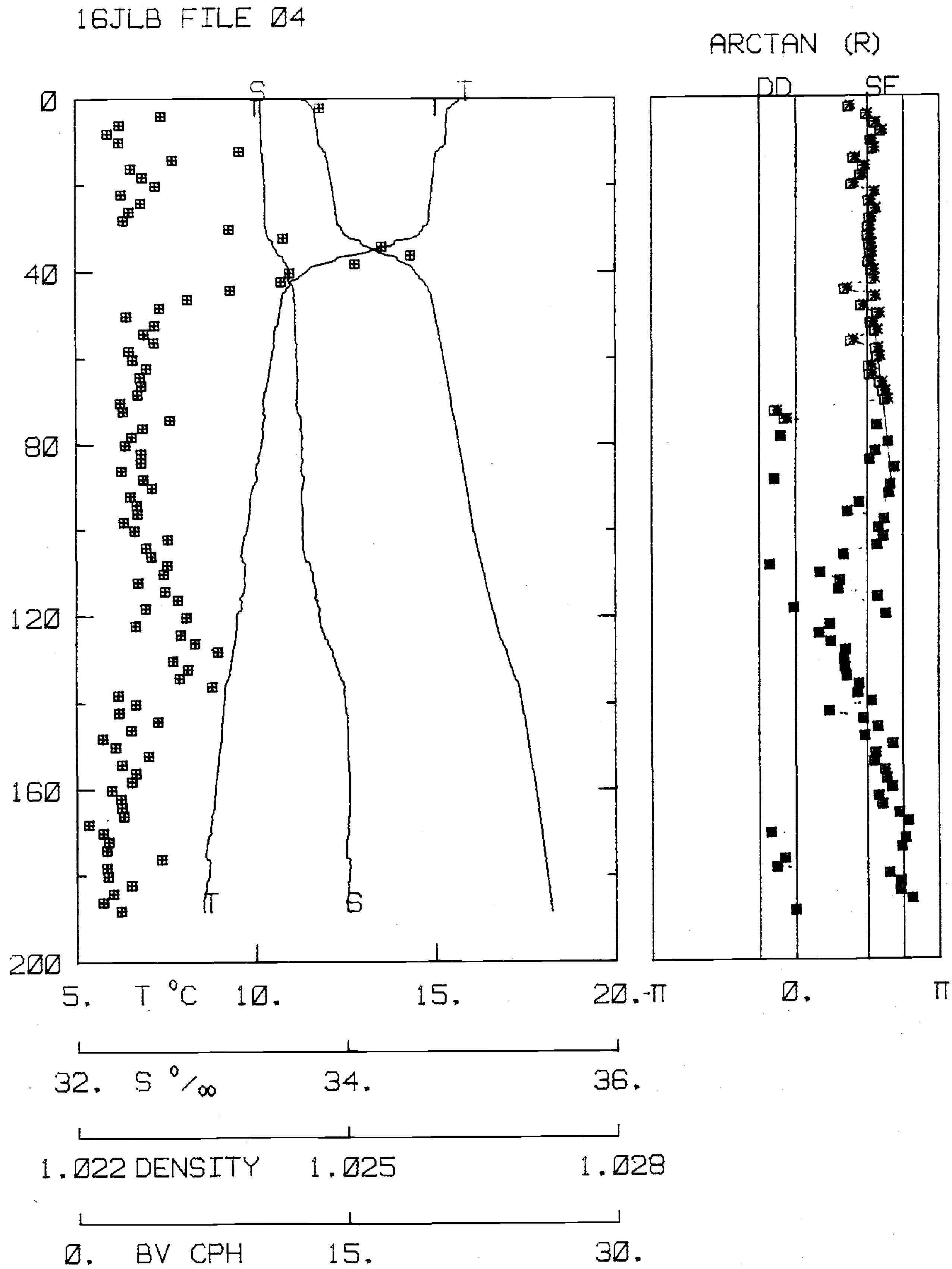
LOCATION 41°41'N 152°00'W

Profile spacing 800m

WIND SPEED 3. m/s

DIRECTION 040°

Ship's heading 0°



16JLB FILE Ø4
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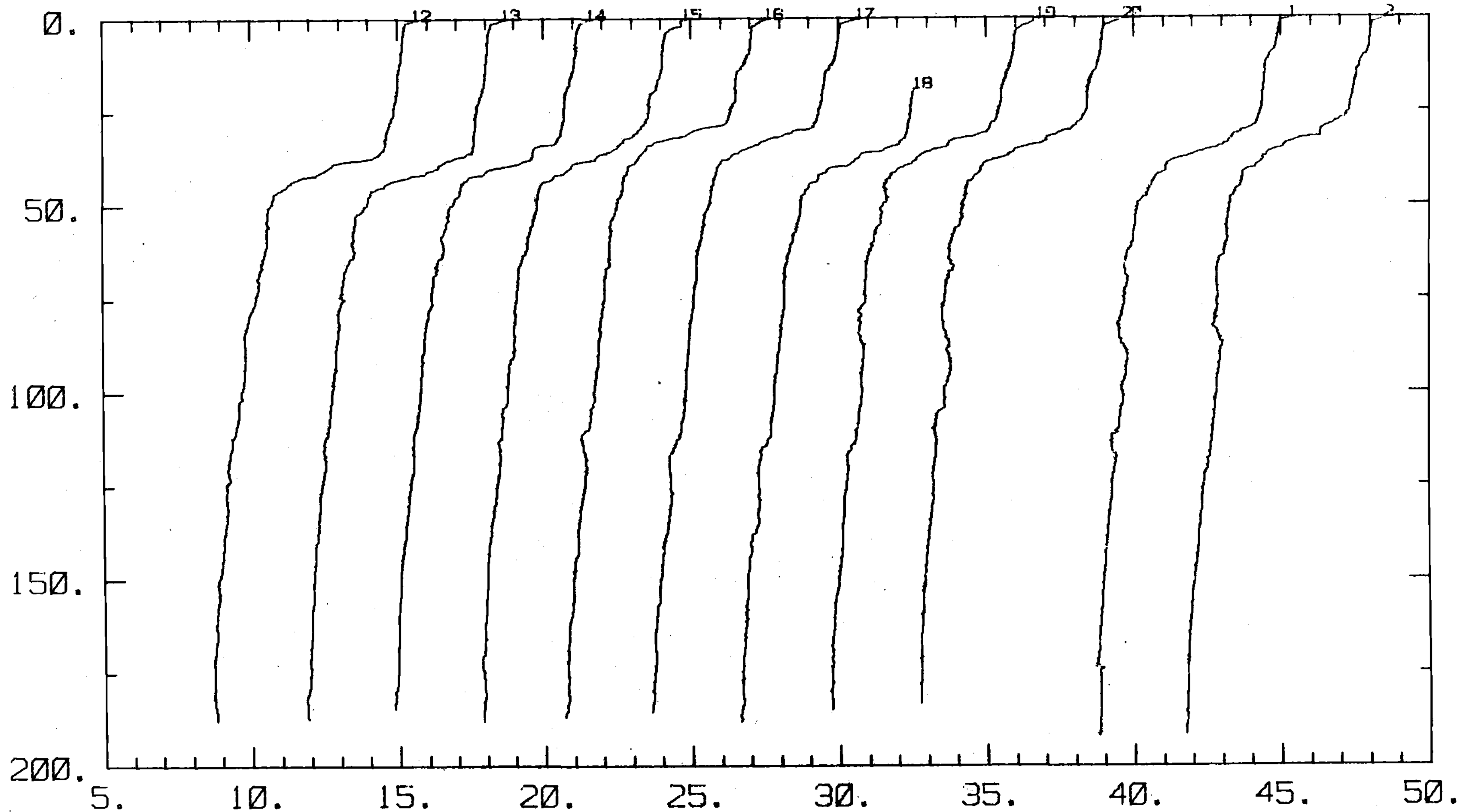
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

16JL82BN , 16JL82CN



108

SEQUENCE 10 PAGE 4

START TIME 02:30 GMT 07/16/82

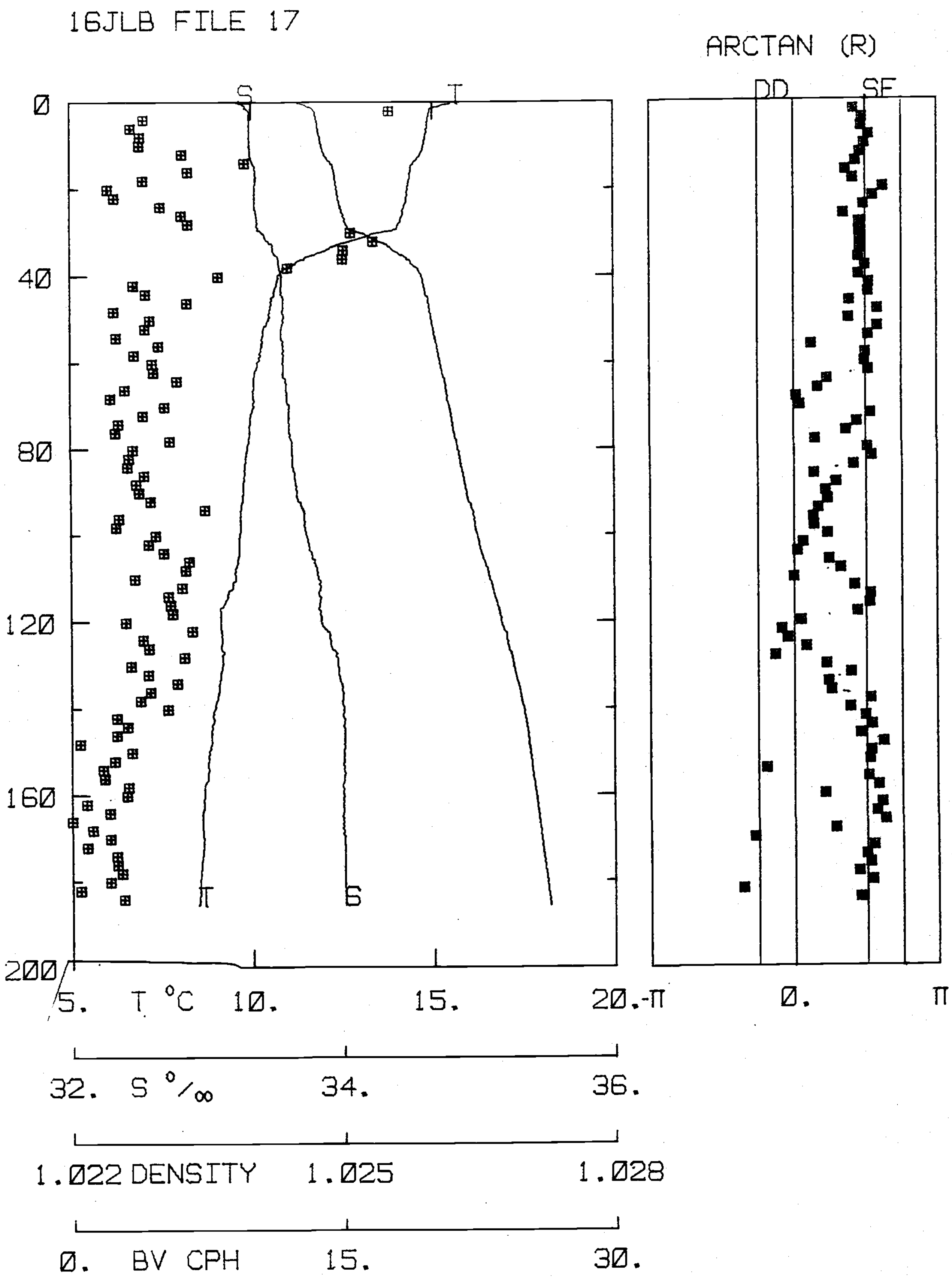
LOCATION 41°47'N 152°00'W

Profile spacing 800m

WIND SPEED 3. m/s

DIRECTION 040°

Ship's heading 0°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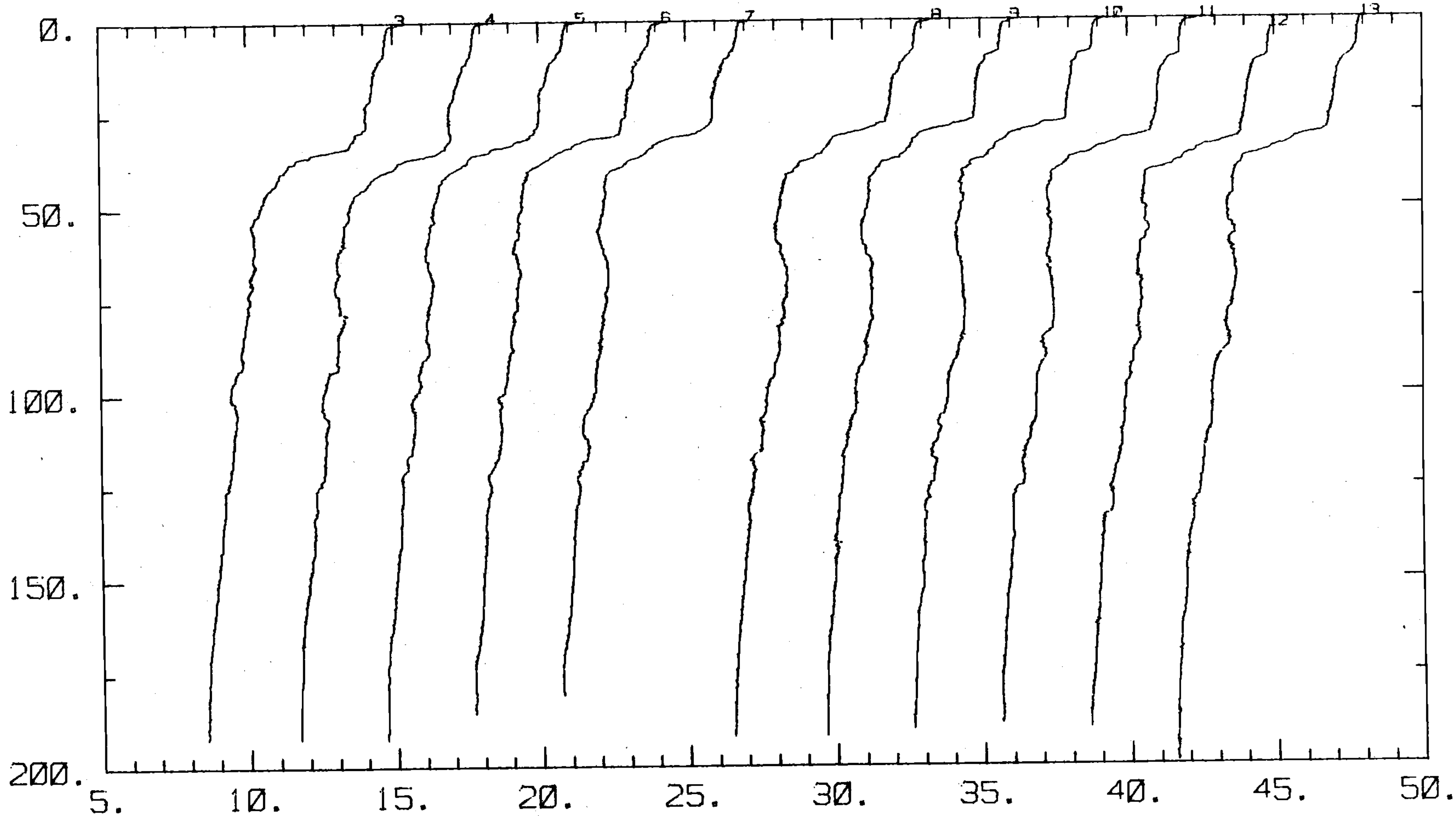
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

16JL82CN



SEQUENCE 10 PAGE 5

START TIME 03:42 GMT 07/16/82

LOCATION 41°52'N 152°00'W

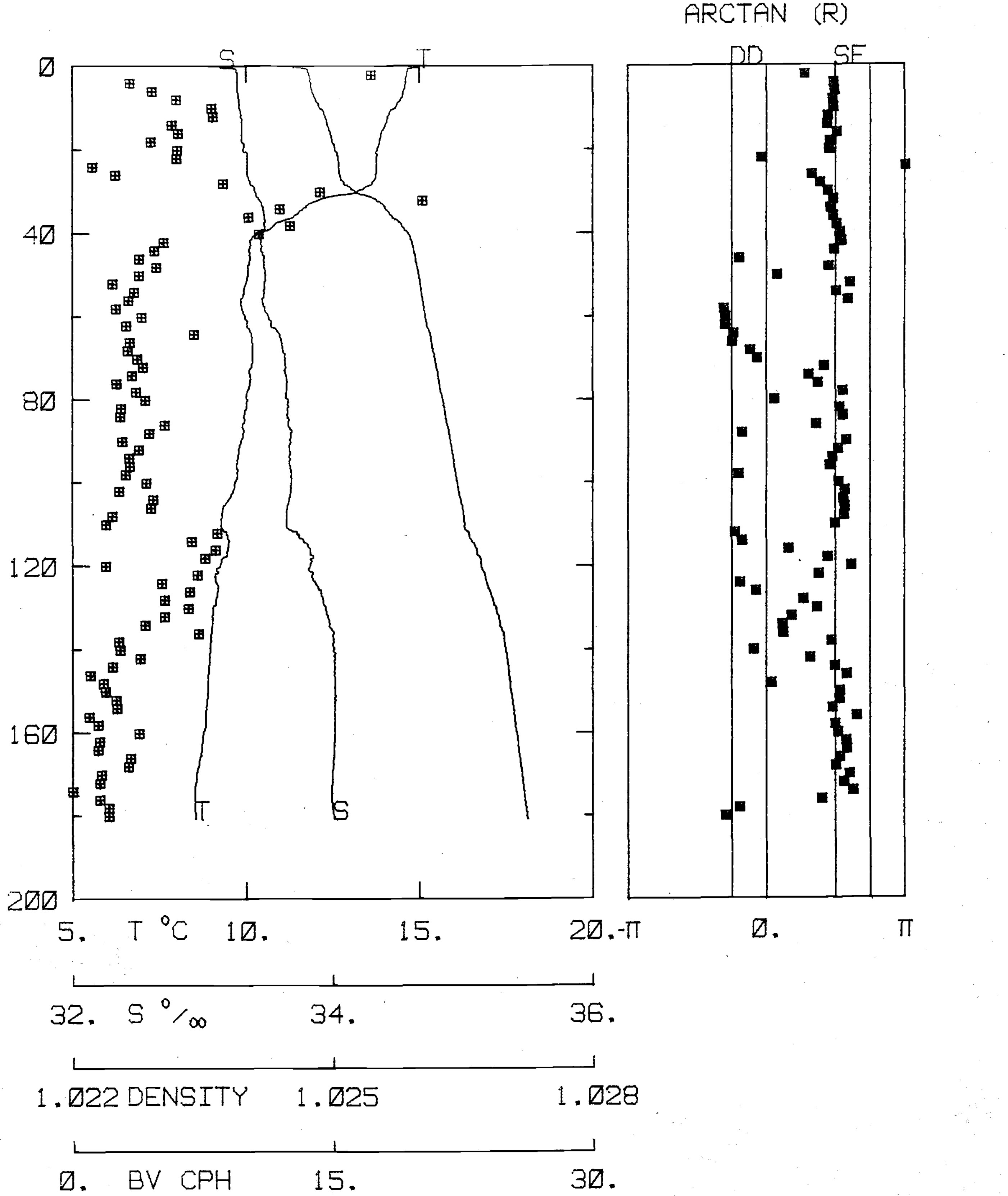
Profile spacing 800m

WIND SPEED 3. m/s

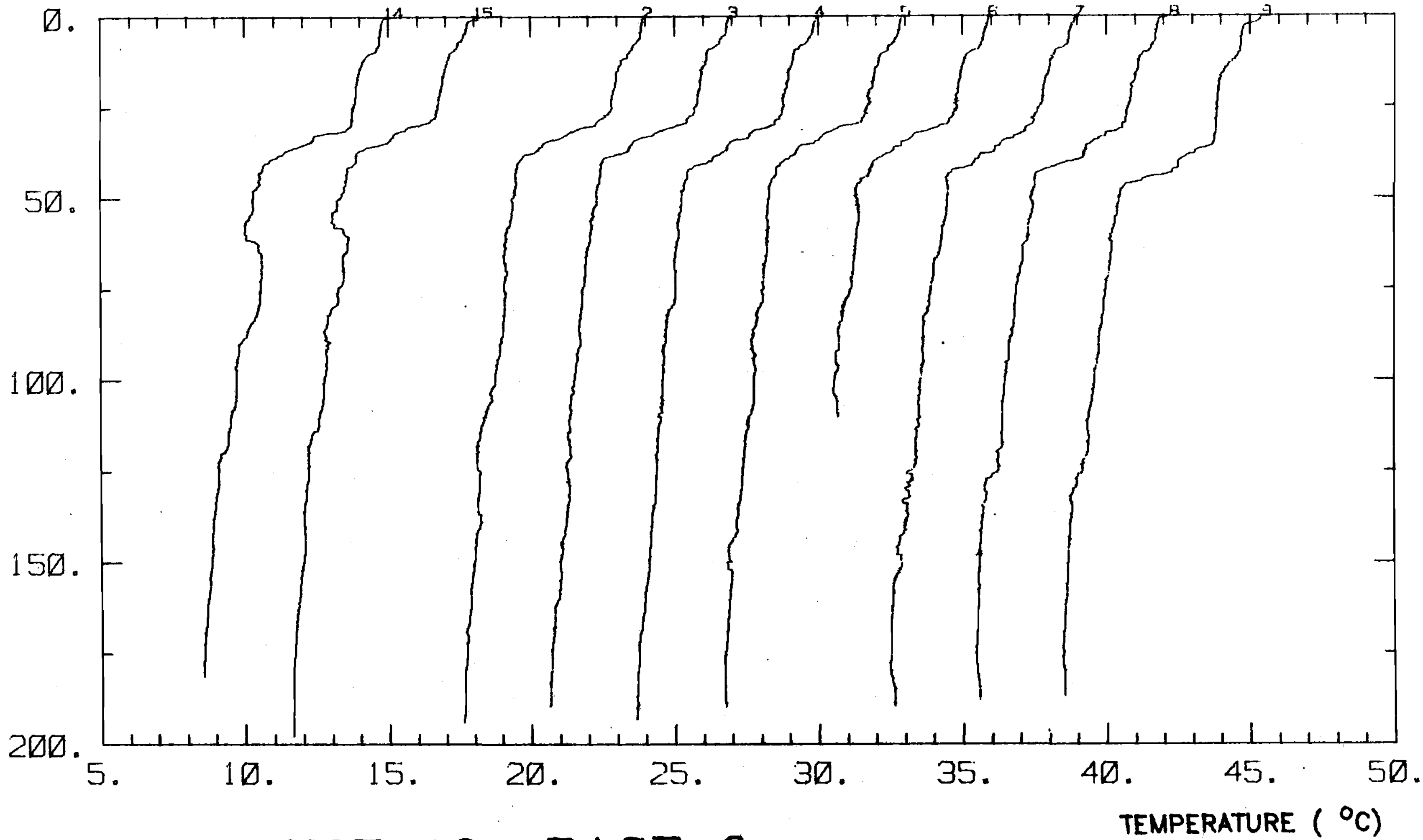
DIRECTION 040°

Ship's heading 0°

16JLC FILE 07



16JL82CN , 16JL82DN



SEQUENCE 10 PAGE 6

START TIME 04:54 GMT 07/16/82

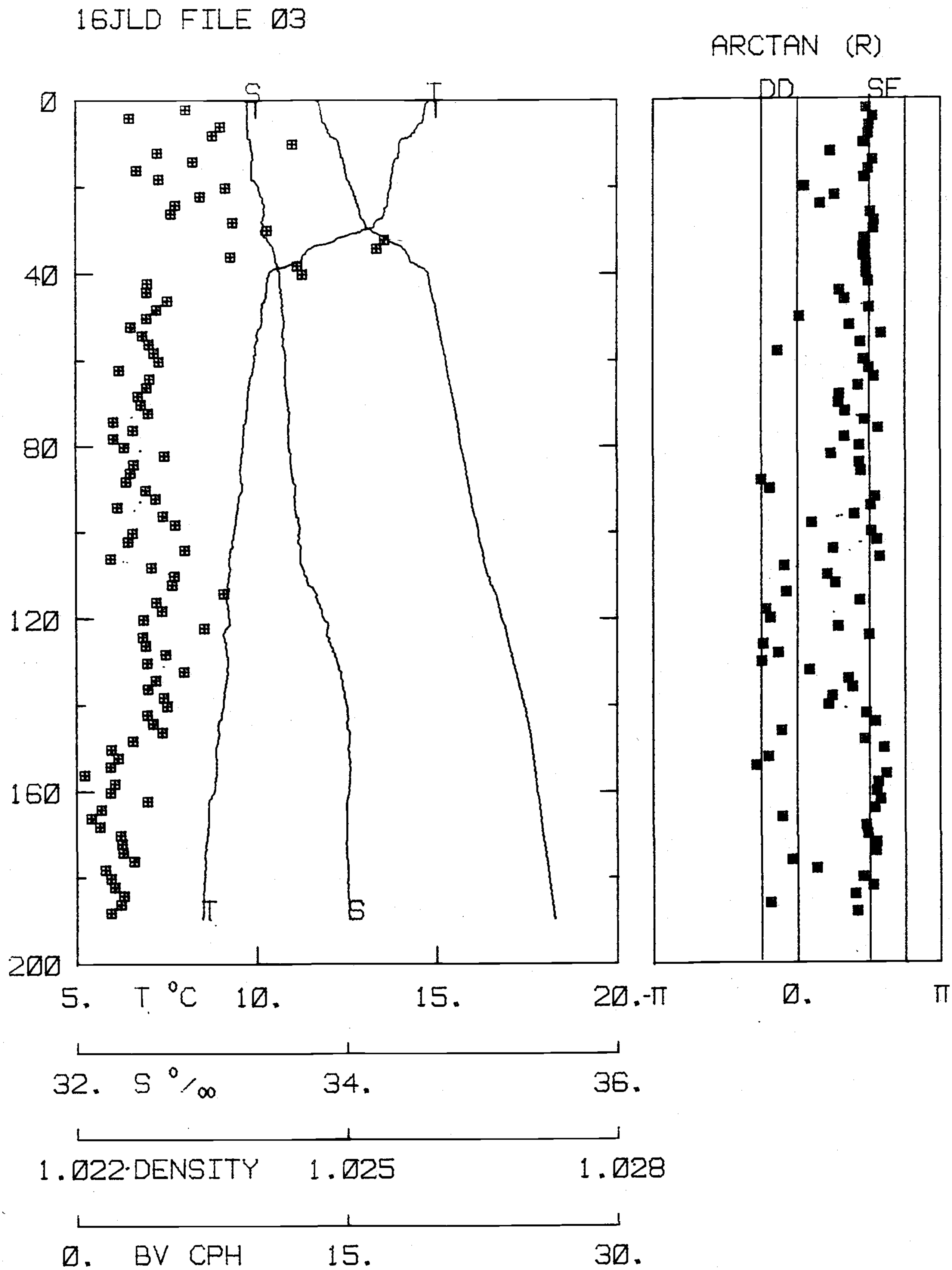
LOCATION 41°57'N 152°00'W

Profile spacing 800m

WIND SPEED 3. m/s

DIRECTION 040°

Ship's heading 0°


16JLD FILE Ø3
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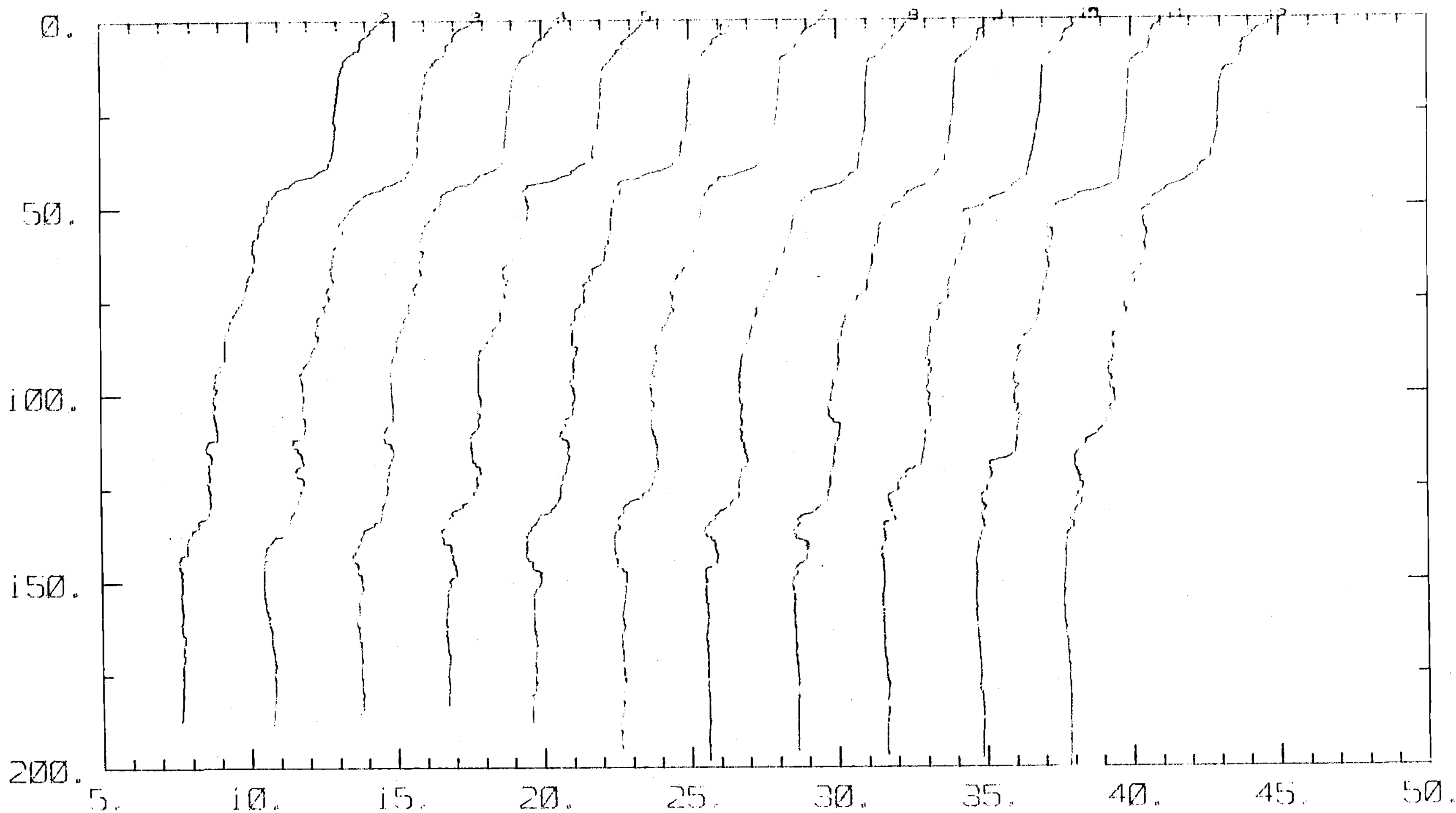
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 30.

16JL82EM



SEQUENCE 11 PAGE 1

START TIME 22:36 GMT 07/16/82

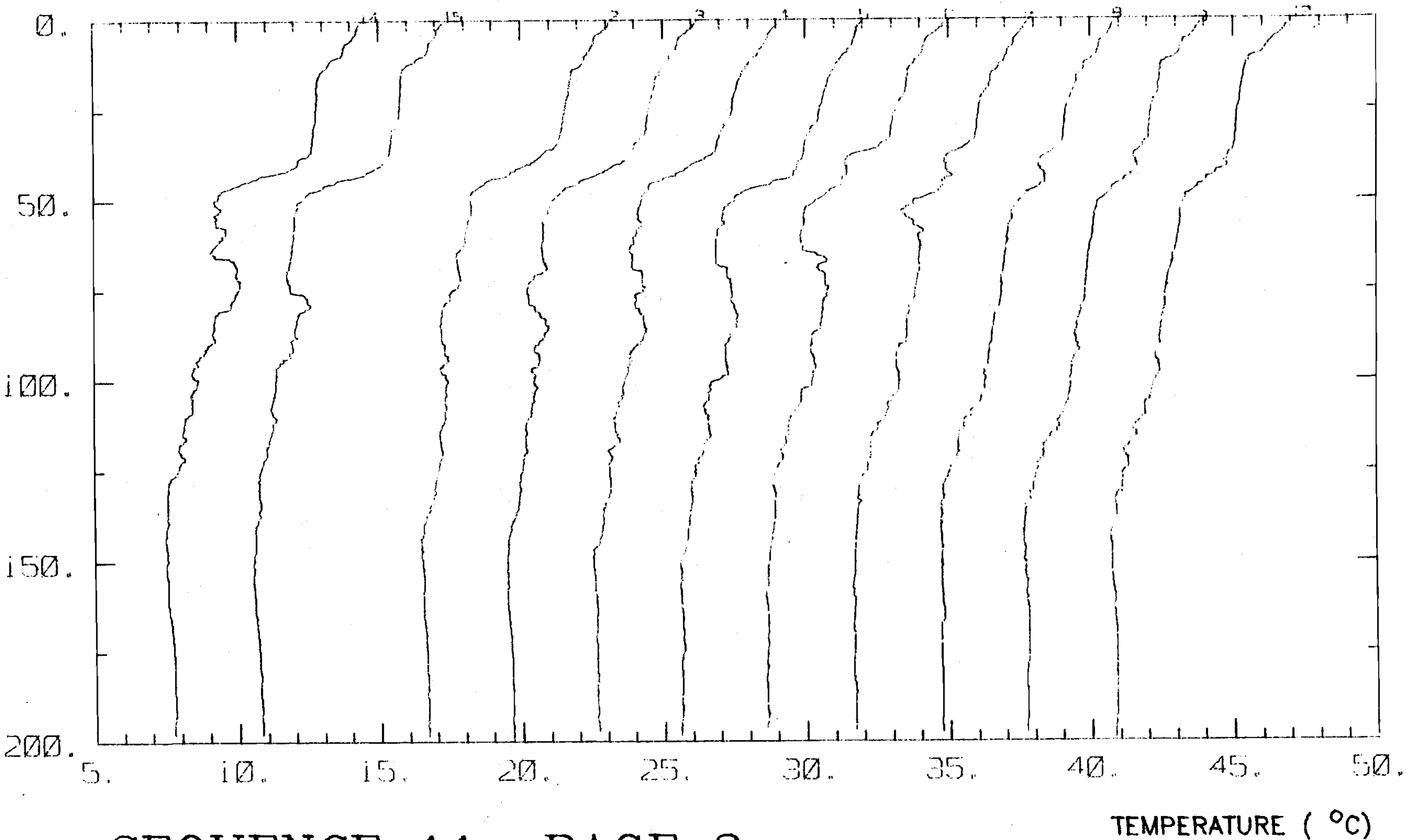
LOCATION 42°45'N 152°01'W

Profile spacing 800m

WIND SPEED 0. m/s

Ship's heading 0°

16JL82EM , 17JL82AM



SEQUENCE 11 PAGE 2

START TIME 23:48 GMT 07/16/82

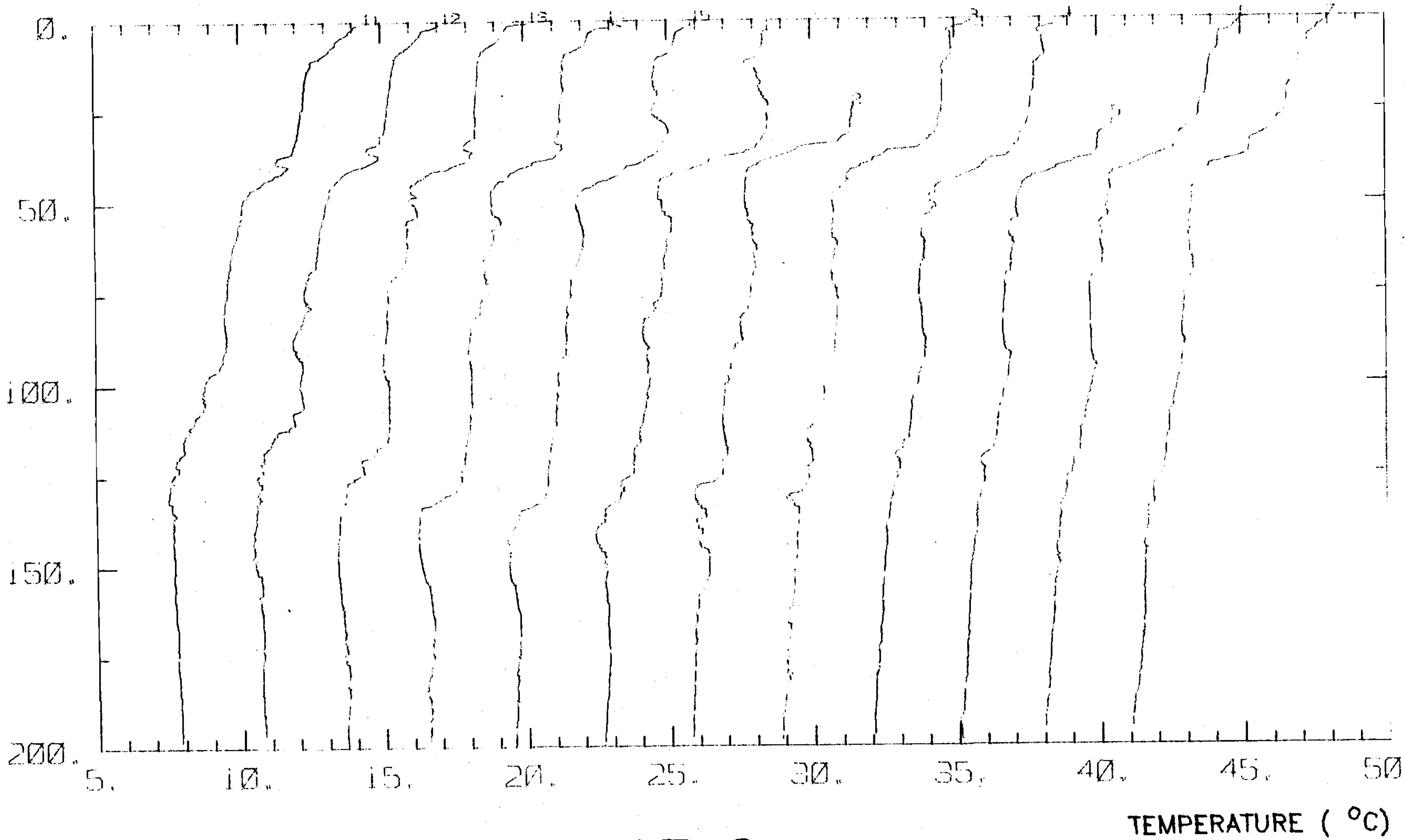
LOCATION 42°49'N 152°01'W

Profile spacing 800m

WIND SPEED 0. m/s

Ship's heading 0°

17JL82AM , 17JL82BM



SEQUENCE 11 PAGE 3

START TIME 01:00 GMT 07/17/82

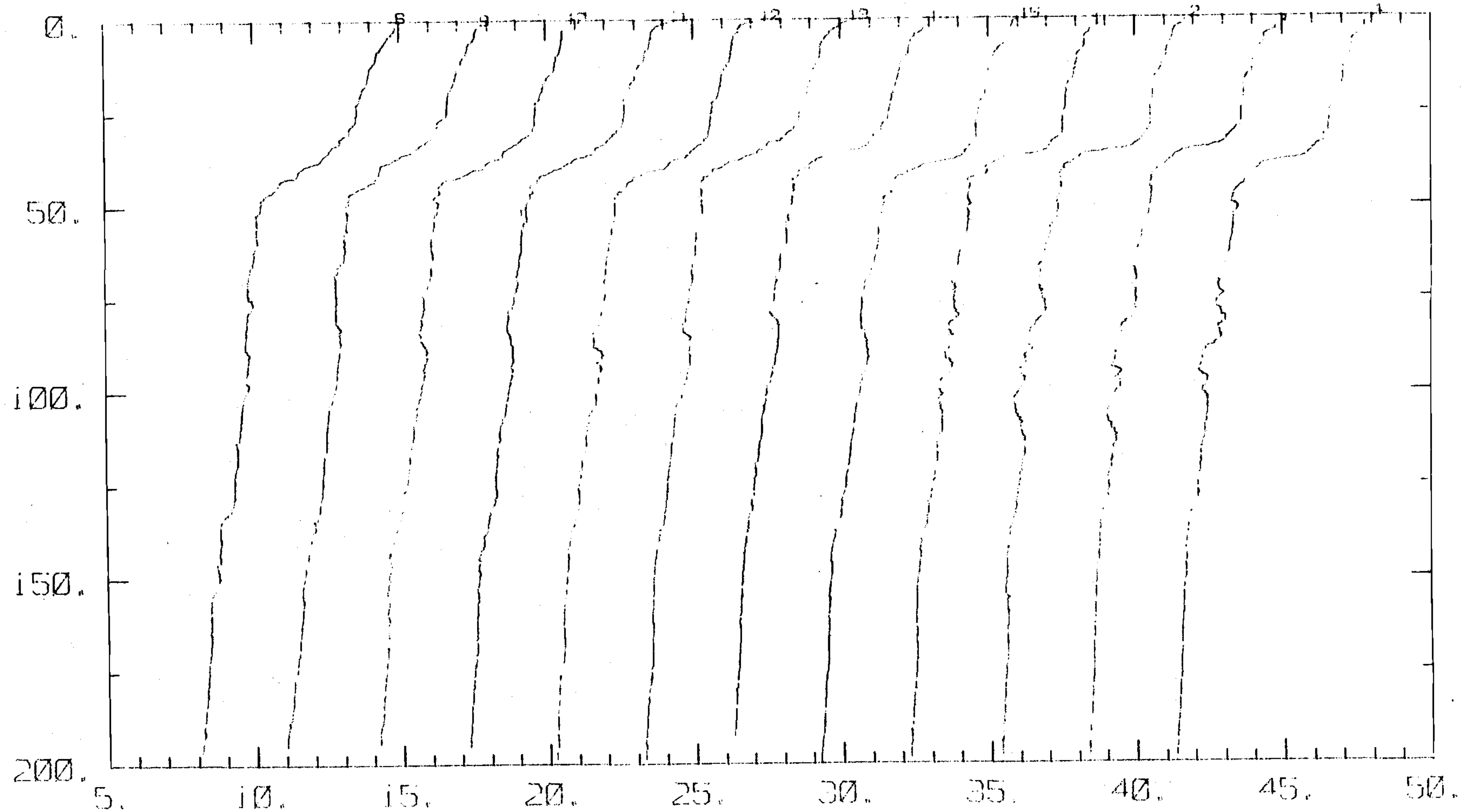
LOCATION 42°44'N 152°02'W

Profile spacing 800m

WIND SPEED 0. m/s

Ship's heading 190°

17JL82BM , 17JL82CM



TEMPERATURE (°C)

SEQUENCE 11 PAGE 4

START TIME 02:12 GMT 07/17/82

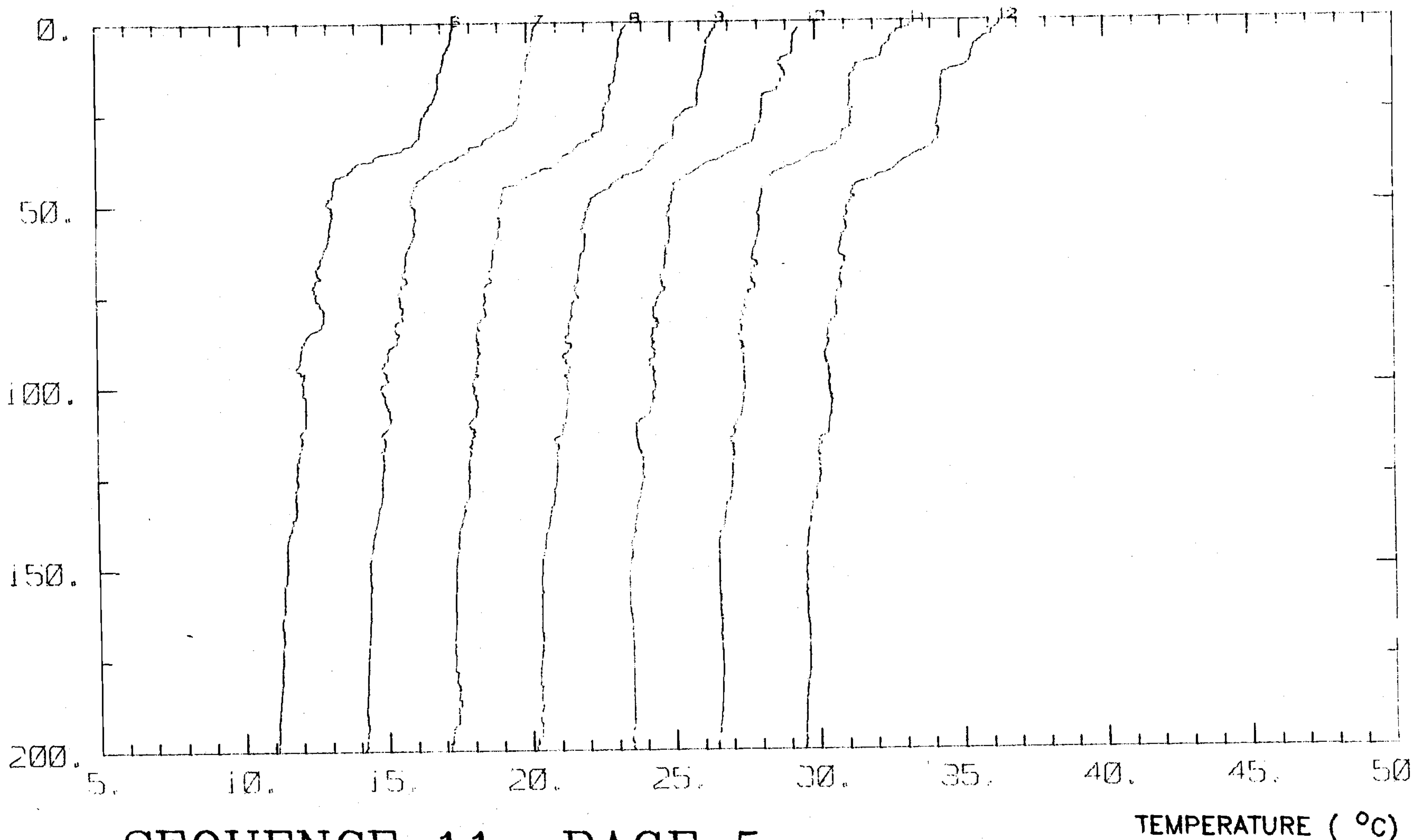
LOCATION 42°39'N 152°02'W

WIND SPEED 0. m/s

Profile spacing 800m

Ship's heading 190°

17JL82CM



SEQUENCE 11 PAGE 5

START TIME 03:24 GMT 07/17/82

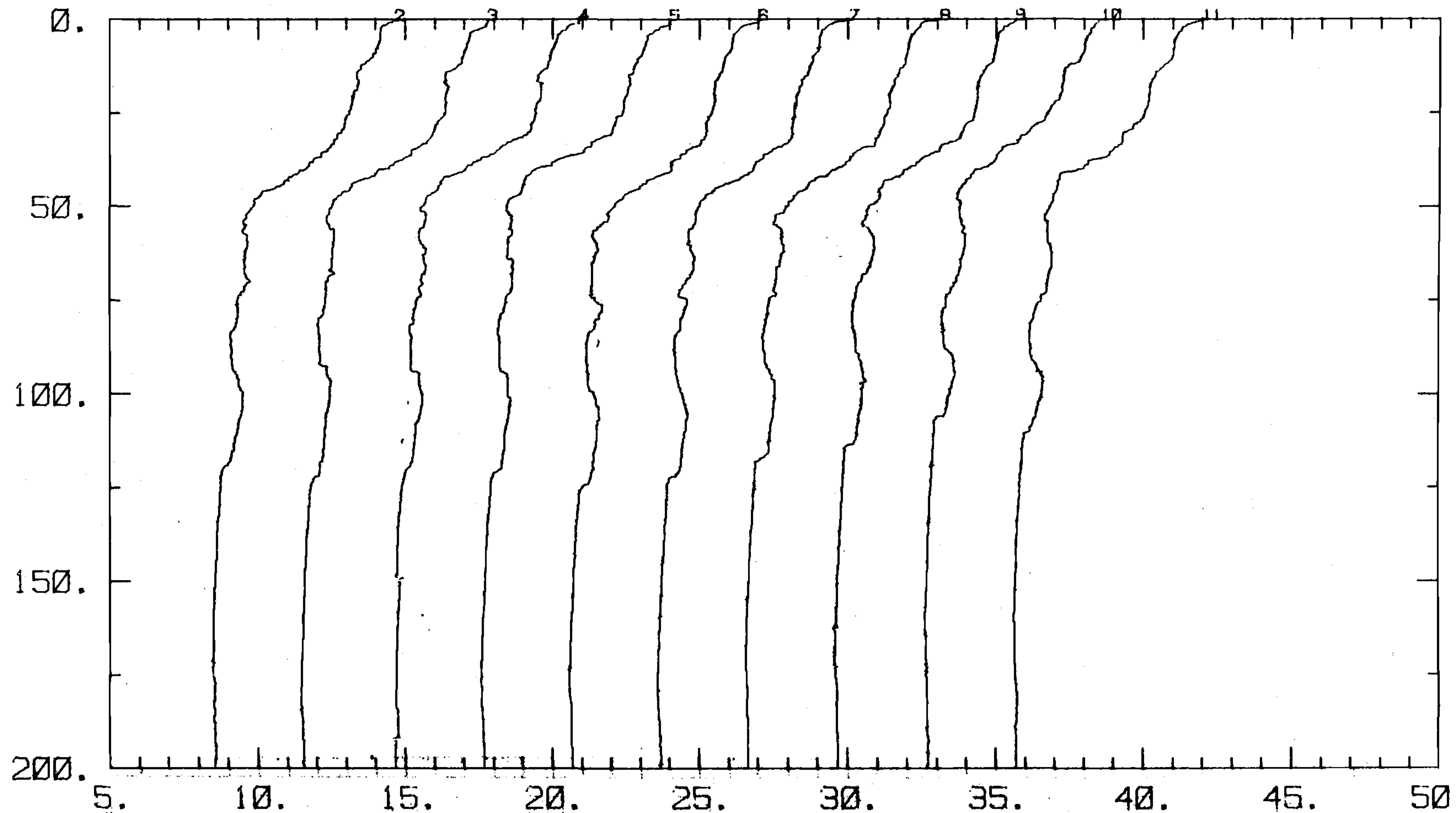
LOCATION 42°34'N 152°02'W

WIND SPEED 0. m/s

Profile spacing 800m

Ship's heading 190°

17JL82DN



TEMPERATURE (°C)

124

SEQUENCE 12 PAGE 1

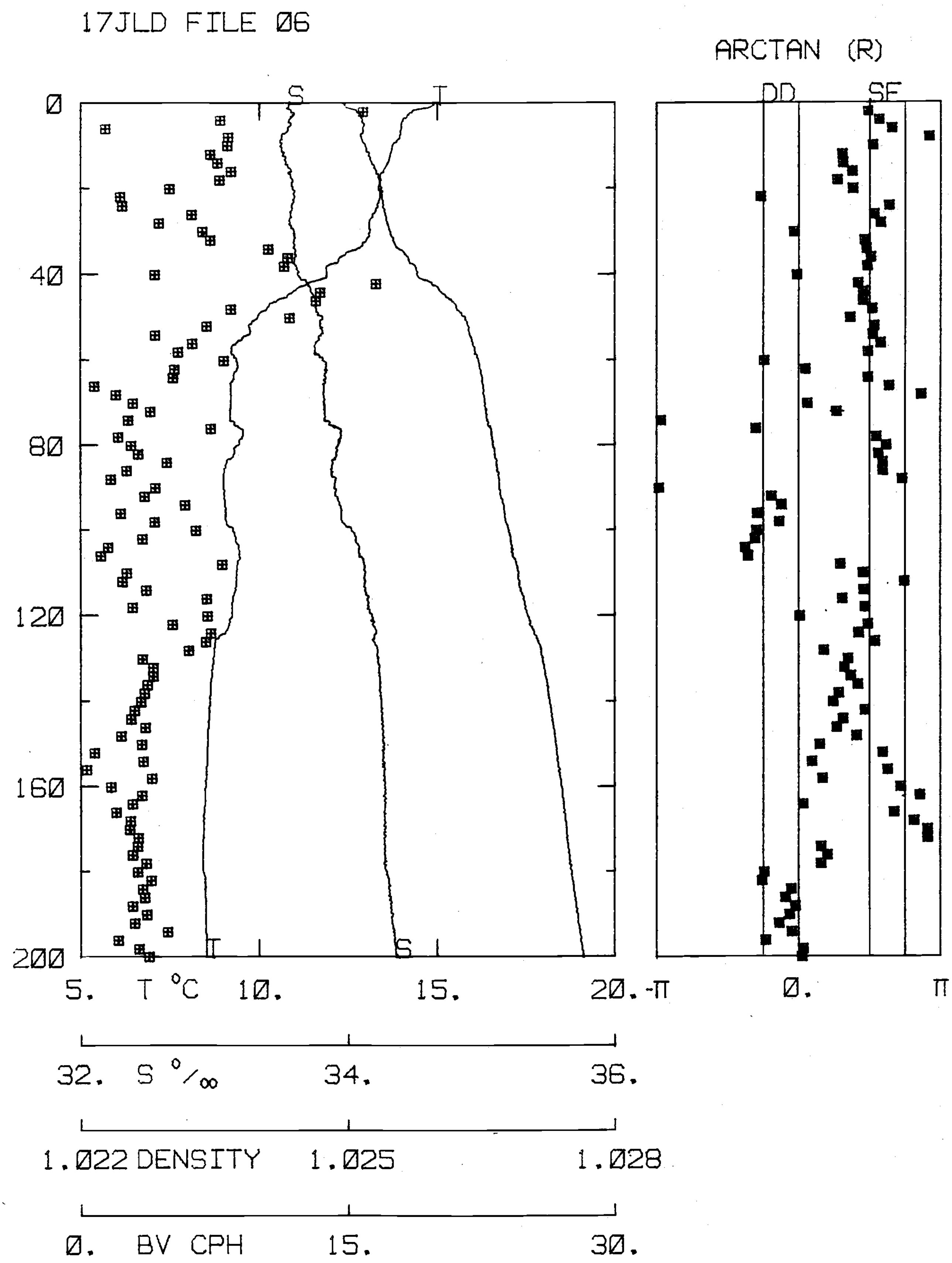
START TIME 04:42 GMT 07/17/82

LOCATION 42°30'N 152°04'W

Profile spacing 800m

WIND SPEED 0. m/s

Ship's heading 190°



17JLD FILE Ø6
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1.Ø22 DENSITY
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BV CPH
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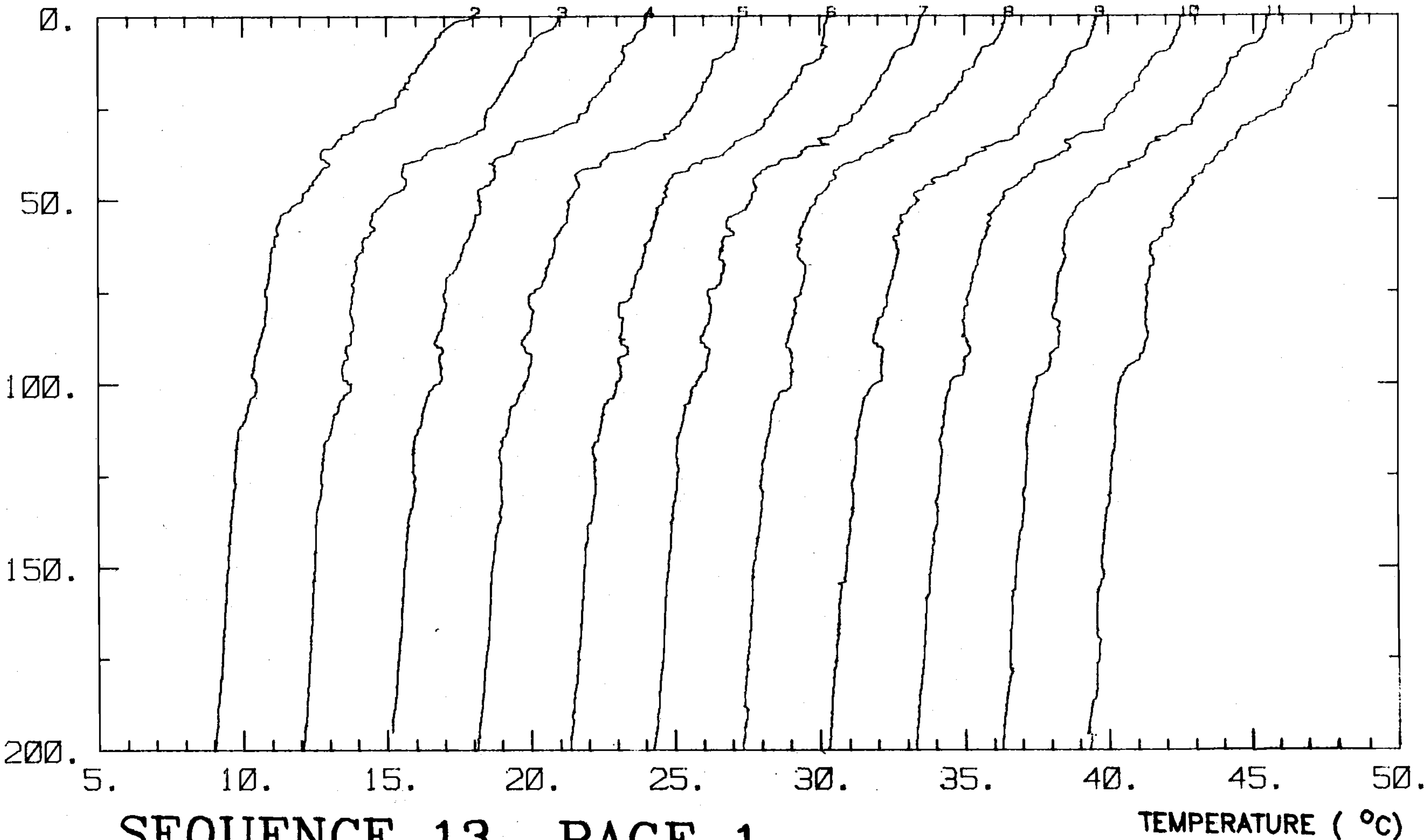
18JL82GN , 19JL82AN



SEQUENCE 13 PAGE 1

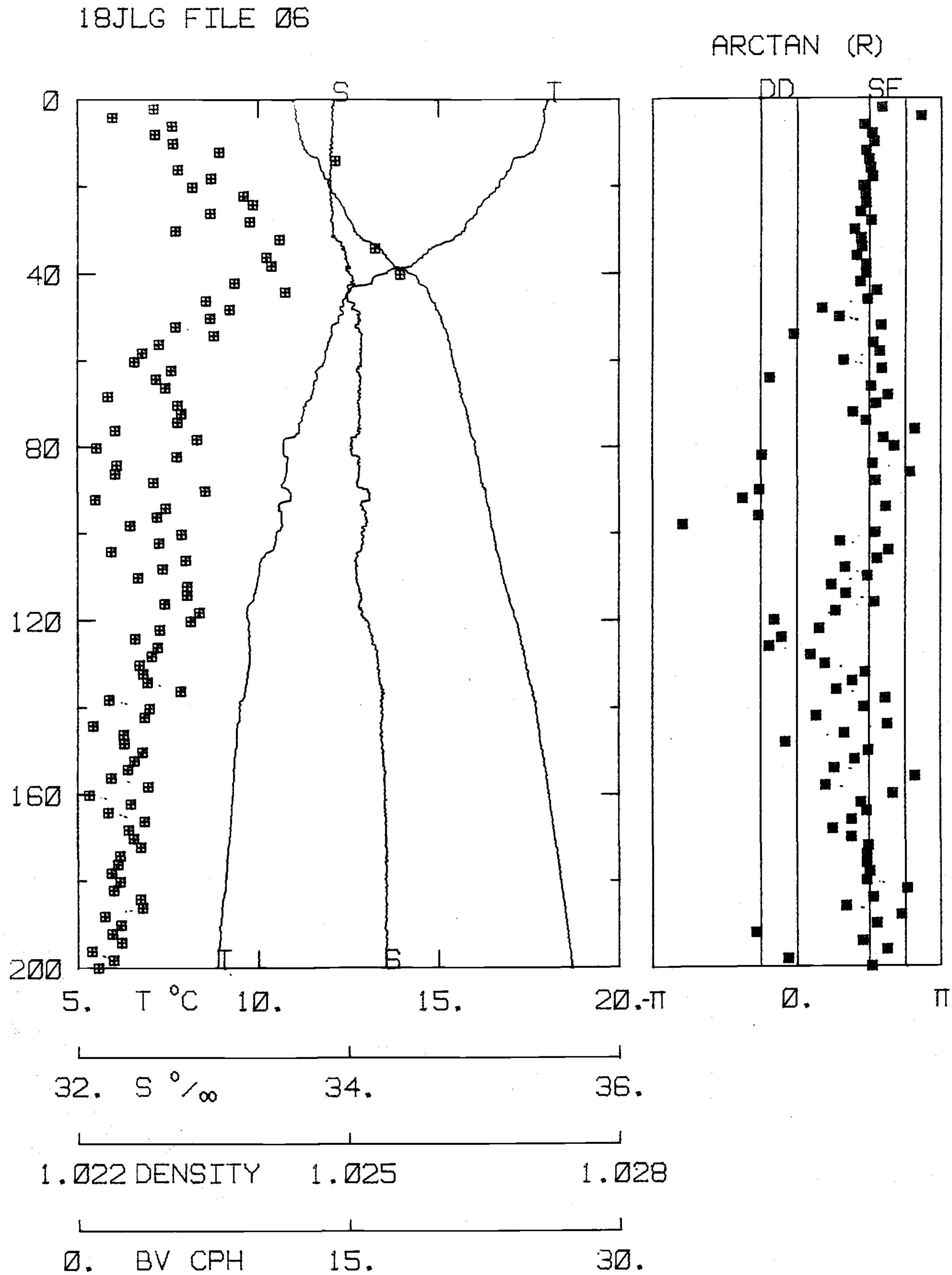
START TIME 23:00 GMT 07/18/82

LOCATION 39°35'N 152°34'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 030°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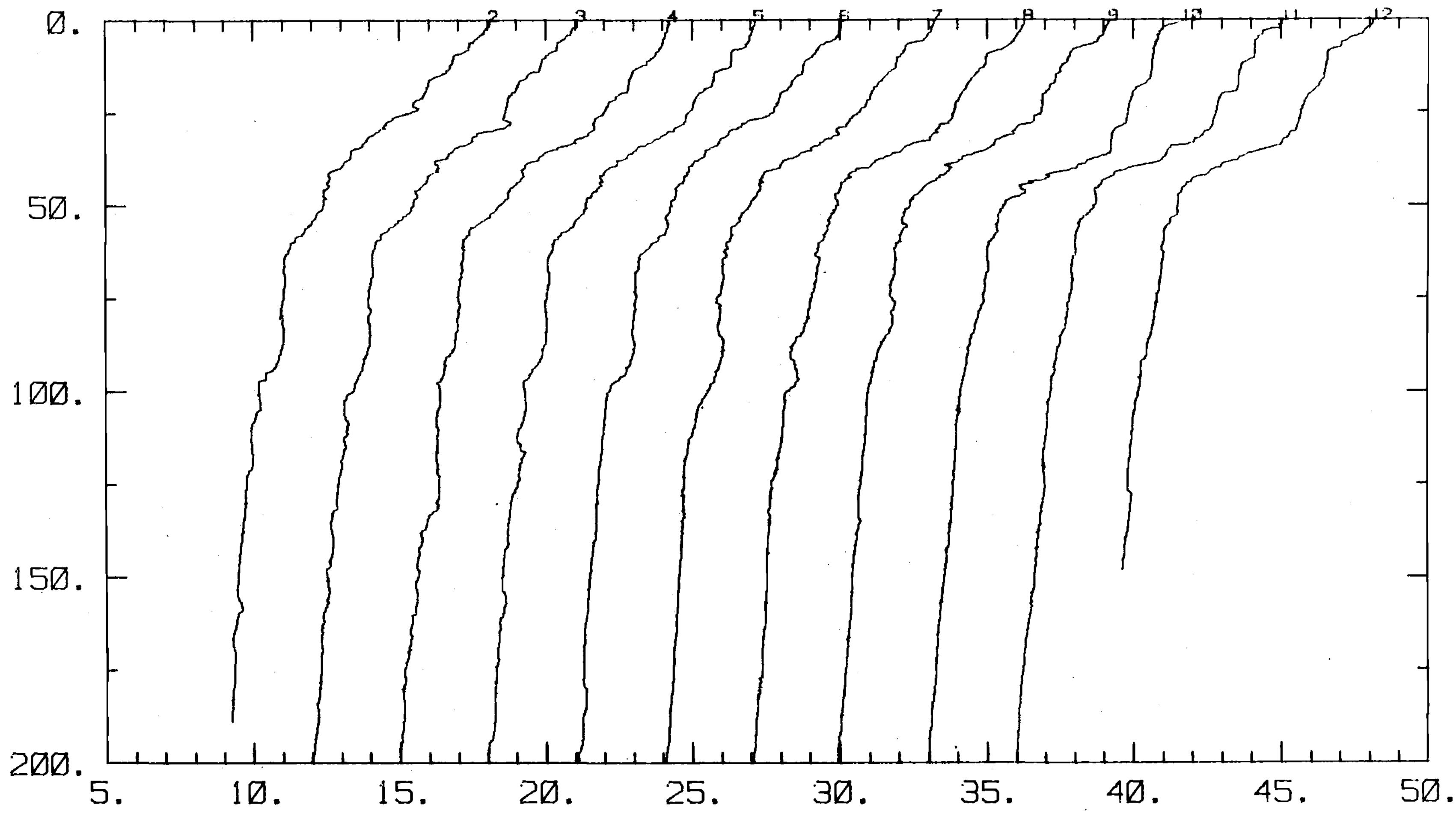
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

19JL82AN



128

SEQUENCE 13 PAGE 2

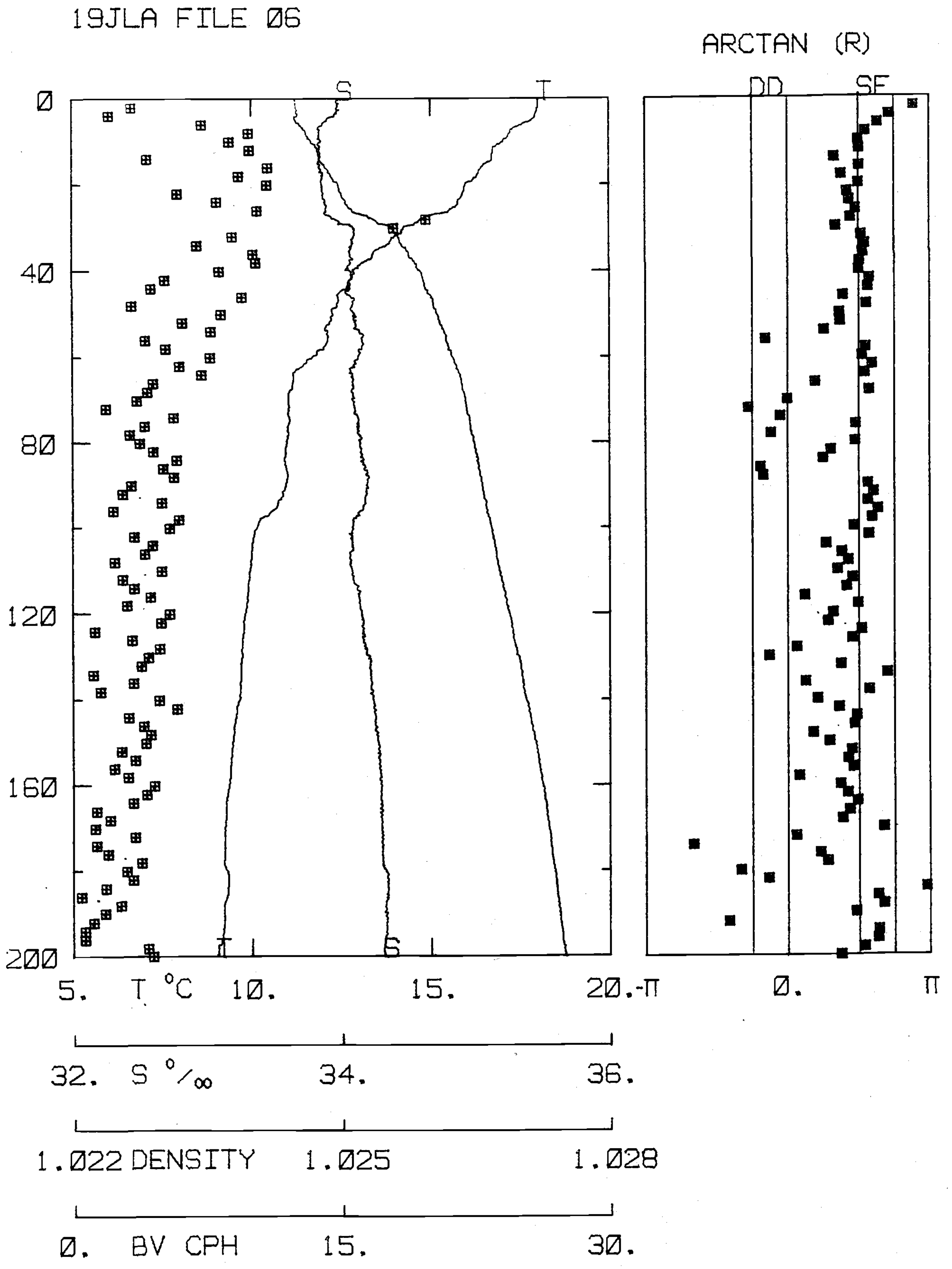
START TIME 00:06 GMT 07/19/82

LOCATION 39°36'N 152°31'W

WIND SPEED 5. m/s

DIRECTION 030.°

Profile spacing 900m


19JLA FILE Ø6
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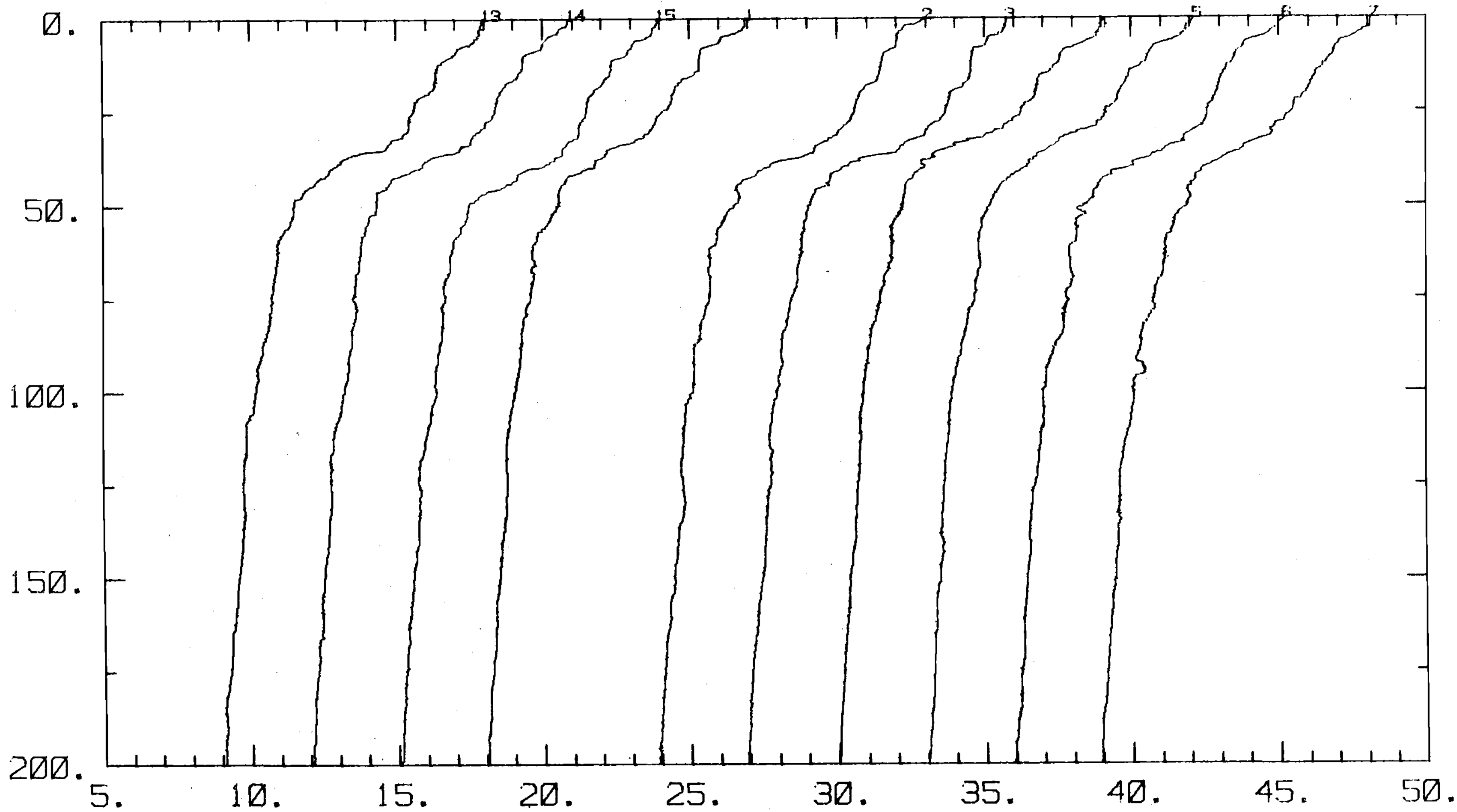
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

19JL82AN , 19JL82BN



130

SEQUENCE 13 PAGE 3

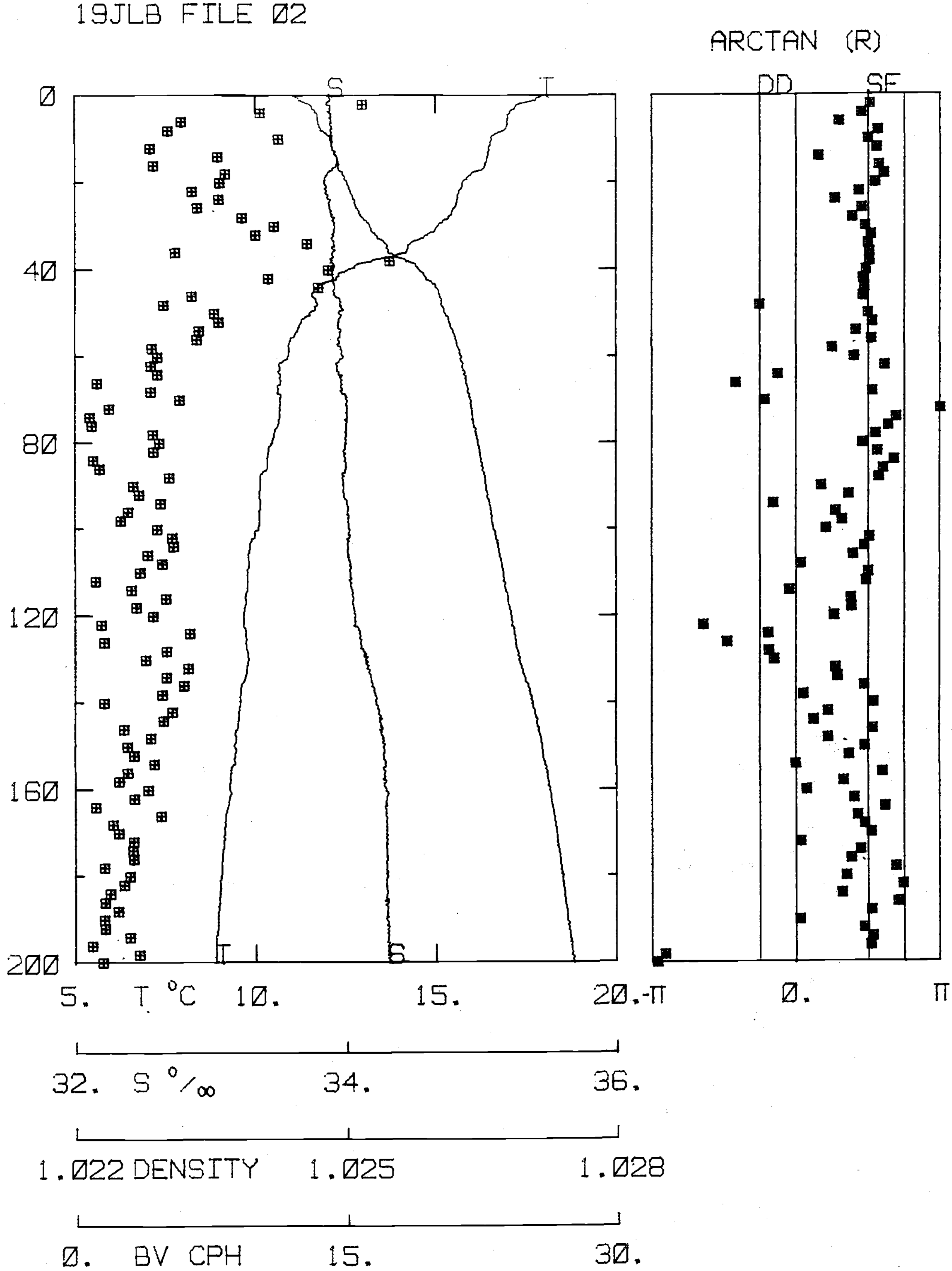
START TIME 01:12 GMT 07/19/82

LOCATION 39°37'N 152°33'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 030°



19JLB FILE Ø2
ARCTAN (R)
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36.
1.Ø22 DENSITY
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BV CPH
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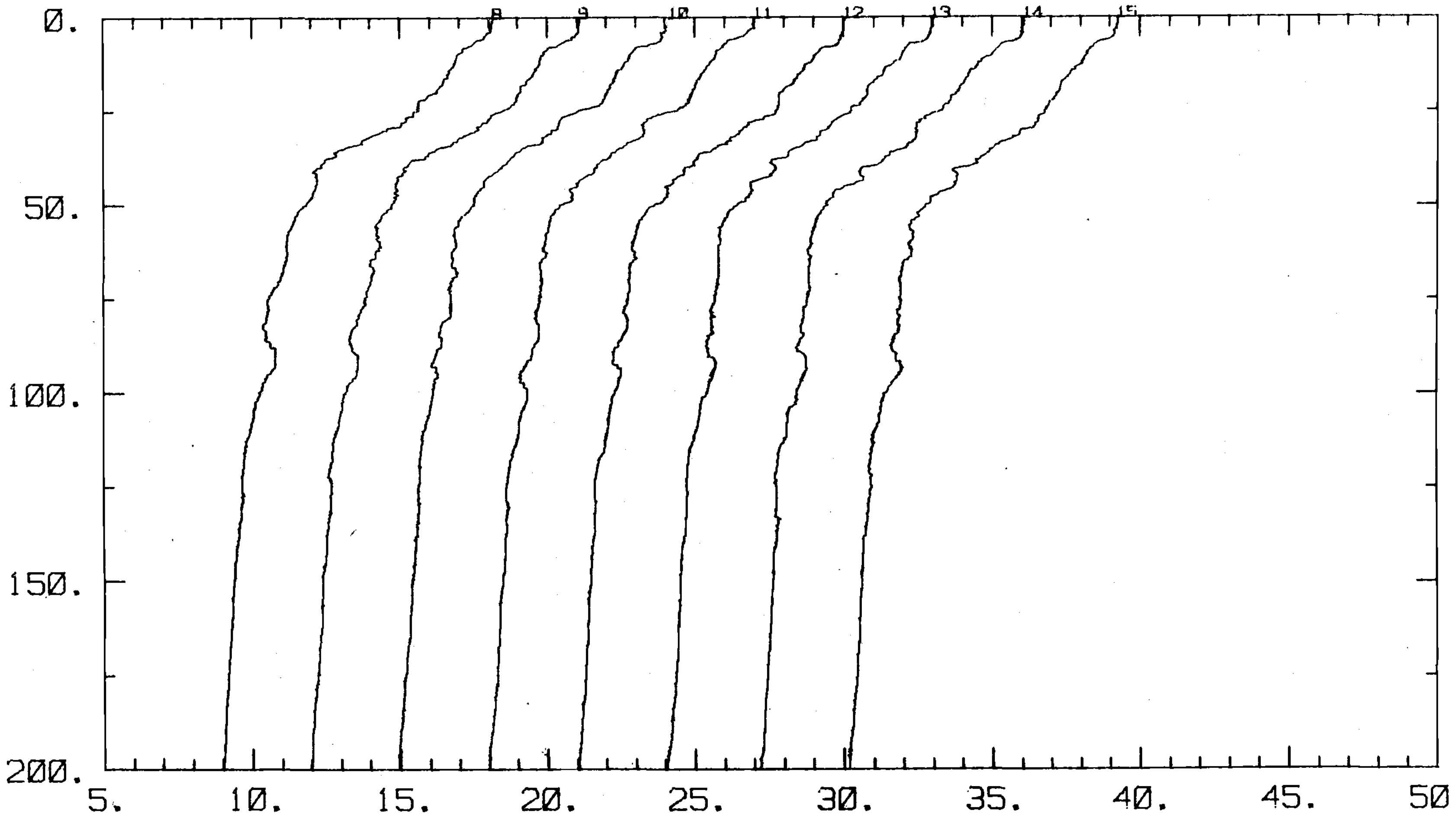
19JL82BN



SEQUENCE 13 PAGE 4

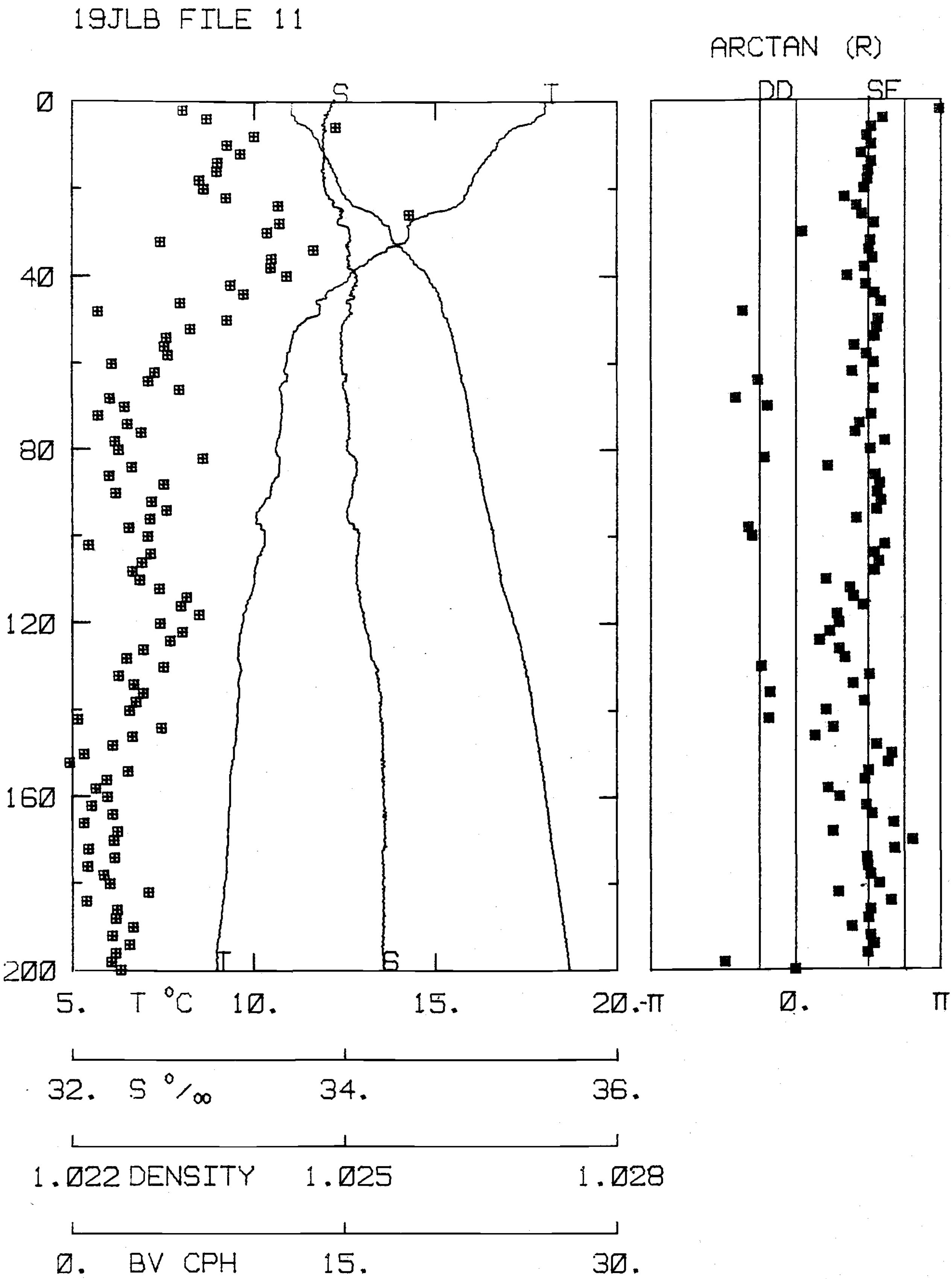
START TIME 02:18 GMT 07/19/82

LOCATION 39°35'N 152°35'W

WIND SPEED 5. m/s

DIRECTION 030°

Profile spacing 900m


19JLB FILE 11
ARCTAN (R)
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SF
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0
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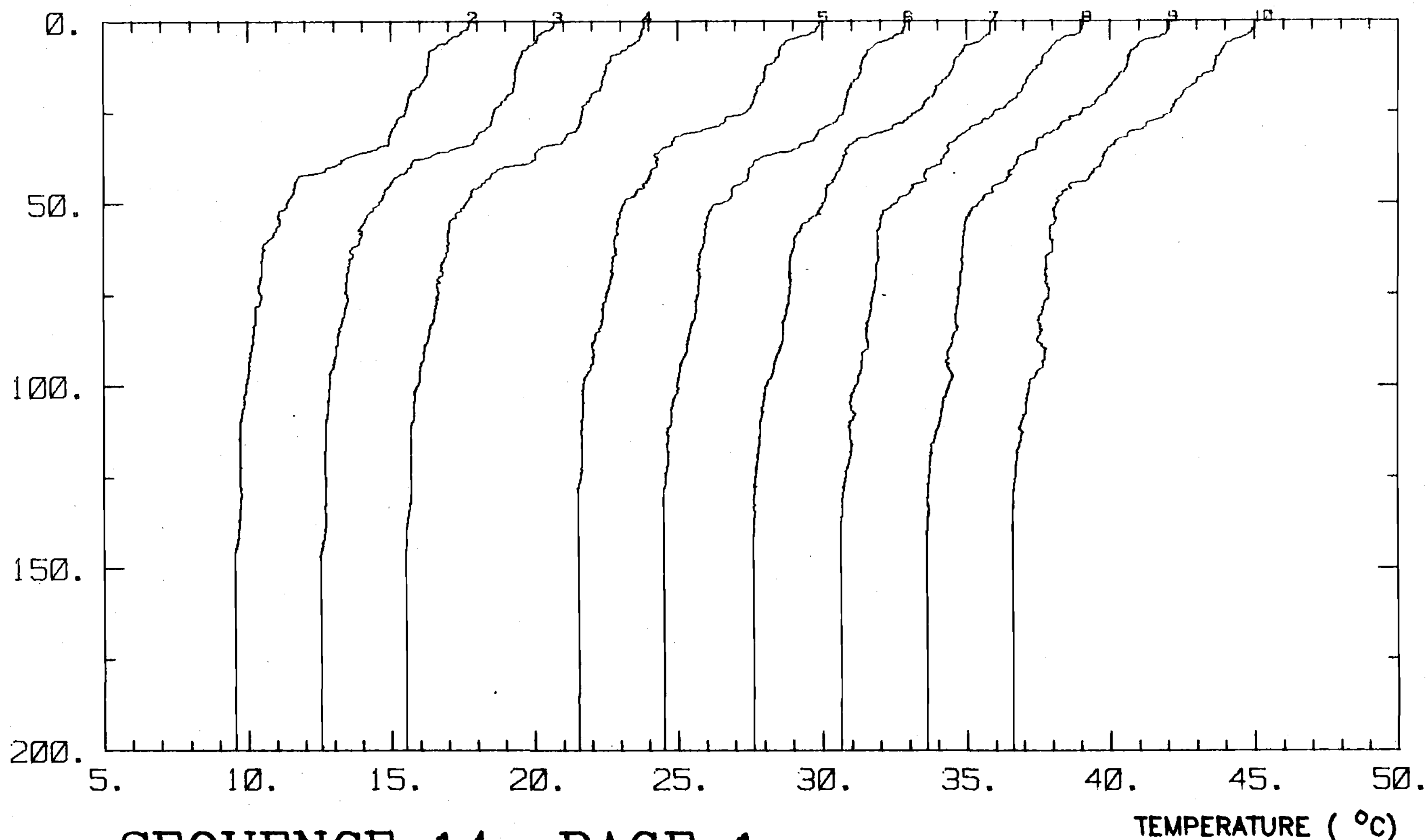
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

19JL82CM



134

SEQUENCE 14 PAGE 1

START TIME 04:15 GMT 07/19/82

LOCATION 39°36'N 152°34'W

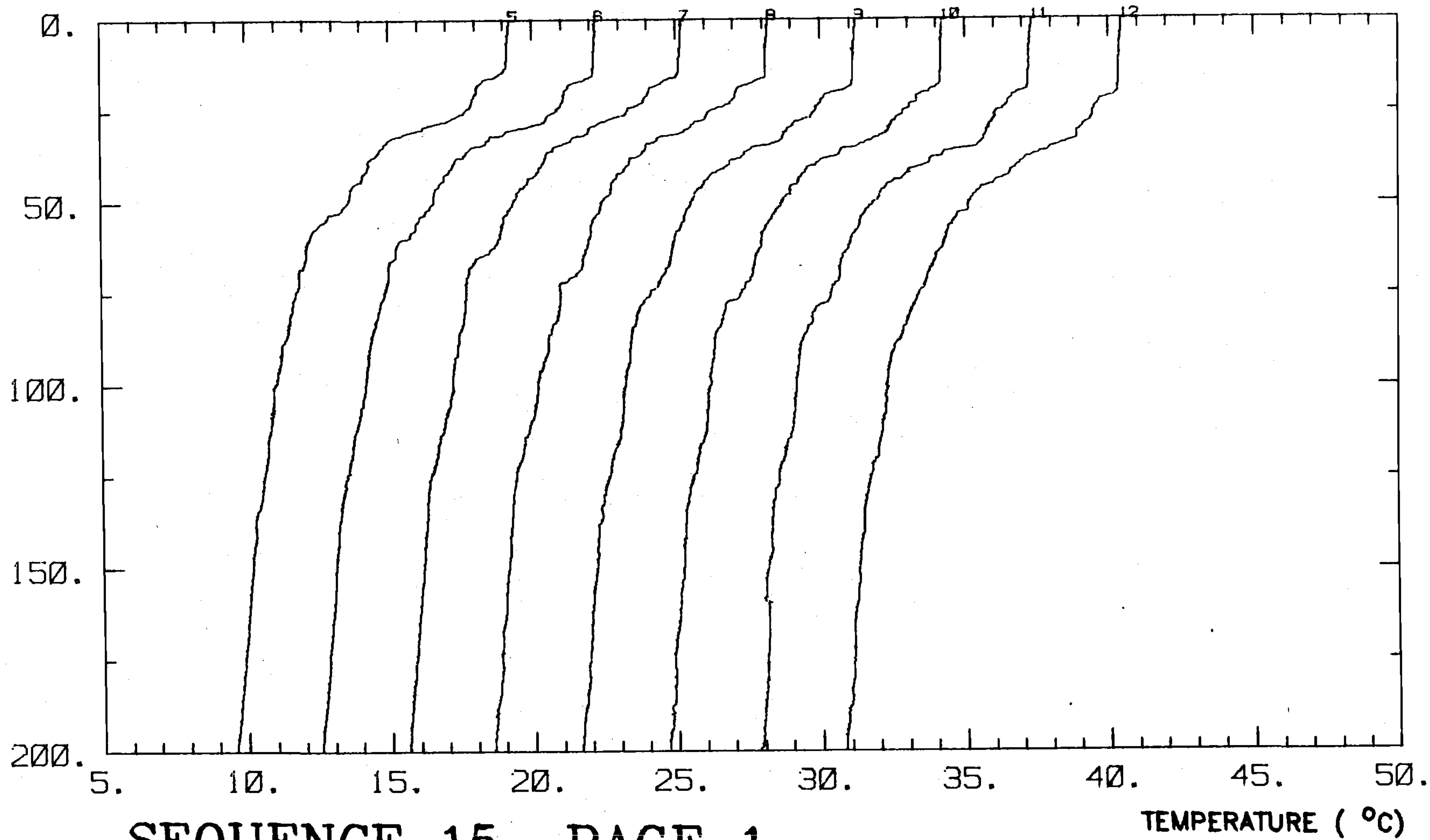
Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 030°

Ship's heading 190°

19JL82DN



SEQUENCE 15 PAGE 1

START TIME 23:12 GMT 07/19/82

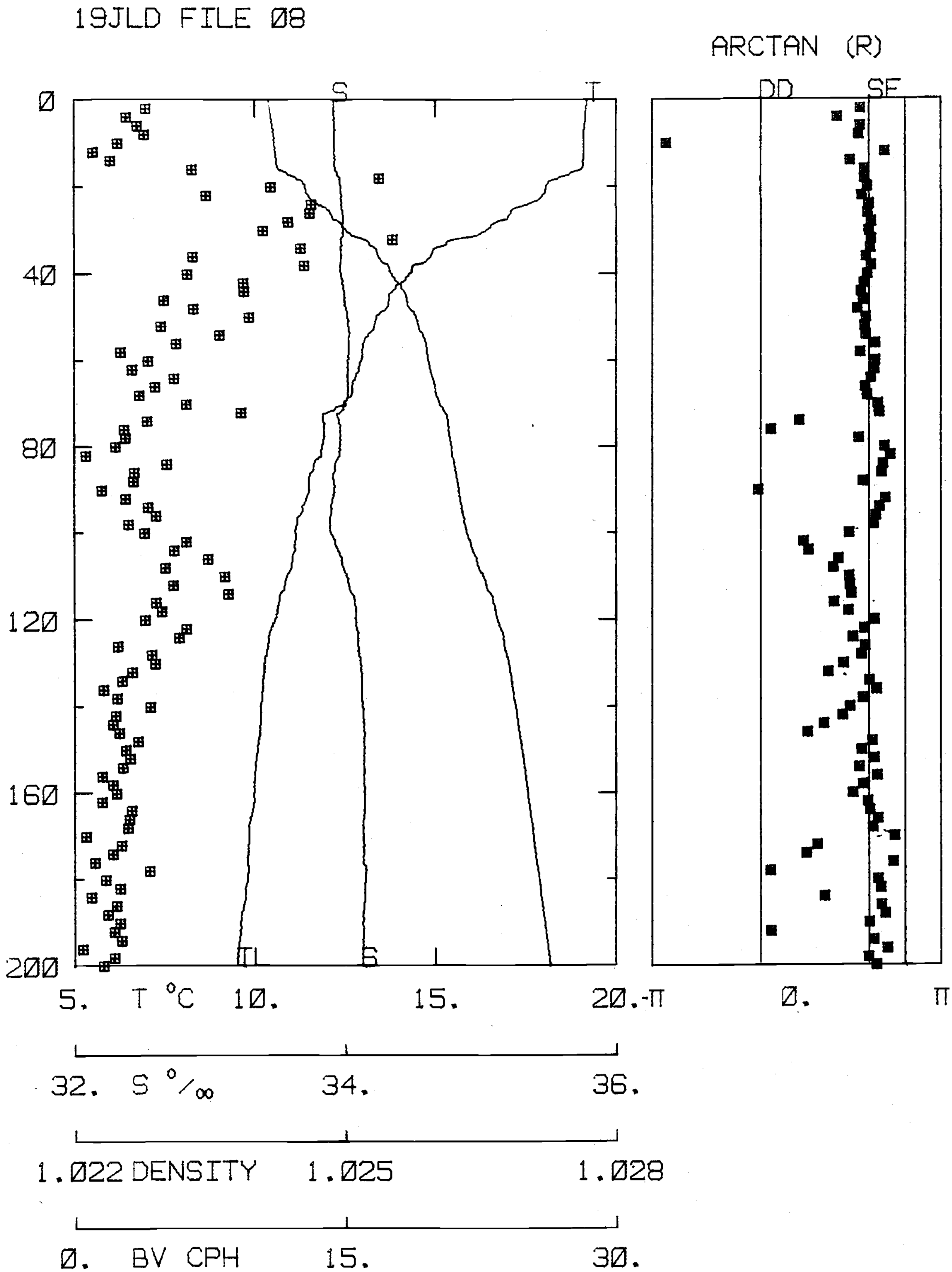
LOCATION 38°08'N 152°02'W

Profile spacing 900m

WIND SPEED 7. m/s

DIRECTION 070°

Ship's heading 190°


19JLD FILE Ø8
ARCTAN (R)
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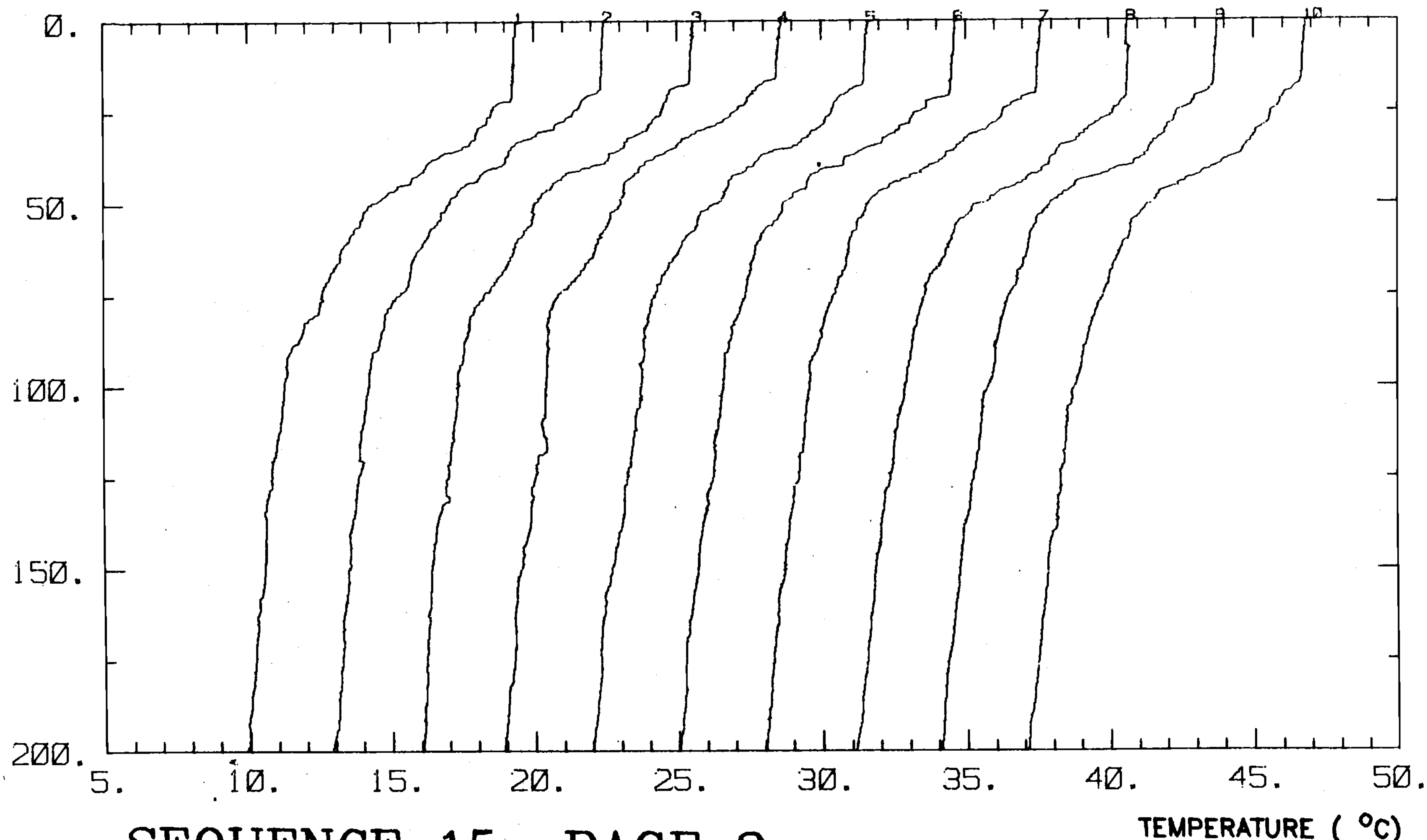
5. T °C 1Ø. 15. 2Ø.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

20ØJL82AN



SEQUENCE 15 PAGE 2

START TIME 00:00 GMT 07/20/82

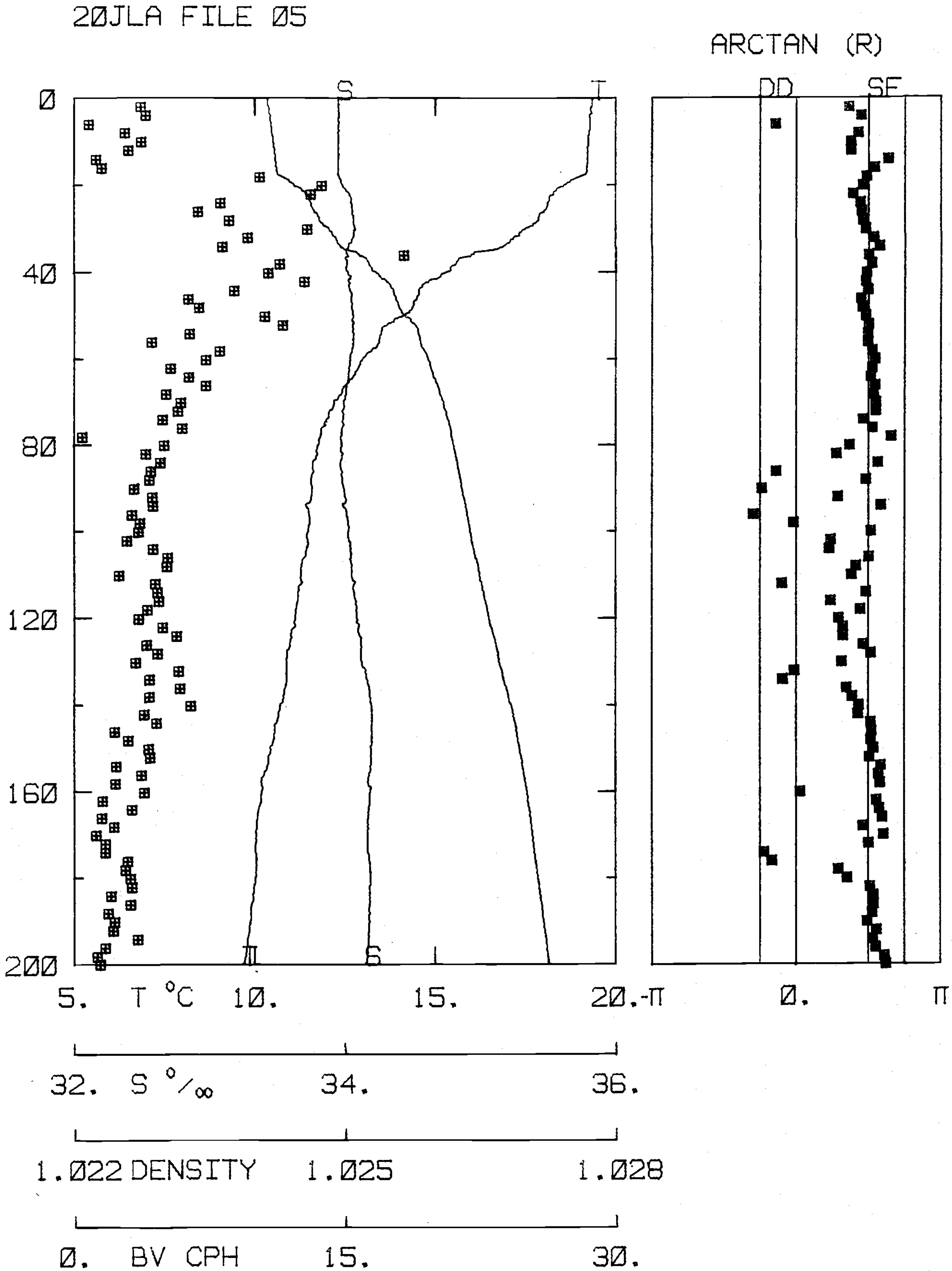
LOCATION 38°03'N 153°05'W

Profile spacing 900m

WIND SPEED 7. m/s

DIRECTION 070°

Ship's heading 190.°


20JLA FILE 05
ARCTAN (R)
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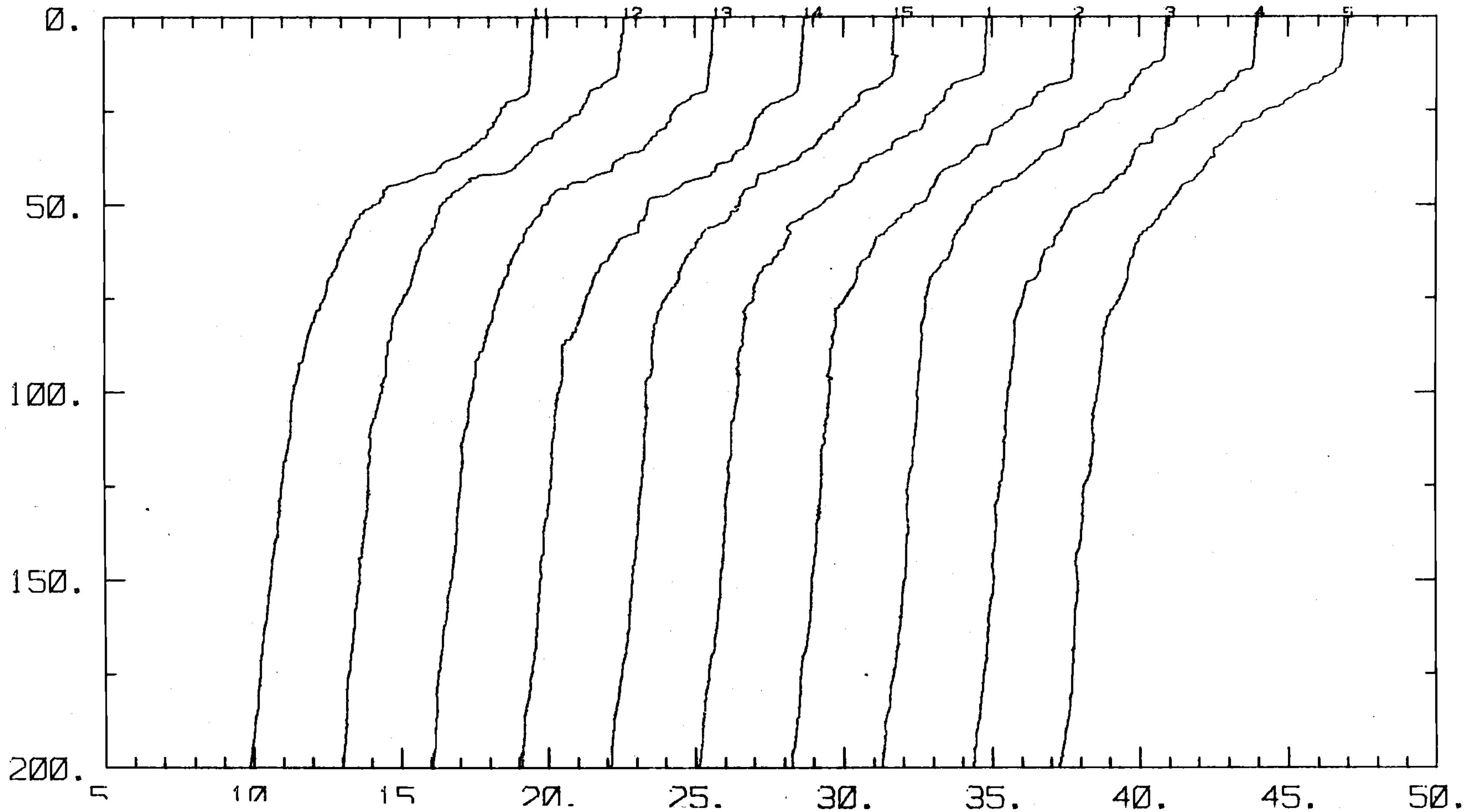
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

20ØJL82AN , 20ØJL82BN



140

SEQUENCE 15 PAGE 3

START TIME 01:00 GMT 07/20/82

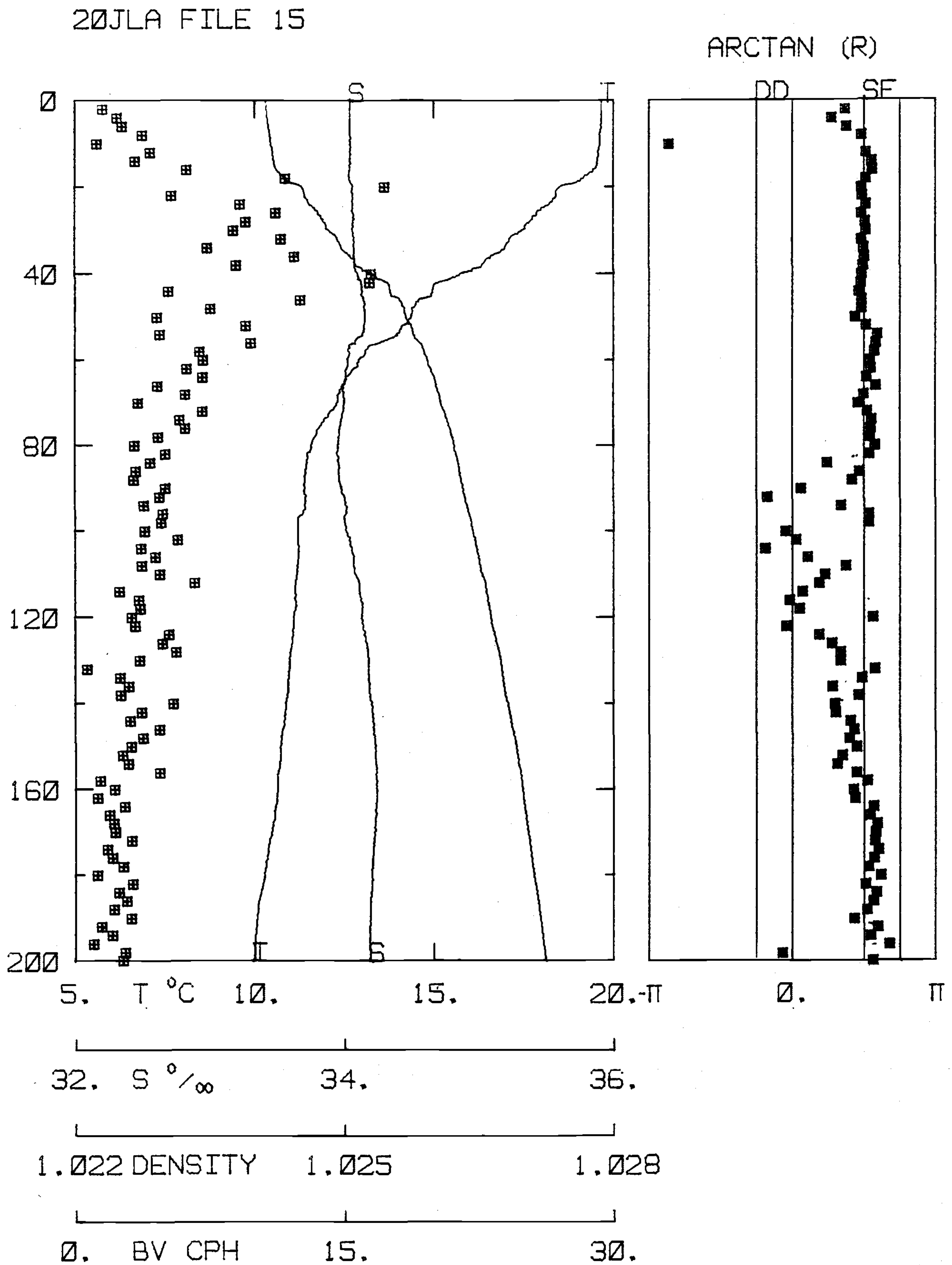
LOCATION 37°58'N 153°06'W

Profile spacing 900m

WIND SPEED 7. m/s

DIRECTION 070°

Ship's heading 190°



20ØJLA FILE 15
ARCTAN (R)
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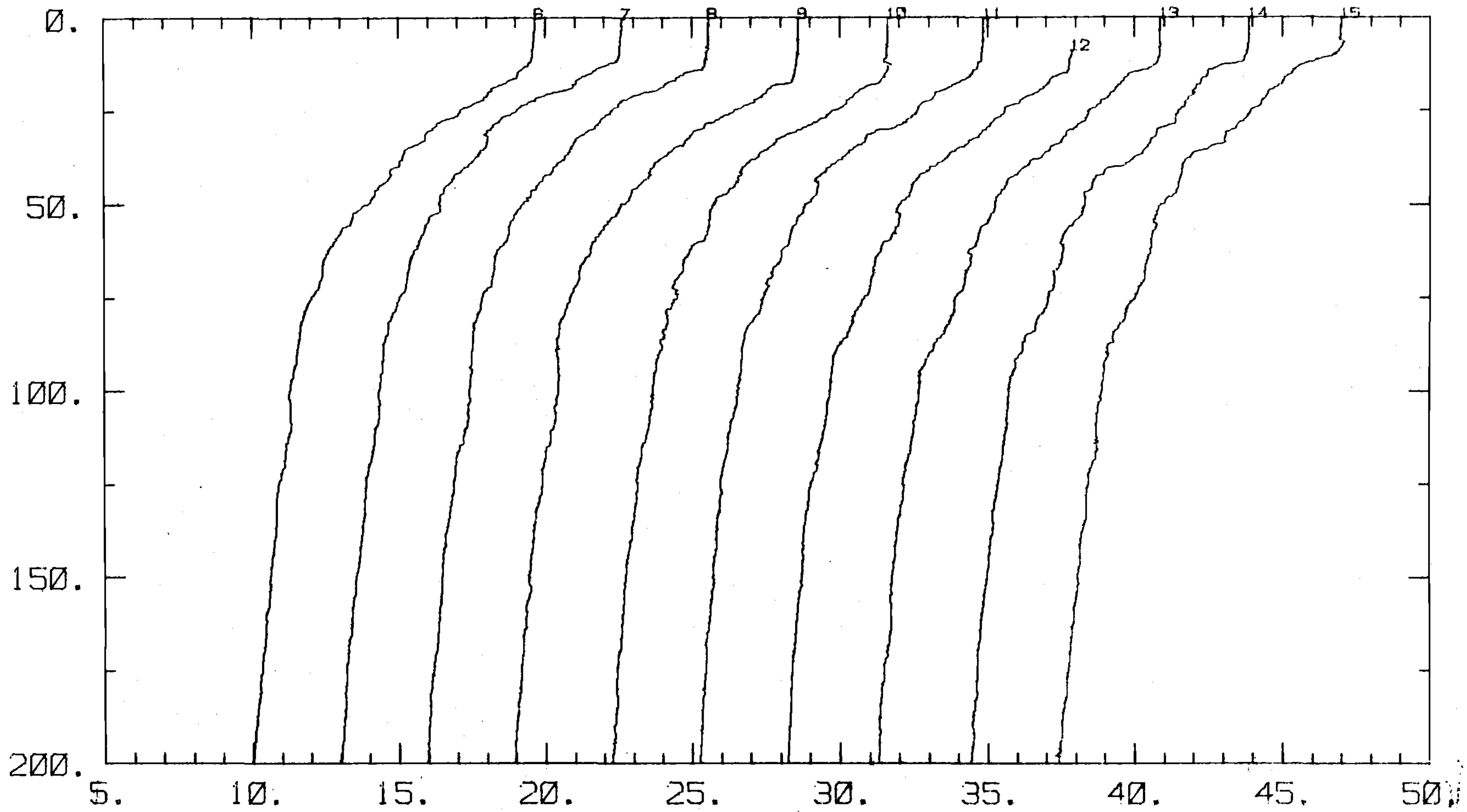
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

20JL82BN



SEQUENCE 15 PAGE 4

START TIME 02:00 GMT 07/20/82

LOCATION 37°53'N 153°07'W

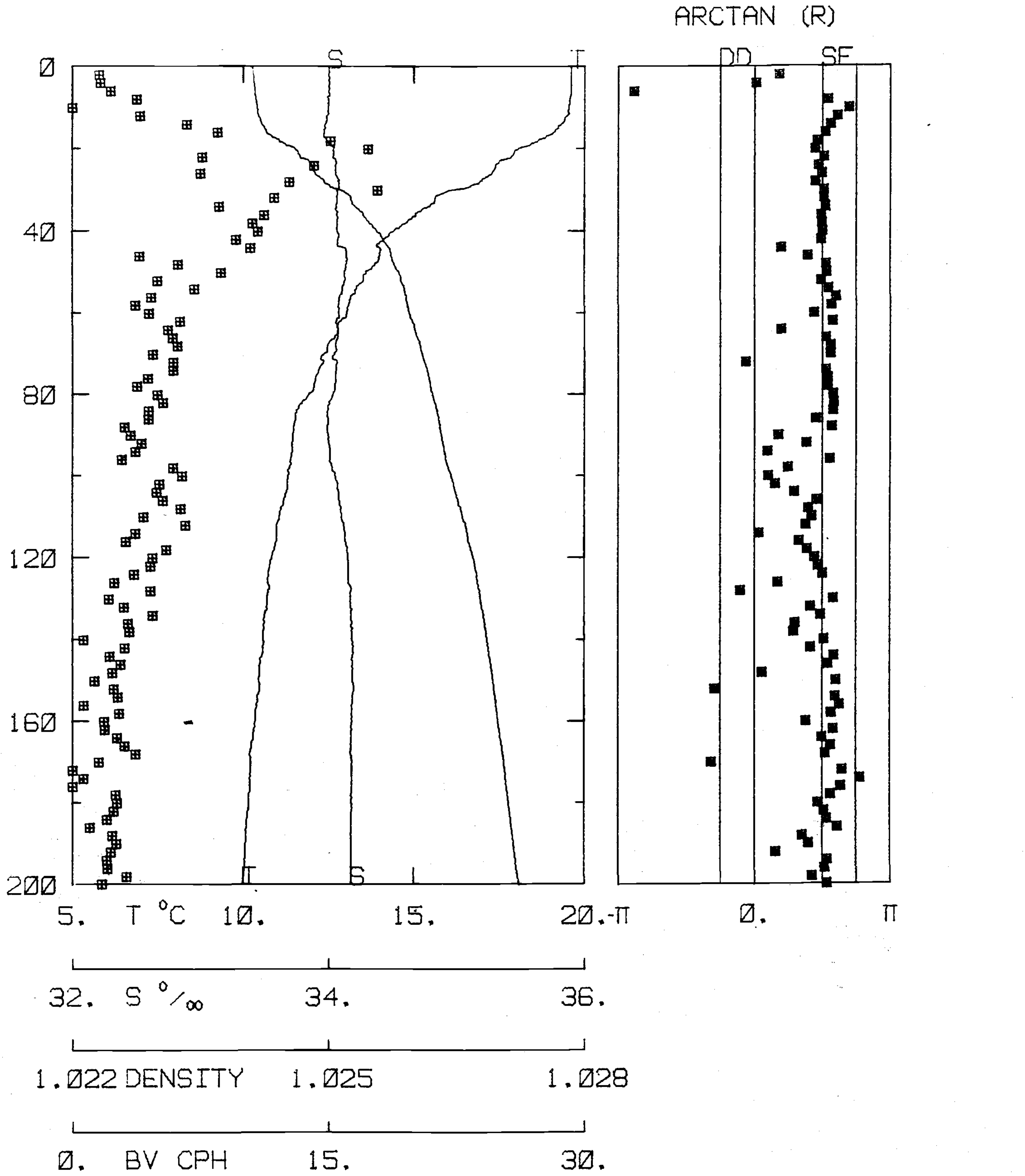
Profile spacing 900m

WIND SPEED 7. m/s

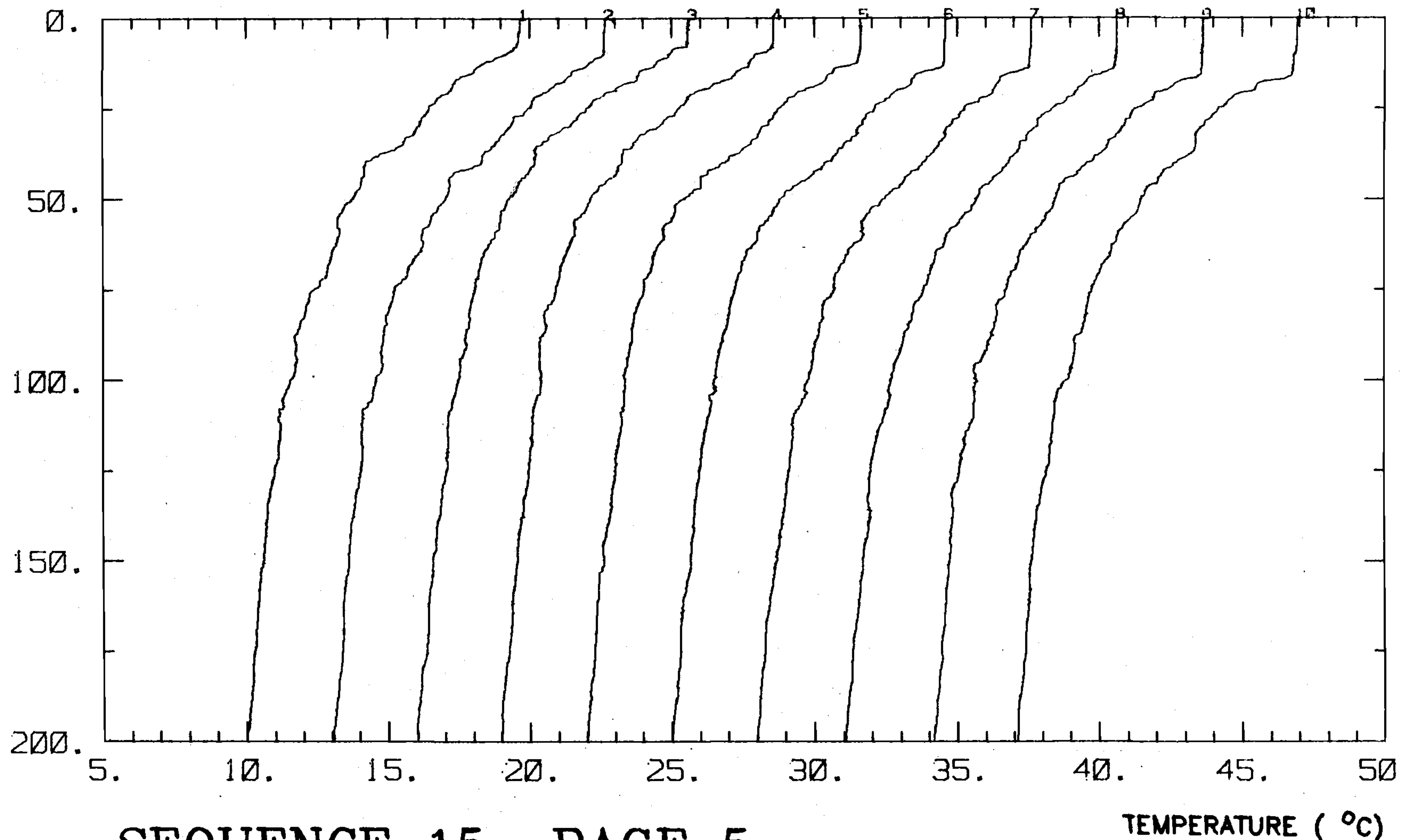
DIRECTION 070°

Ship's heading 190°

2ØJLB FILE 11



20JL82CN



SEQUENCE 15 PAGE 5

START TIME 03:00 GMT 07/20/82

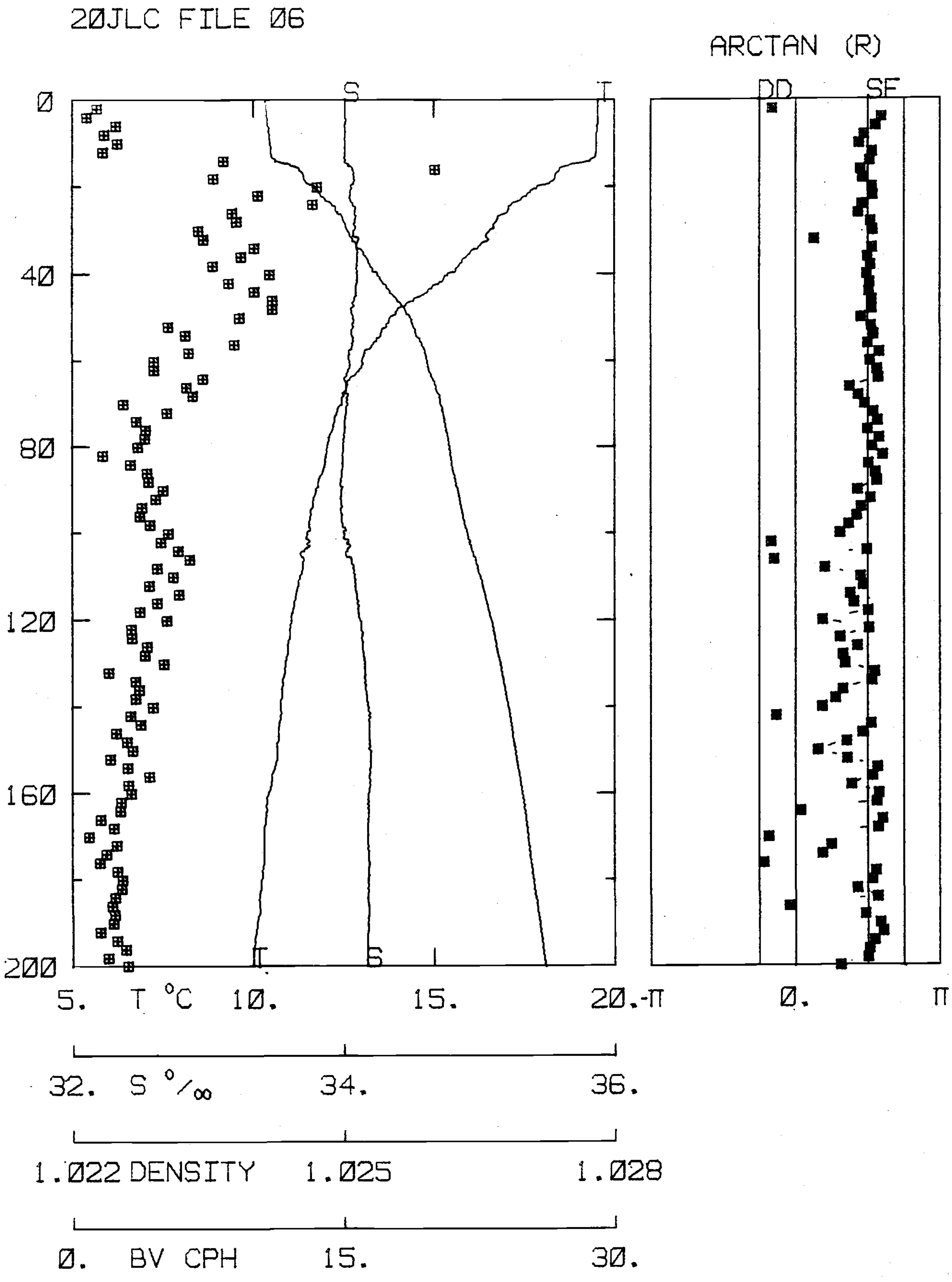
LOCATION 37°48'N 153°07'W

Profile spacing 900m

WIND SPEED 7. m/s

DIRECTION 070°

Ship's heading 190°


20JLC FILE 06
ARCTAN (R)
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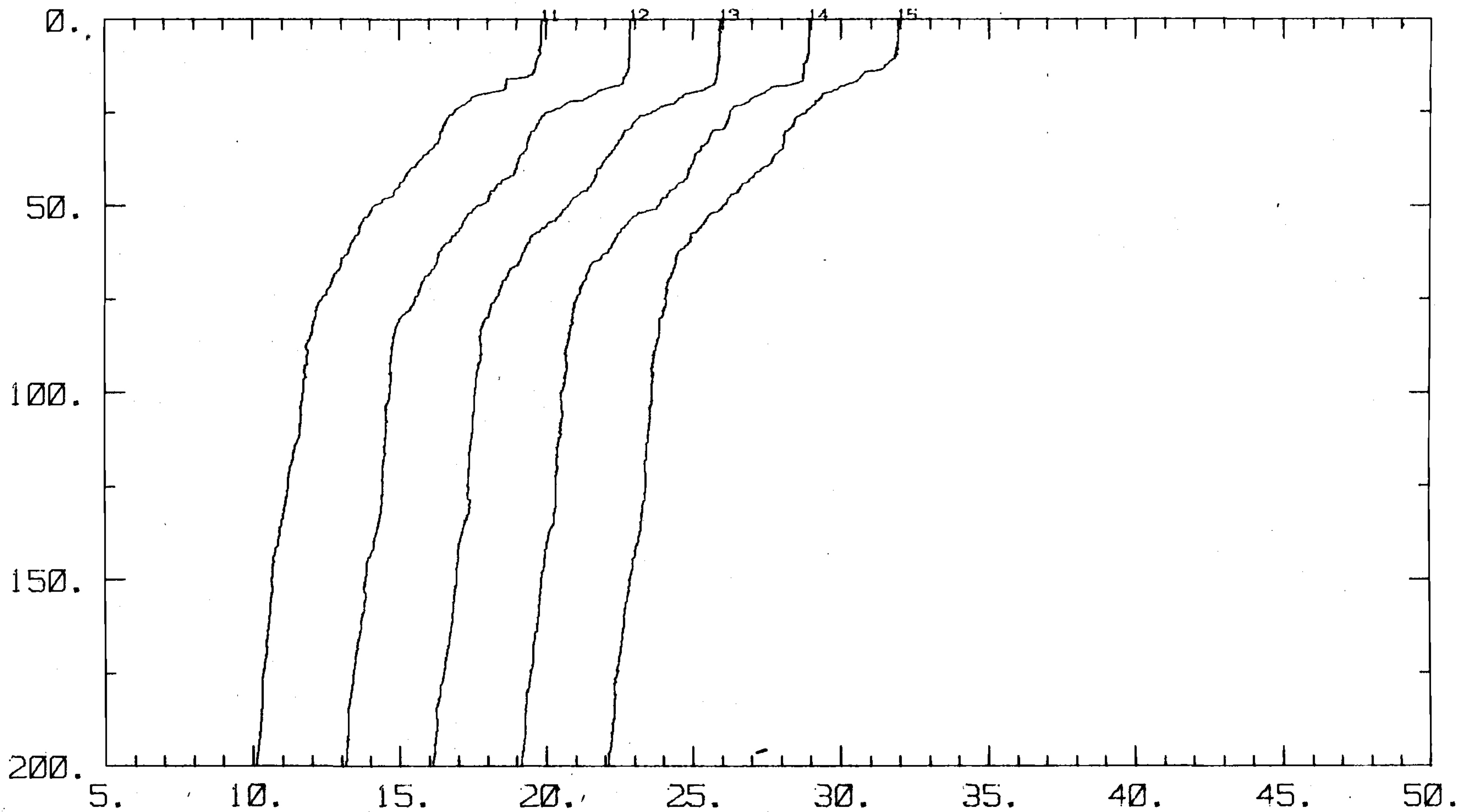
5. T °C 10. 15. 20.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

20JL82CN



146

SEQUENCE 15 PAGE 6

START TIME 04:00 GMT 07/20/82

LOCATION 37°43'N 153°08'W

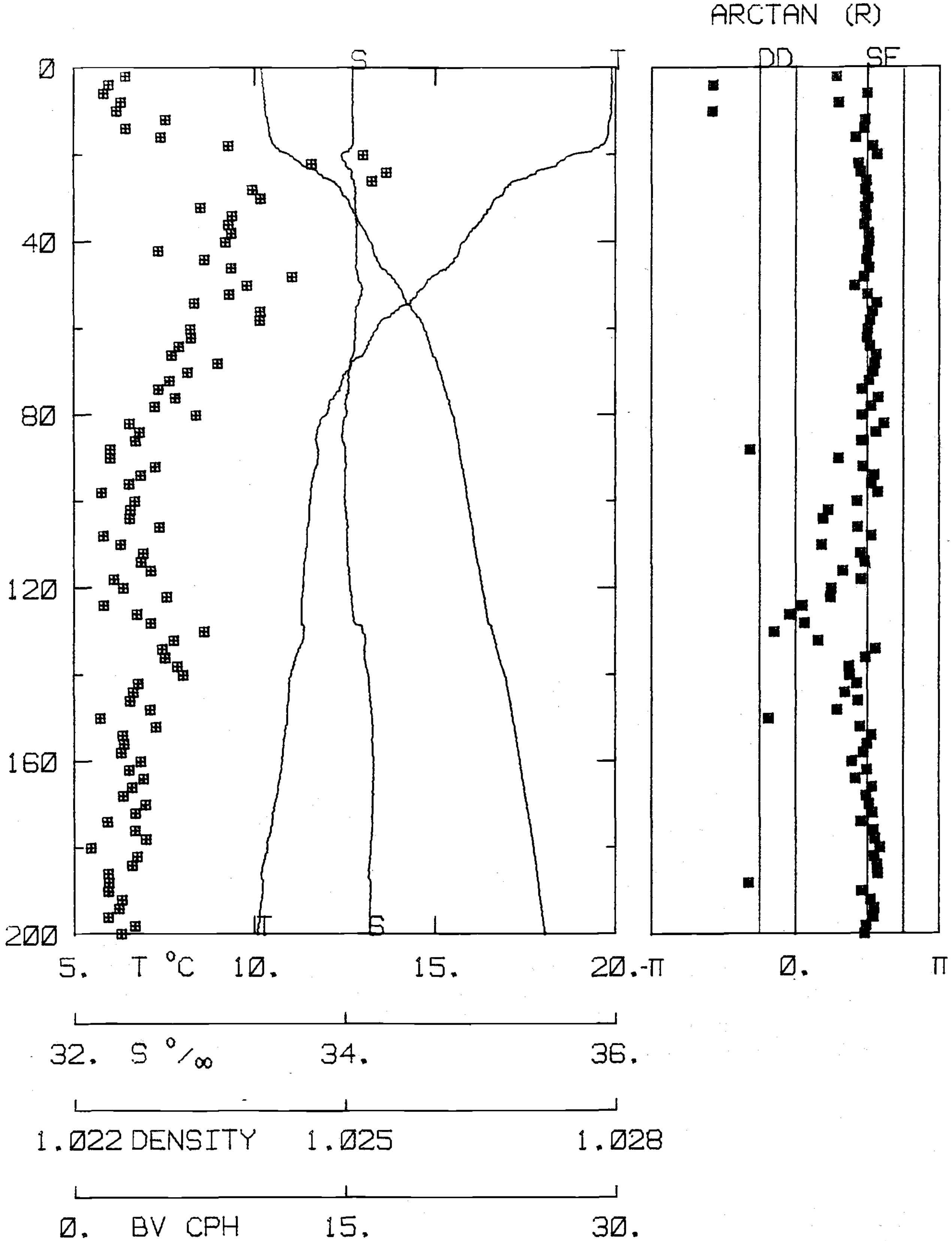
Profile spacing 900m

WIND SPEED 7. m/s

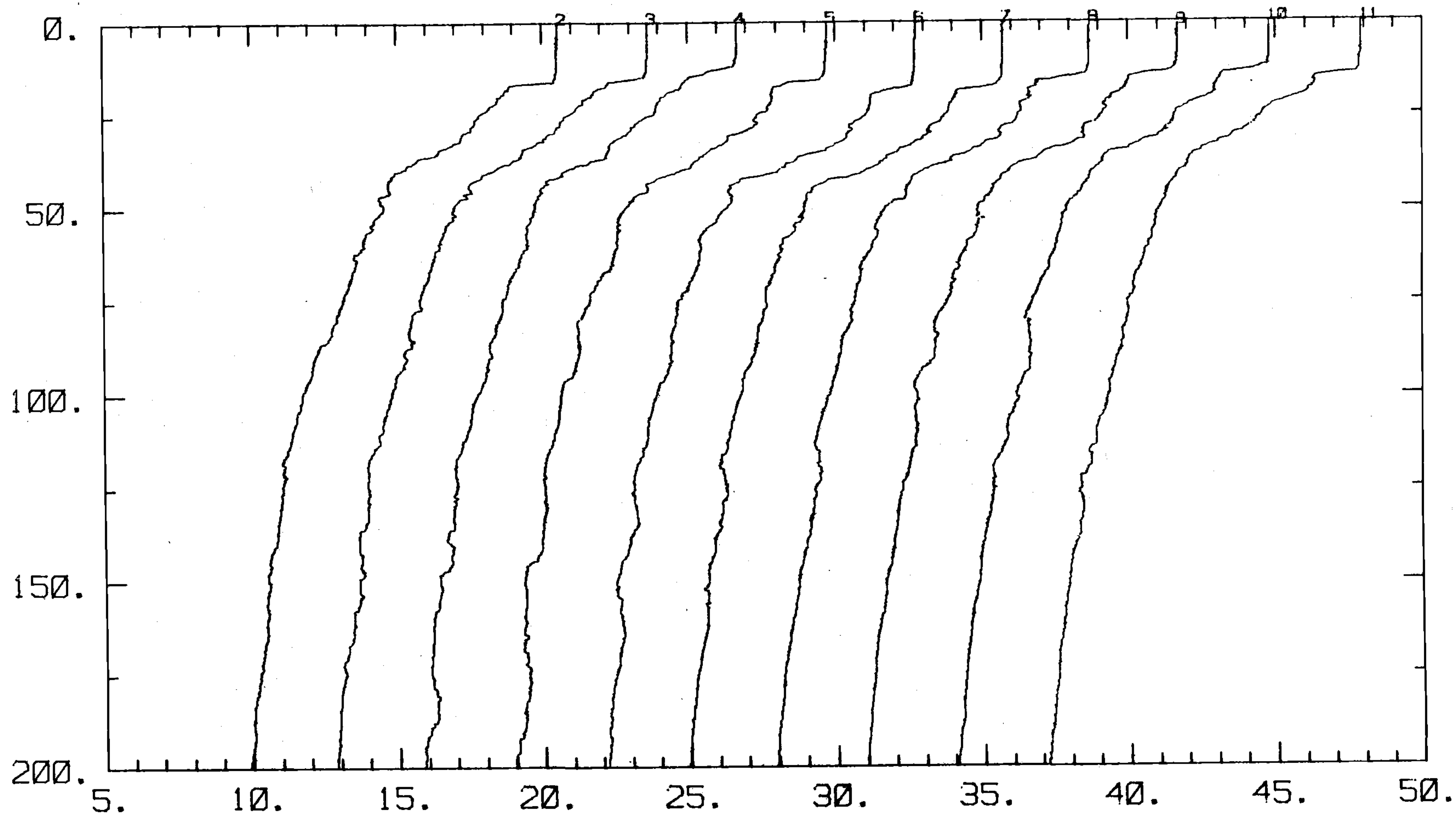
DIRECTION 070°

Ship's heading 190°

20JLC FILE 13



20JL82DN



SEQUENCE 16 PAGE 1

START TIME 22:30 GMT 07/20/82

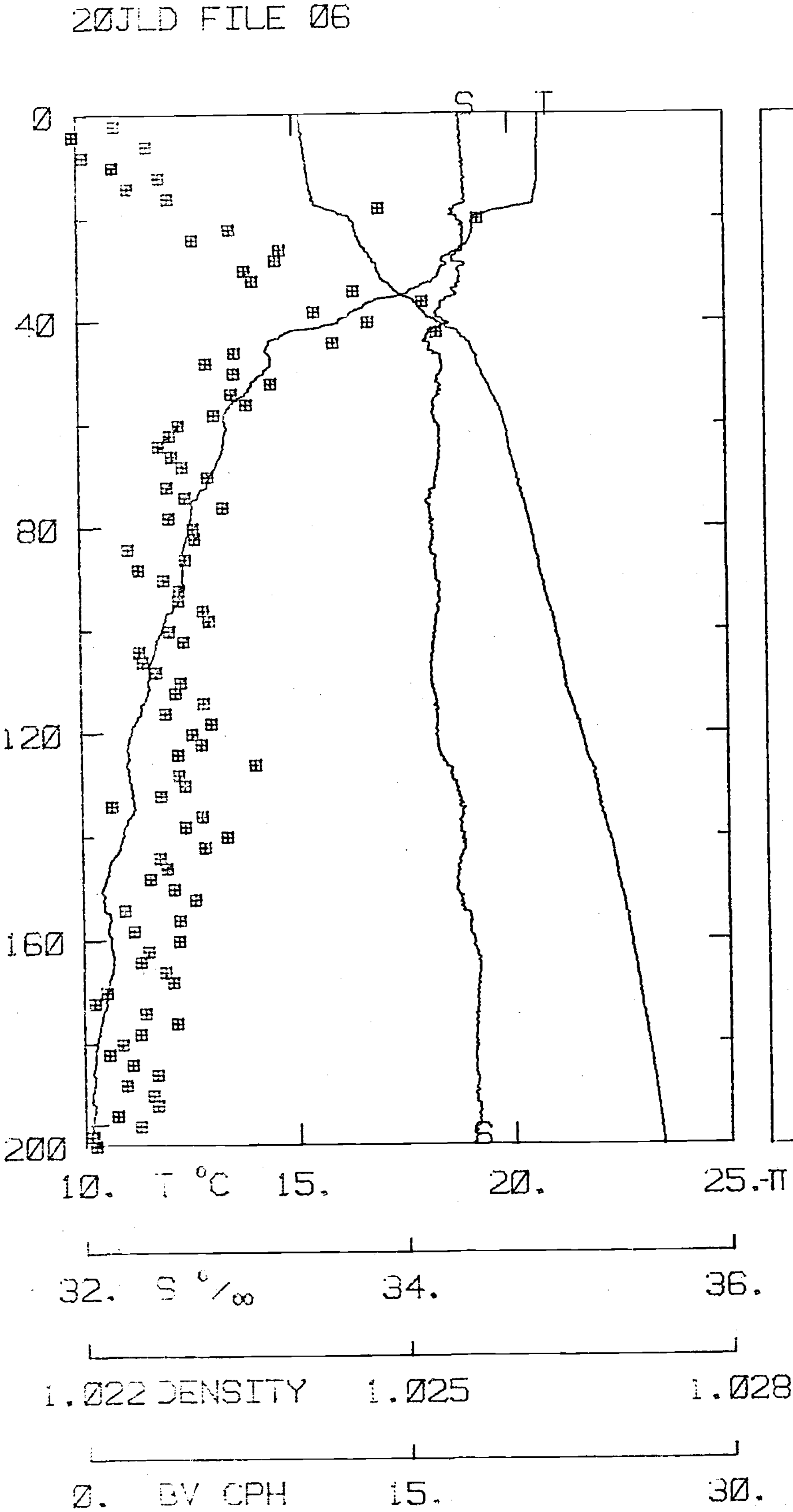
LOCATION 36°09'N 153°35'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°



2ØJLD FILE Ø6
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1.Ø22 DENSITY
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BV CPH
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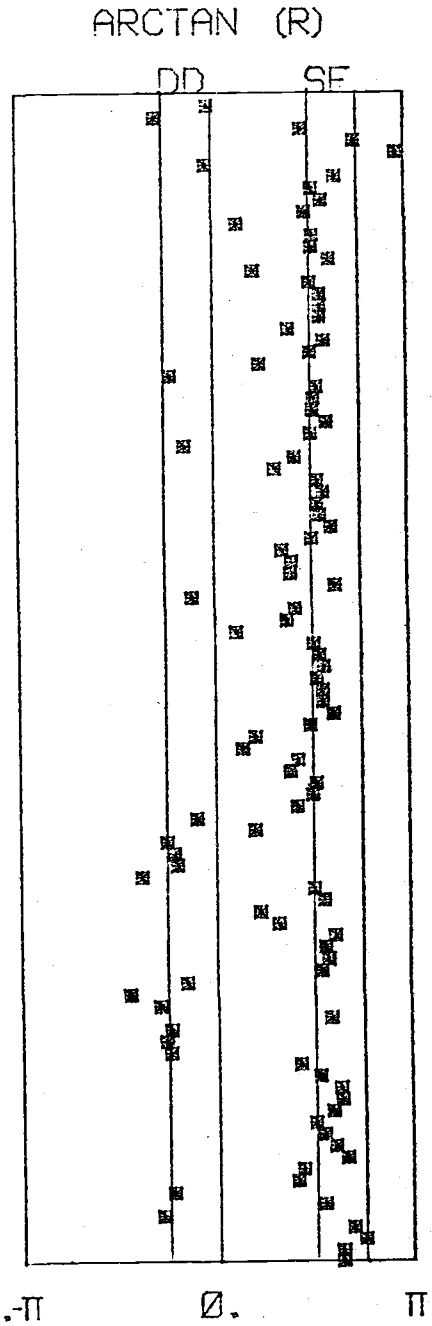

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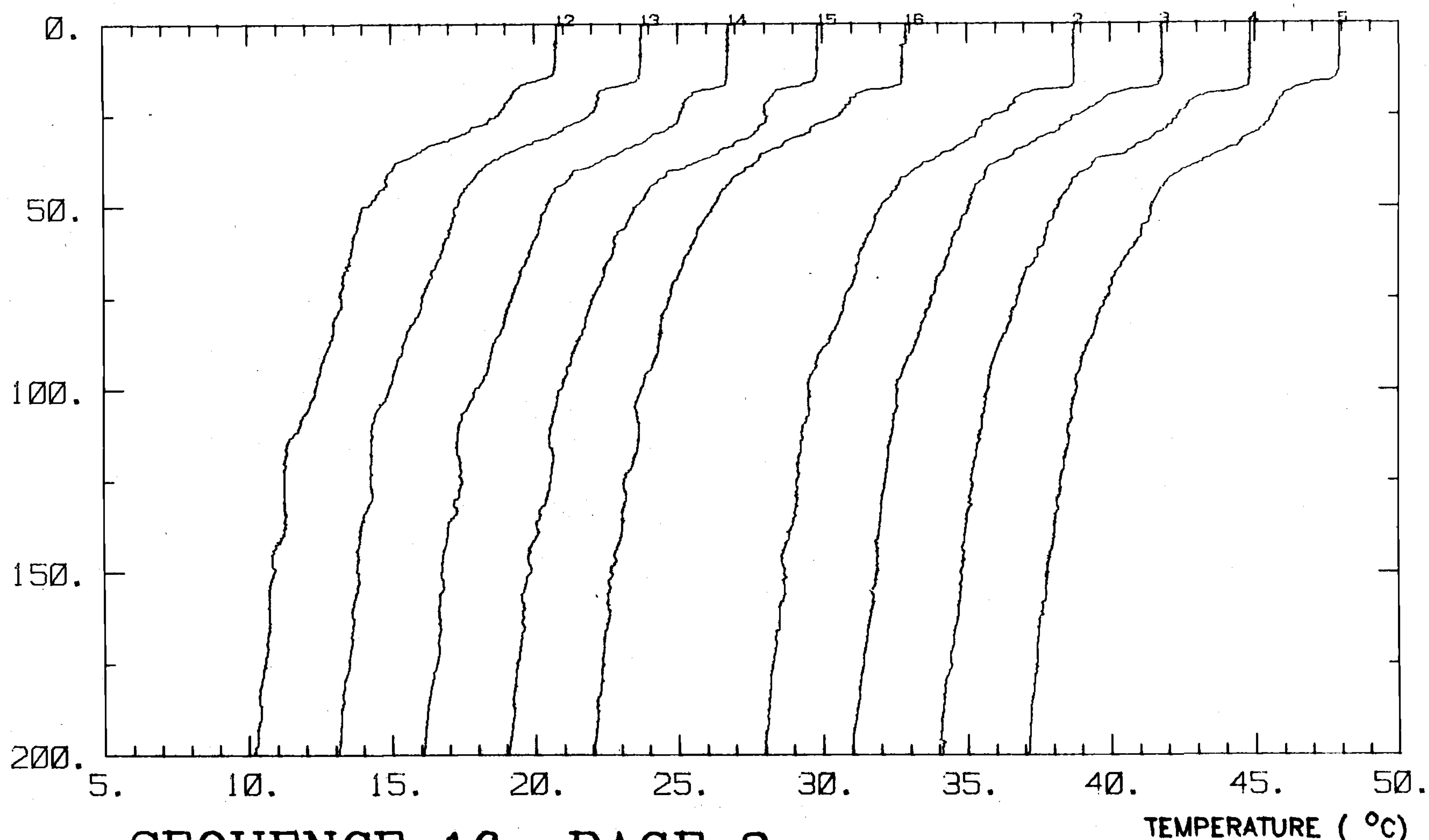
20JL82DN , 21JL82AN



SEQUENCE 16 PAGE 2

START TIME 23:30 GMT 07/20/82

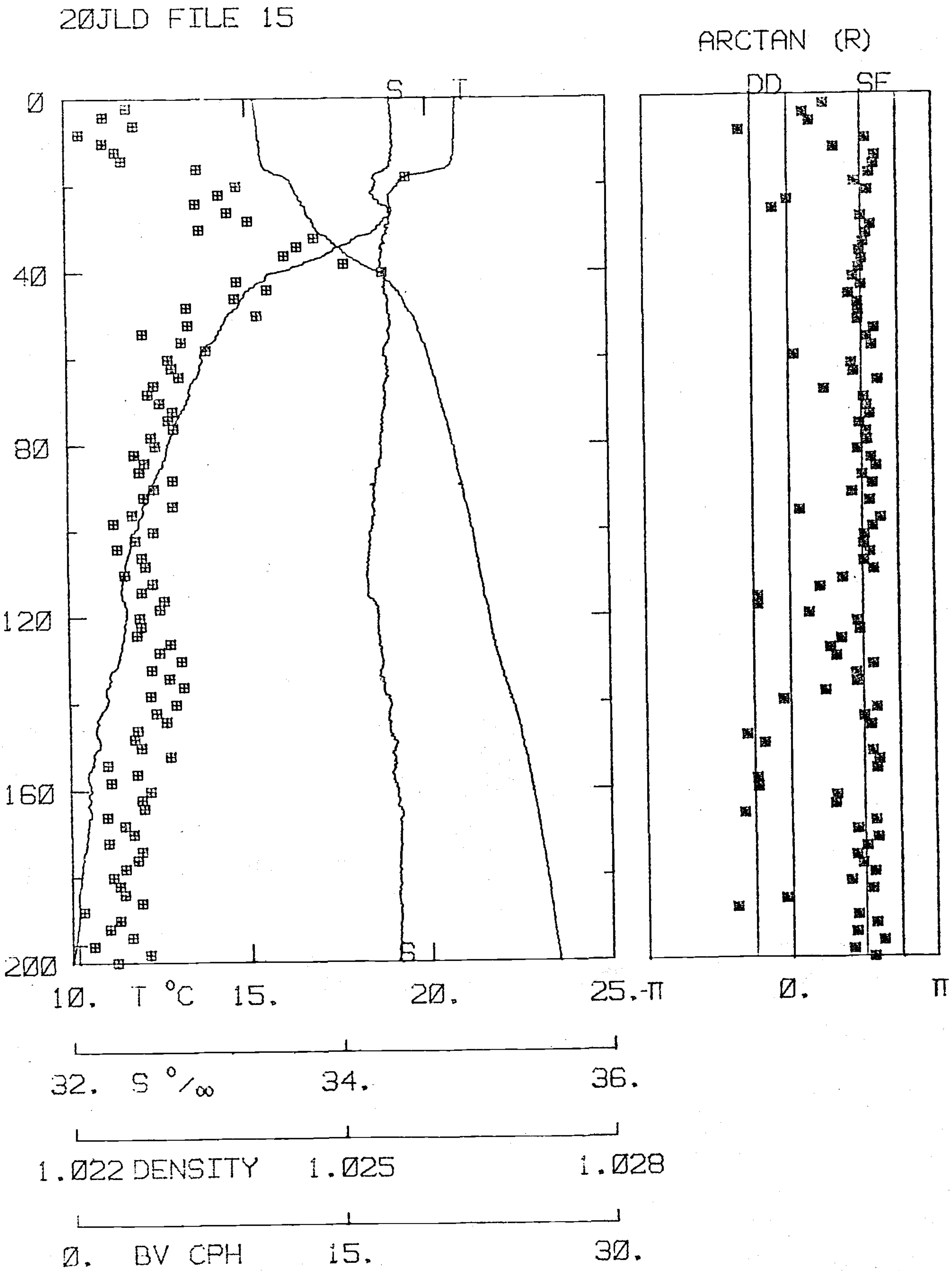
LOCATION 36°06'N 153°38'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°


20JLD FILE 15
ARCTAN (R)
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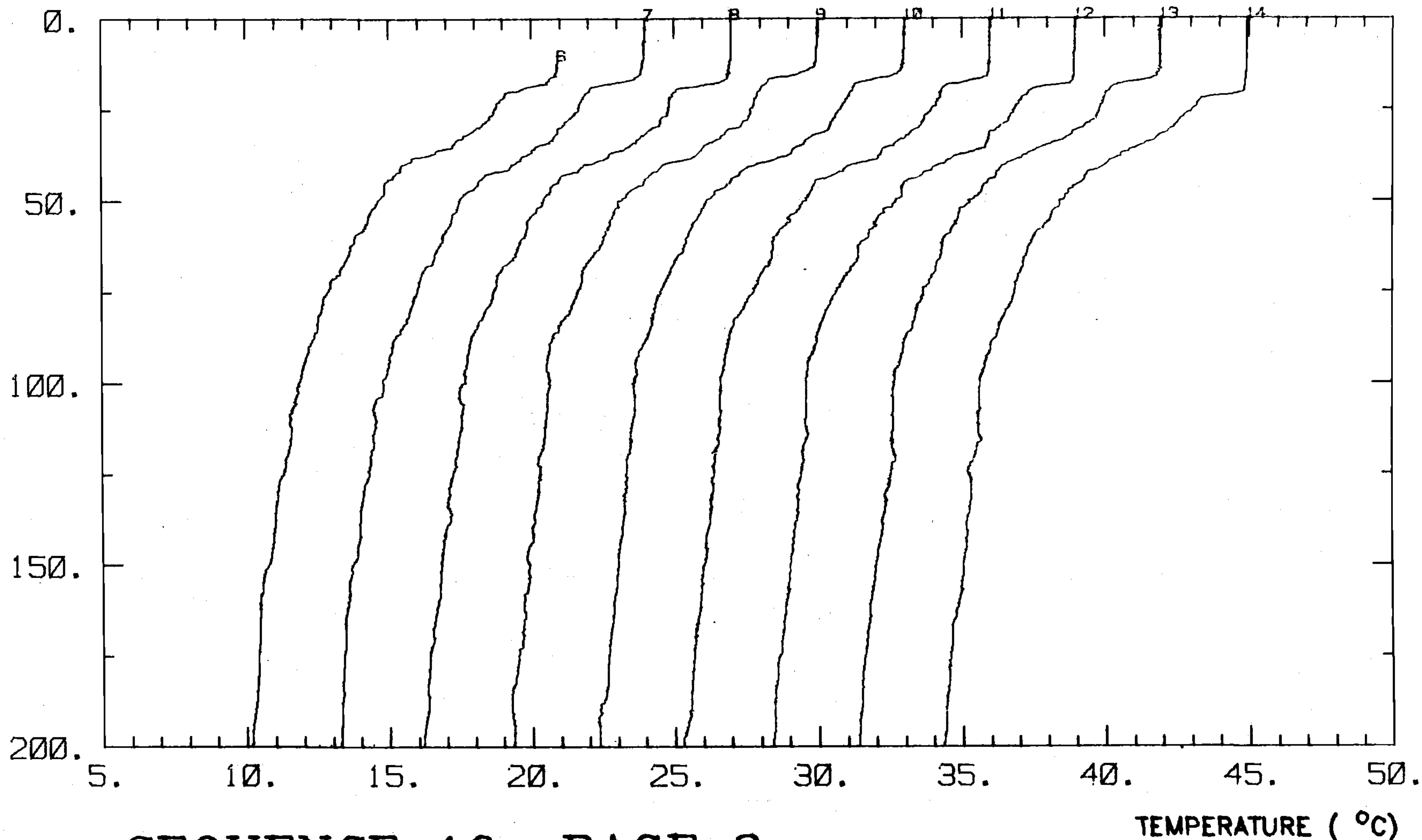
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

21JL82AN



152

SEQUENCE 16 PAGE 3

START TIME 00:30 GMT 07/21/82

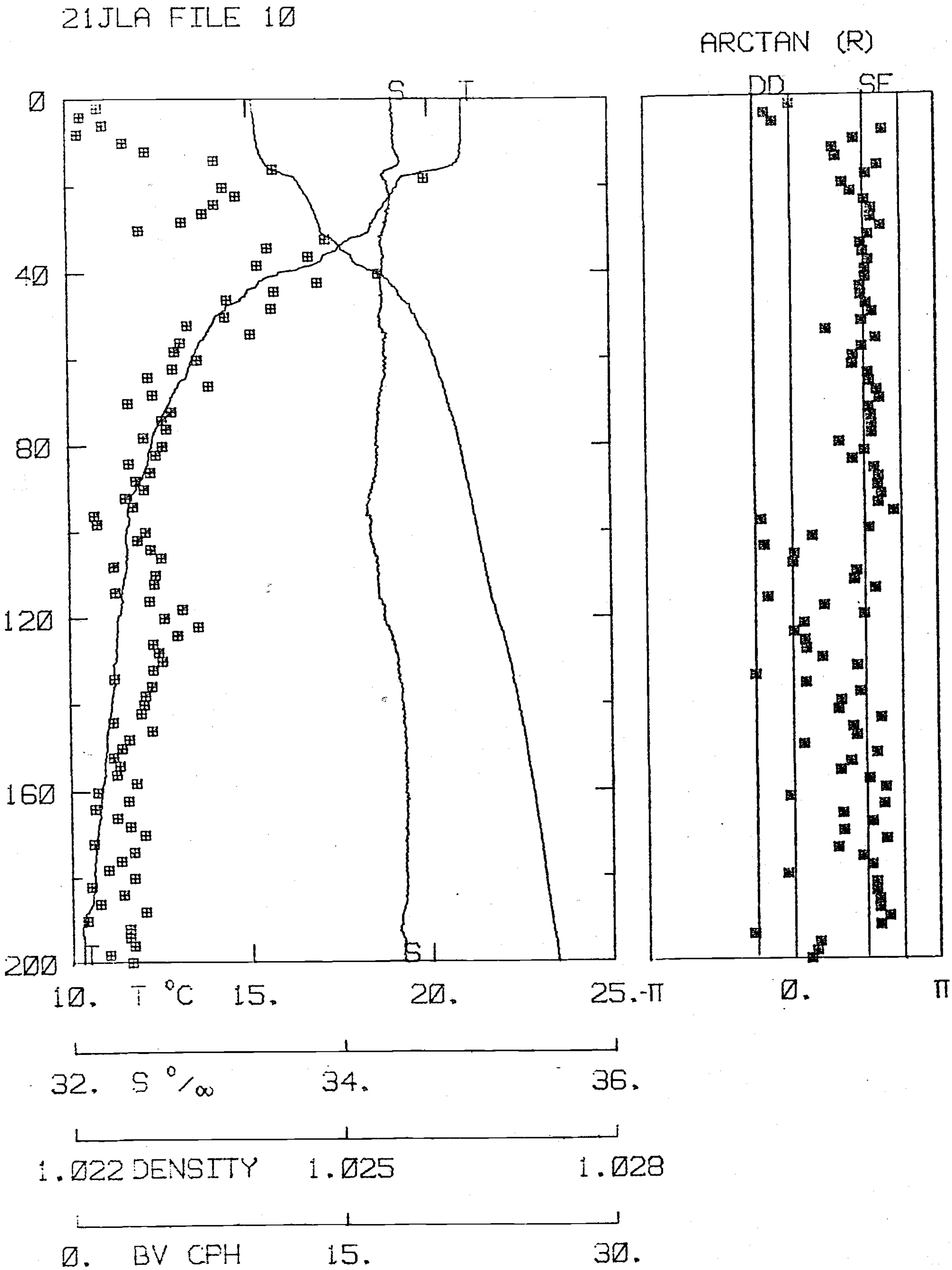
LOCATION 36°03'N 153°39'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°


21JLA FILE 10
ARCTAN (R)
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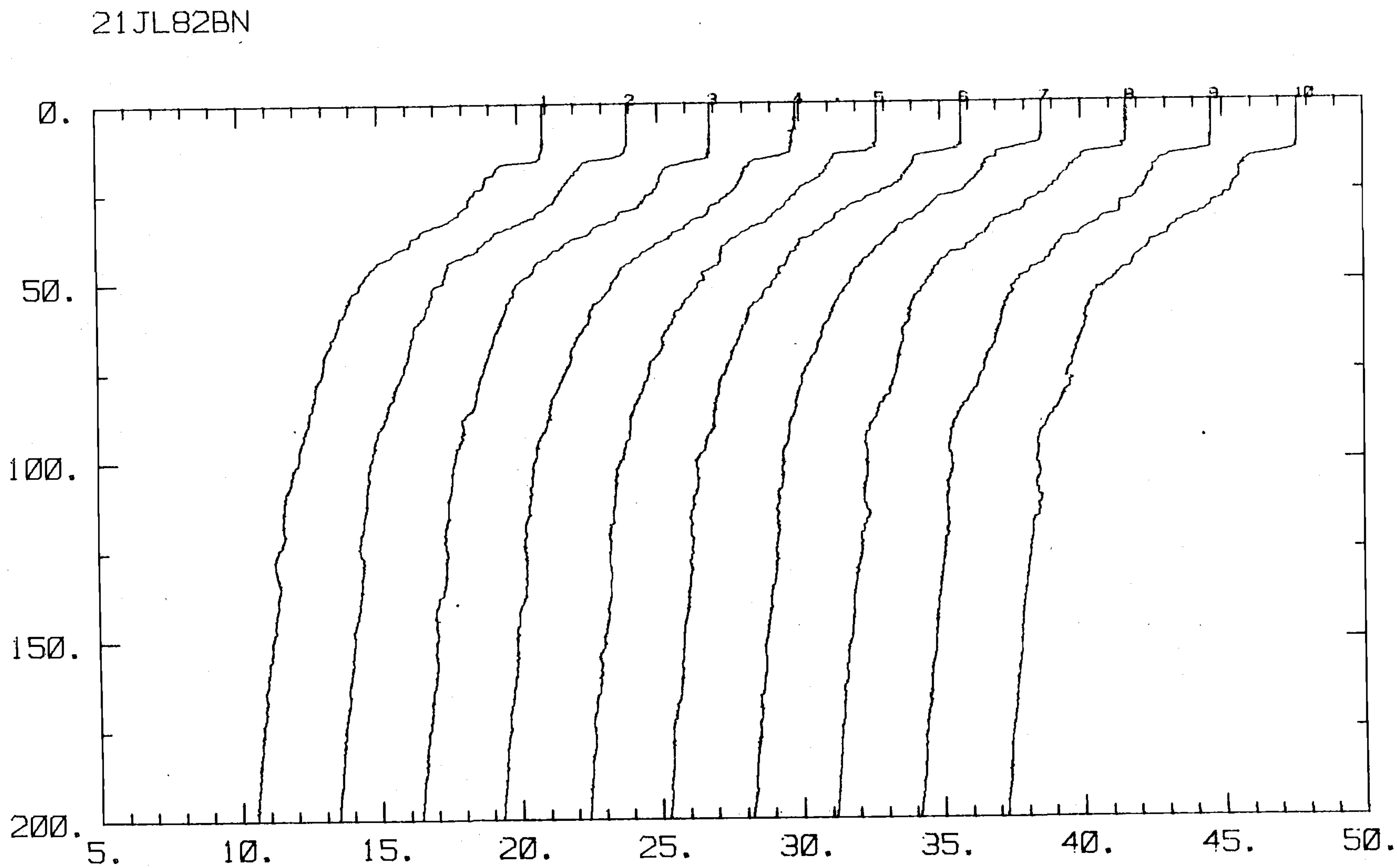
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.



SEQUENCE 16 PAGE 4

START TIME 01:30 GMT 07/21/82

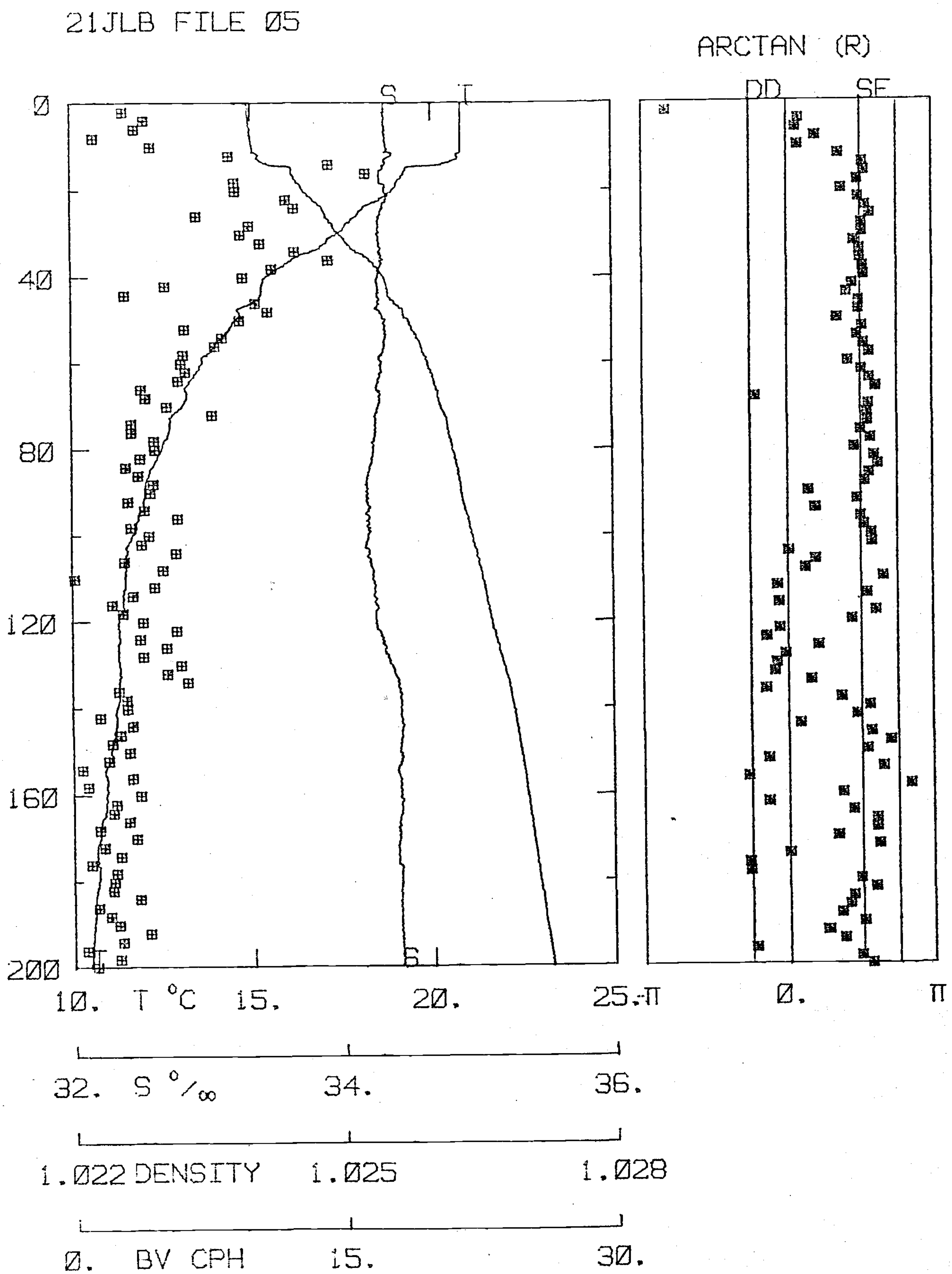
LOCATION 35°59'N 153°40'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°


21JLB FILE Ø5
ARCTAN (R)
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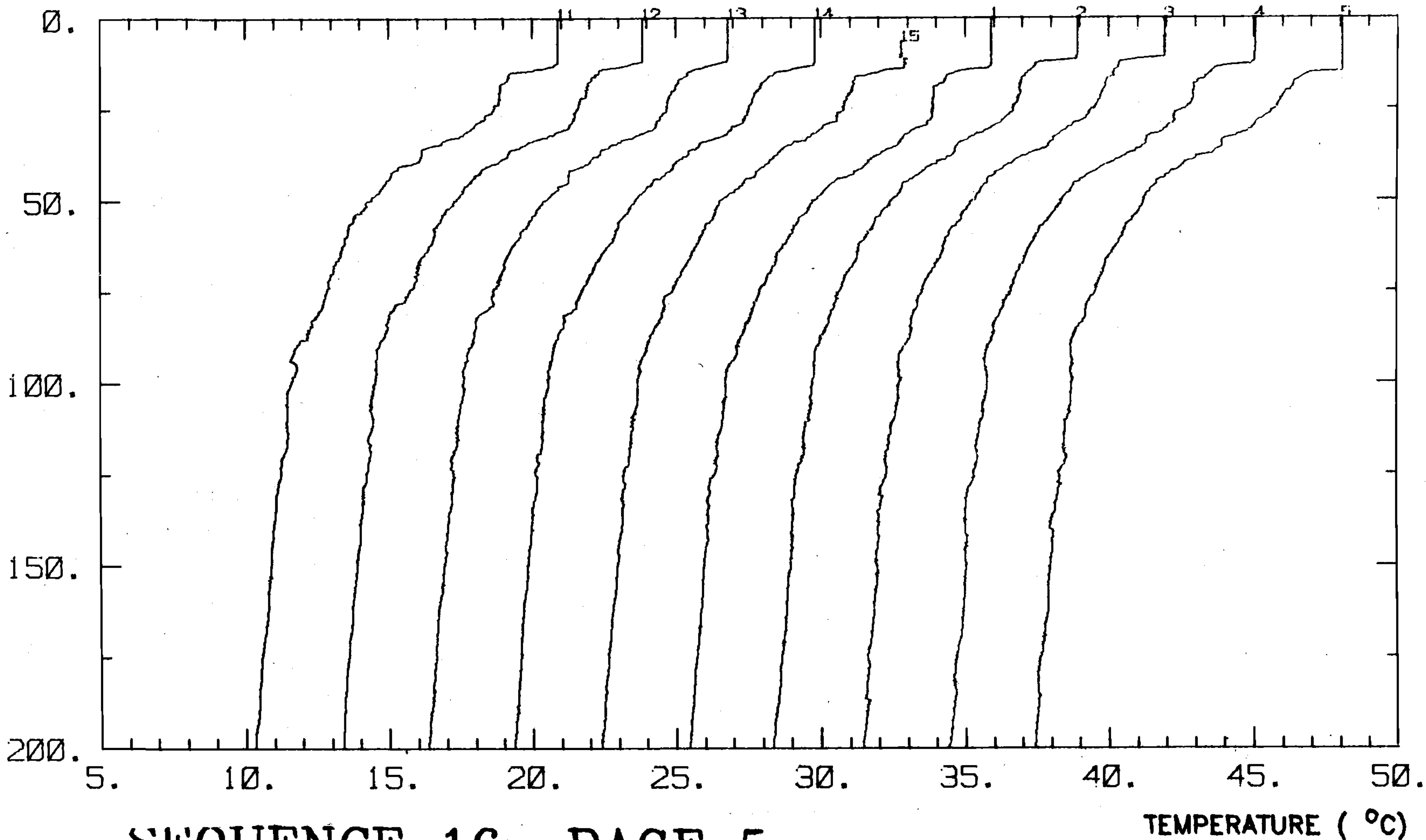
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

21JL82BN , 21JL82CN



SEQUENCE 16 PAGE 5

START TIME 02:30 GMT 07/21/82

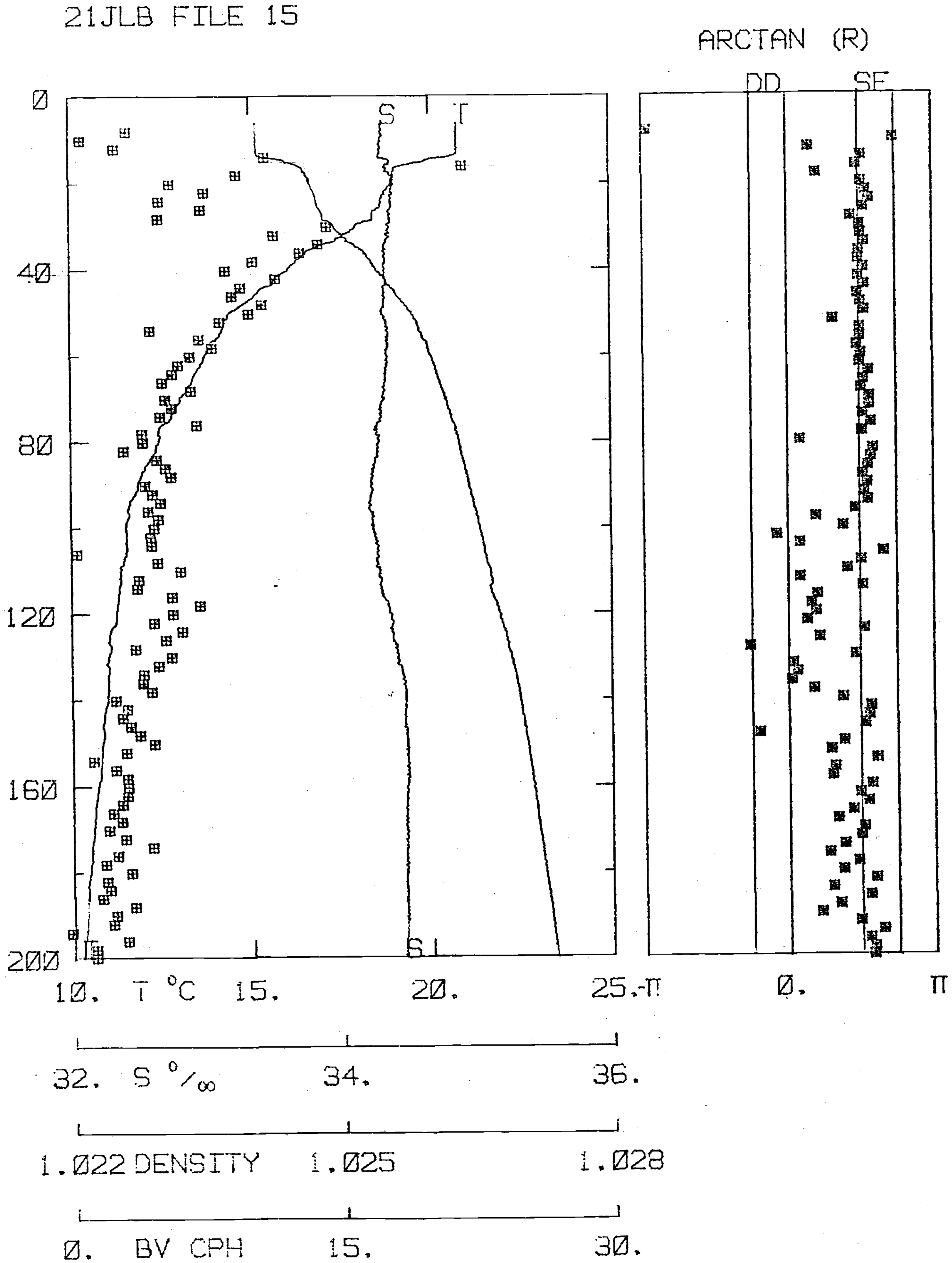
LOCATION 35°54'N 153°41'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°



21JLB FILE 15
ARCTAN (R)
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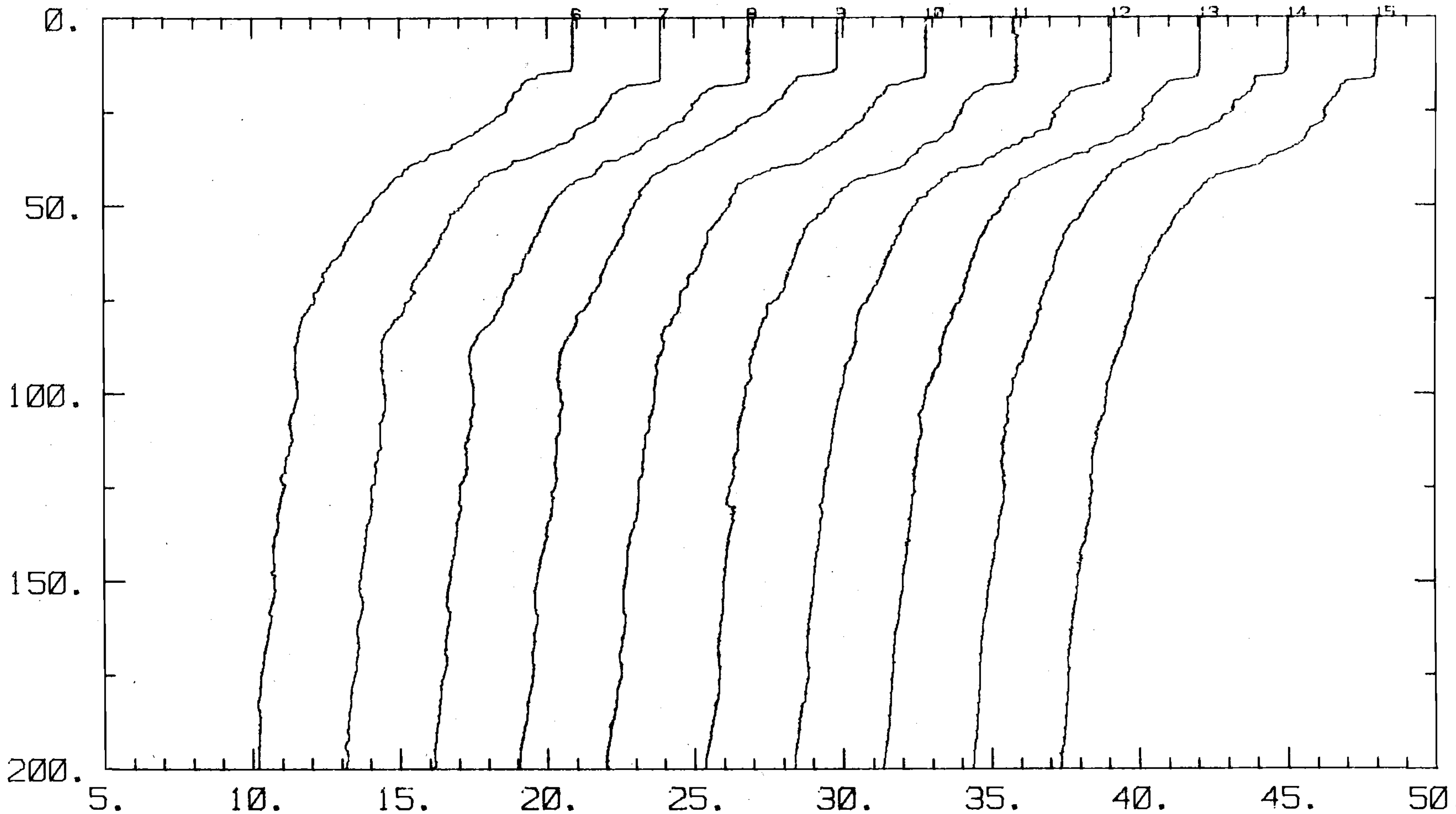
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

21JL82CN



SEQUENCE 16 PAGE 6

START TIME 03:30 GMT 07/21/82

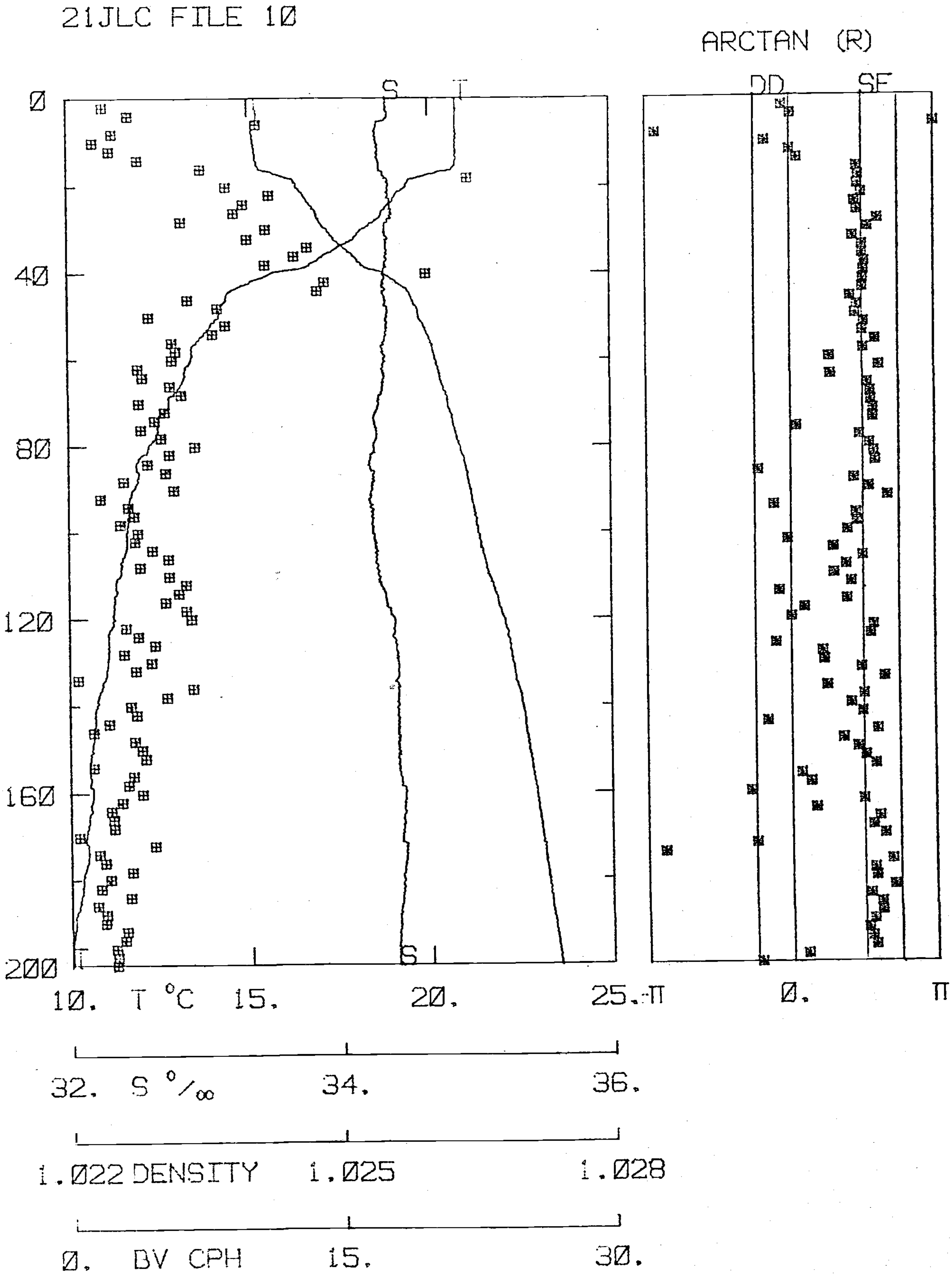
LOCATION 35°49'N 153°41'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°



21JLC FILE 10
ARCTAN (R)
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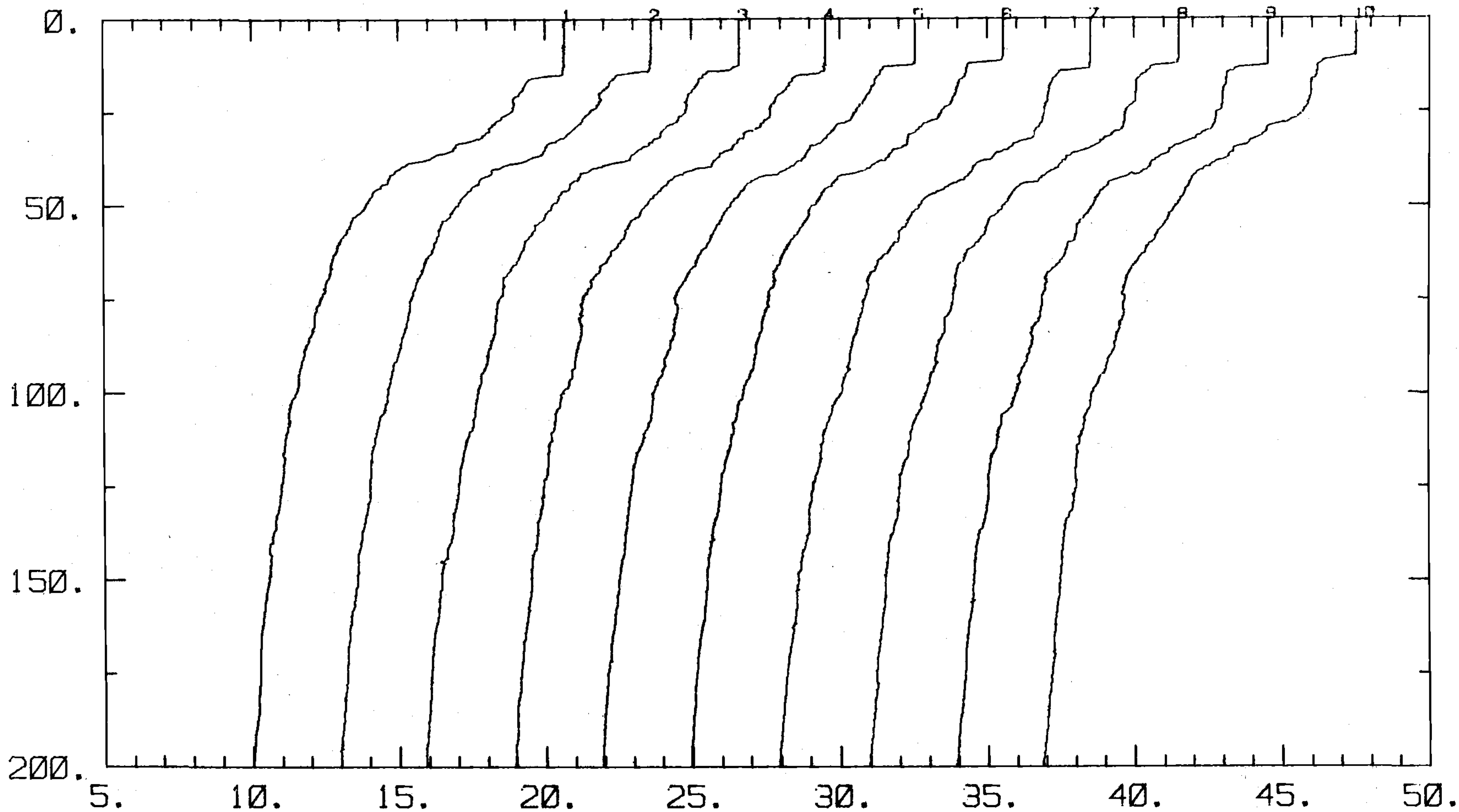
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

21JL82DN



160

SEQUENCE 16 PAGE 7

START TIME 04:30 GMT 07/21/82

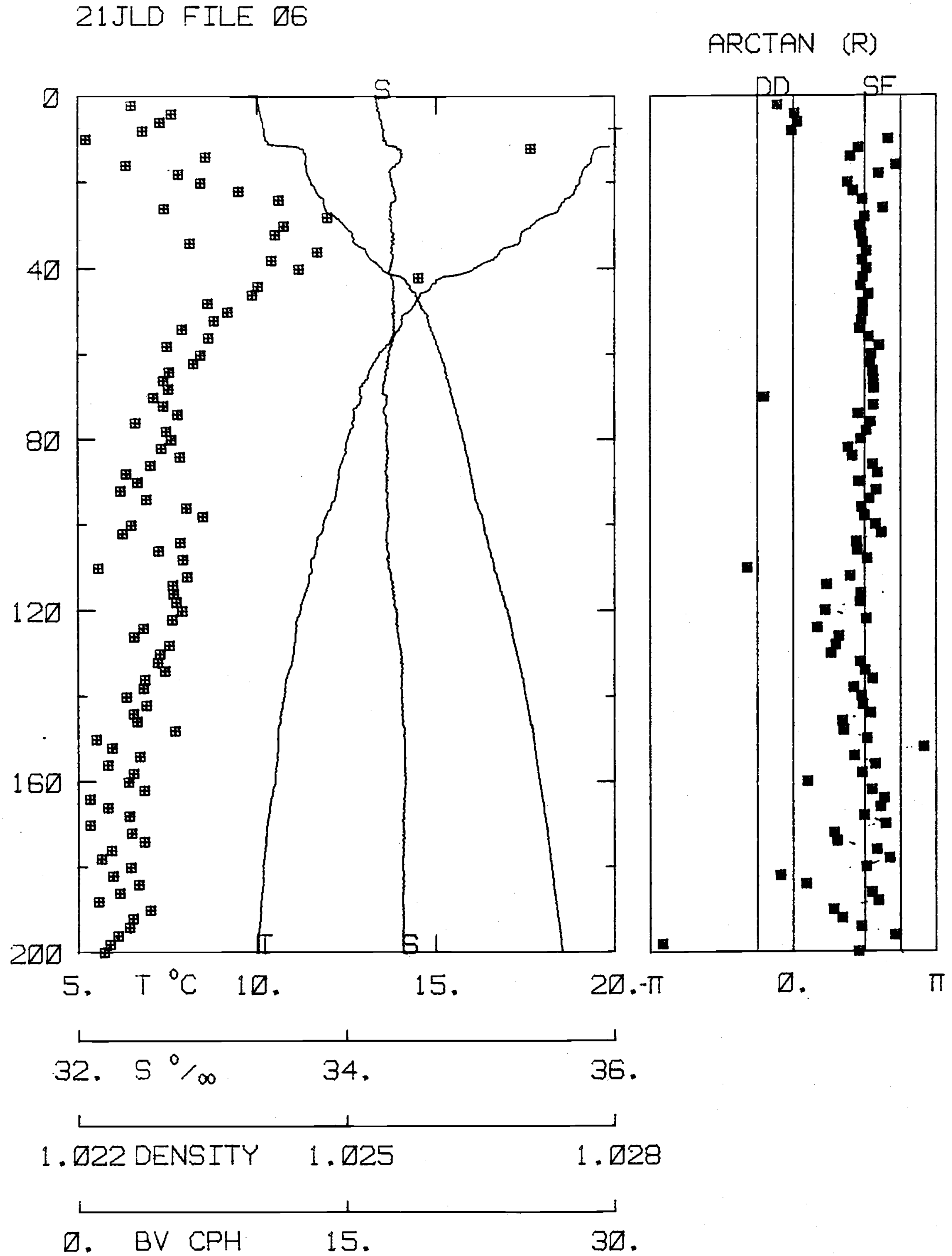
LOCATION 35°44'N 153°42'W

Profile spacing 900m

WIND SPEED 5. m/s

DIRECTION 055°

Ship's heading 200°



21JLD FILE Ø6
ARCTAN (R)
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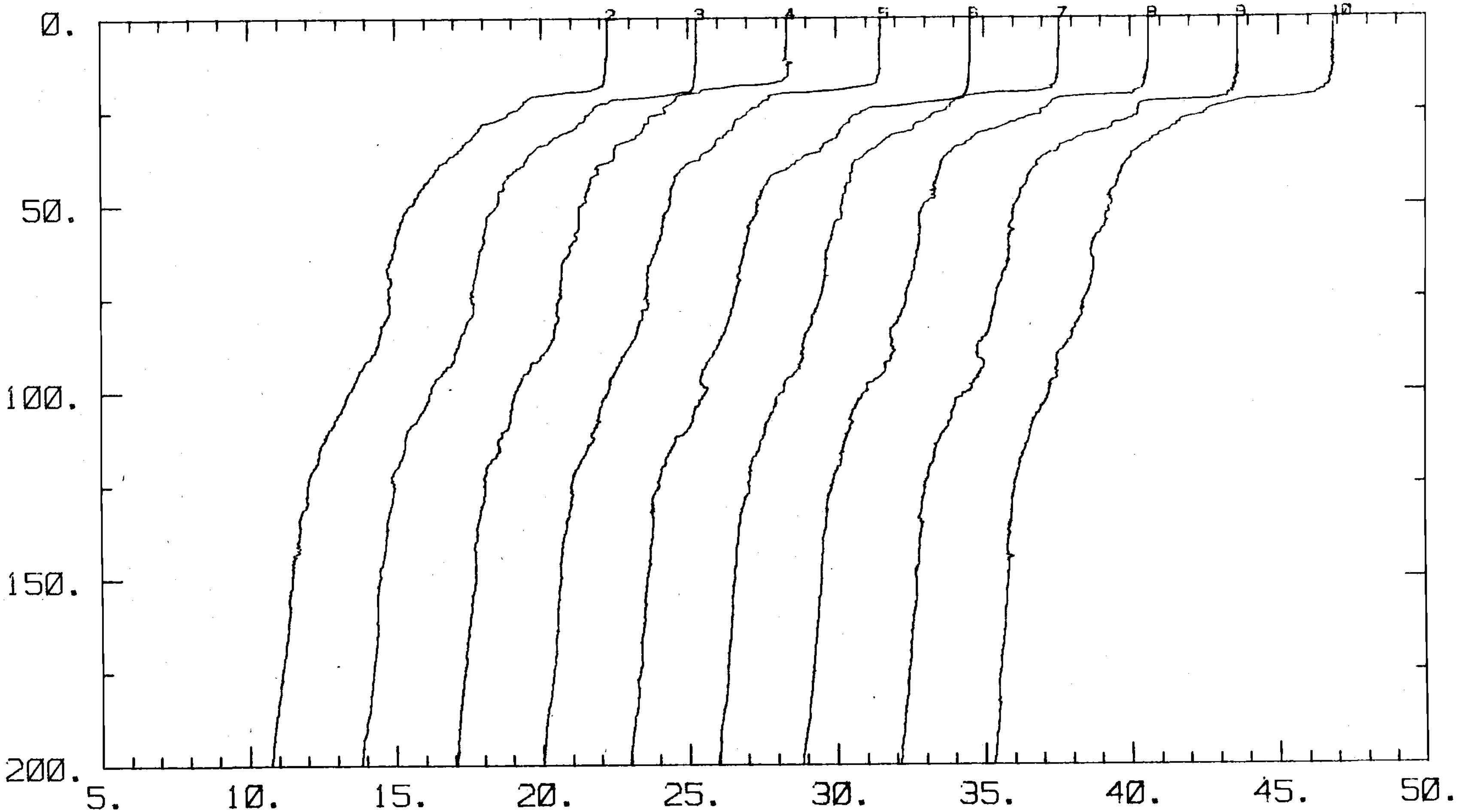
5. T °C 1Ø. 15. 2Ø.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

22JL82AN



162

SEQUENCE 17 PAGE 1

START TIME 01:42 GMT 07/22/82

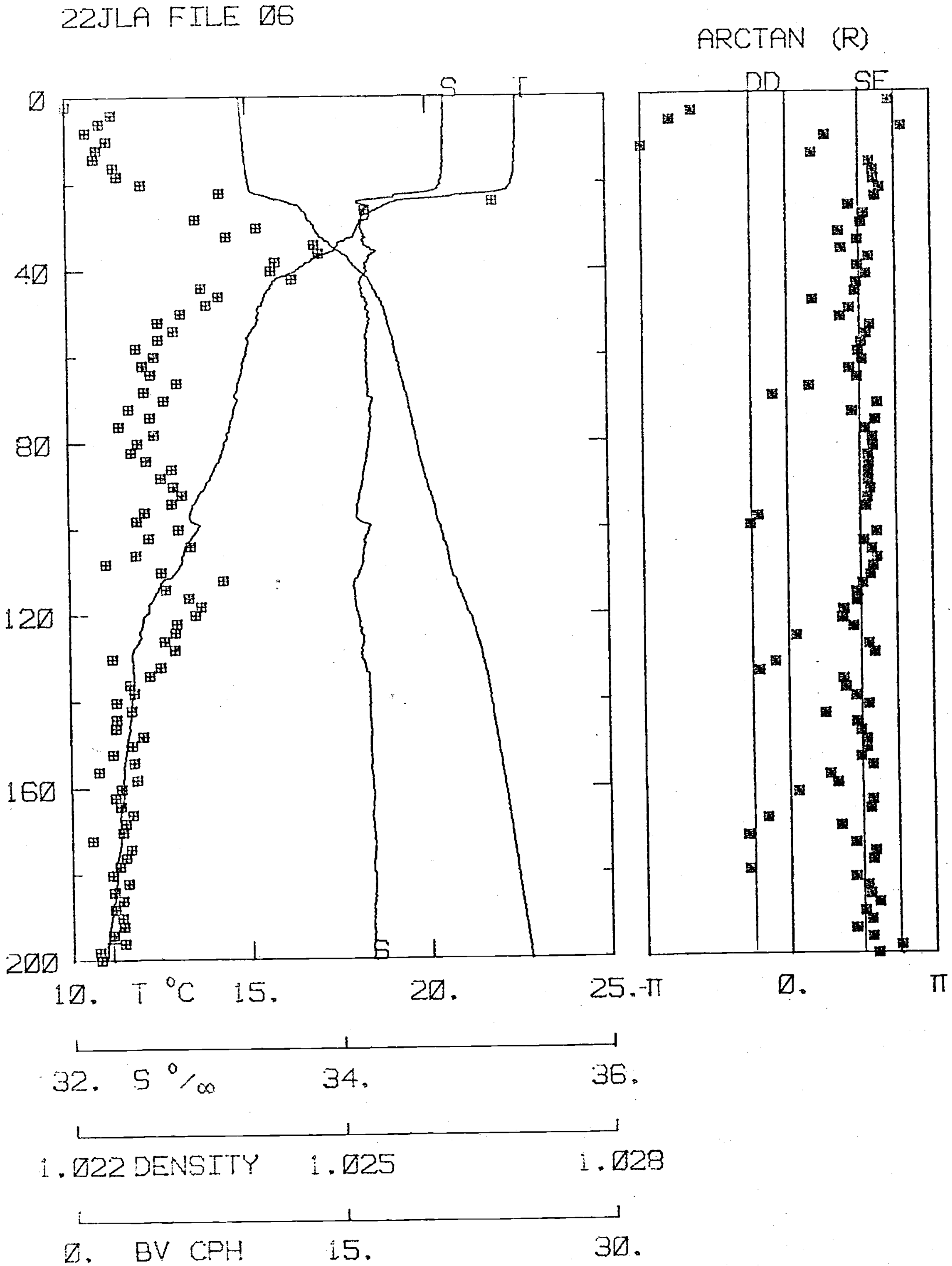
LOCATION 34°00'N 154°12'W

Profile spacing 900m

WIND SPEED 8. m/s

DIRECTION 050°

Ship's heading 190°


22JLA FILE Ø6
ARCTAN (R)
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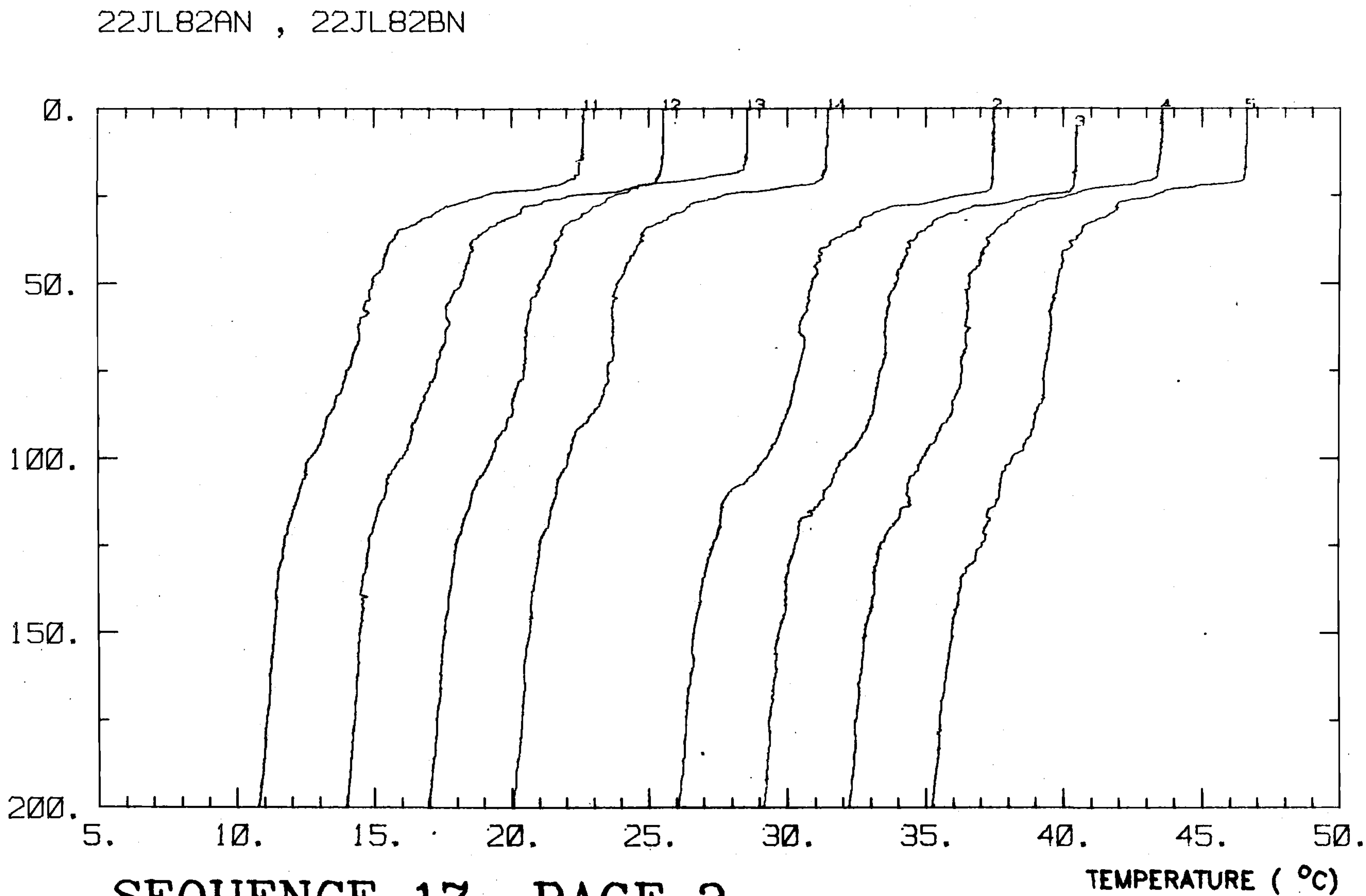
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
Ø. BV CPH 15. 30.



SEQUENCE 17 PAGE 2

START TIME 02:36 GMT 07/22/82

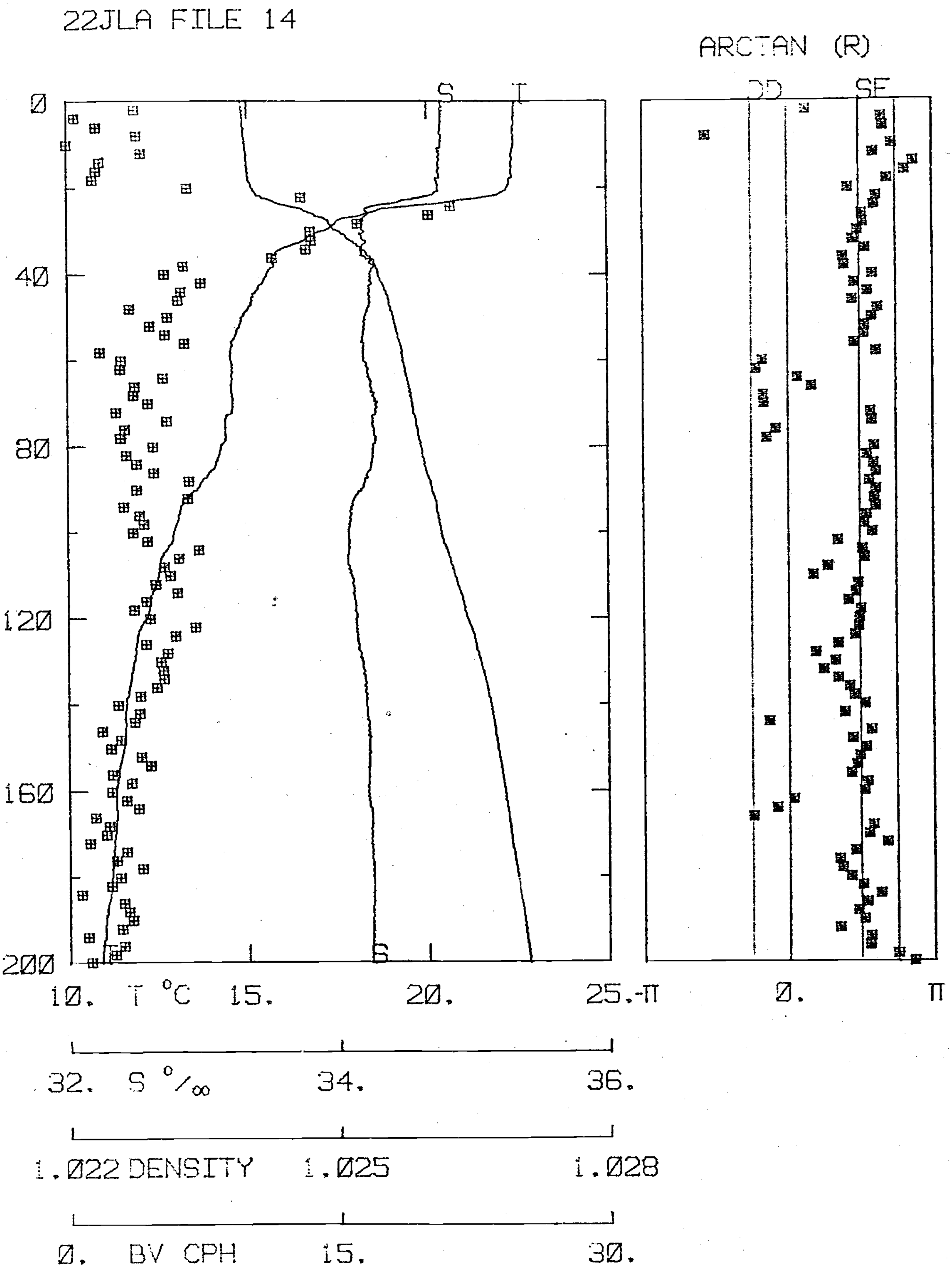
LOCATION 33°55'N 154°13'W

Profile spacing 900m

WIND SPEED 8. m/s

DIRECTION 050°

Ship's heading 190°



22JLA FILE 14
ARCTAN (R)
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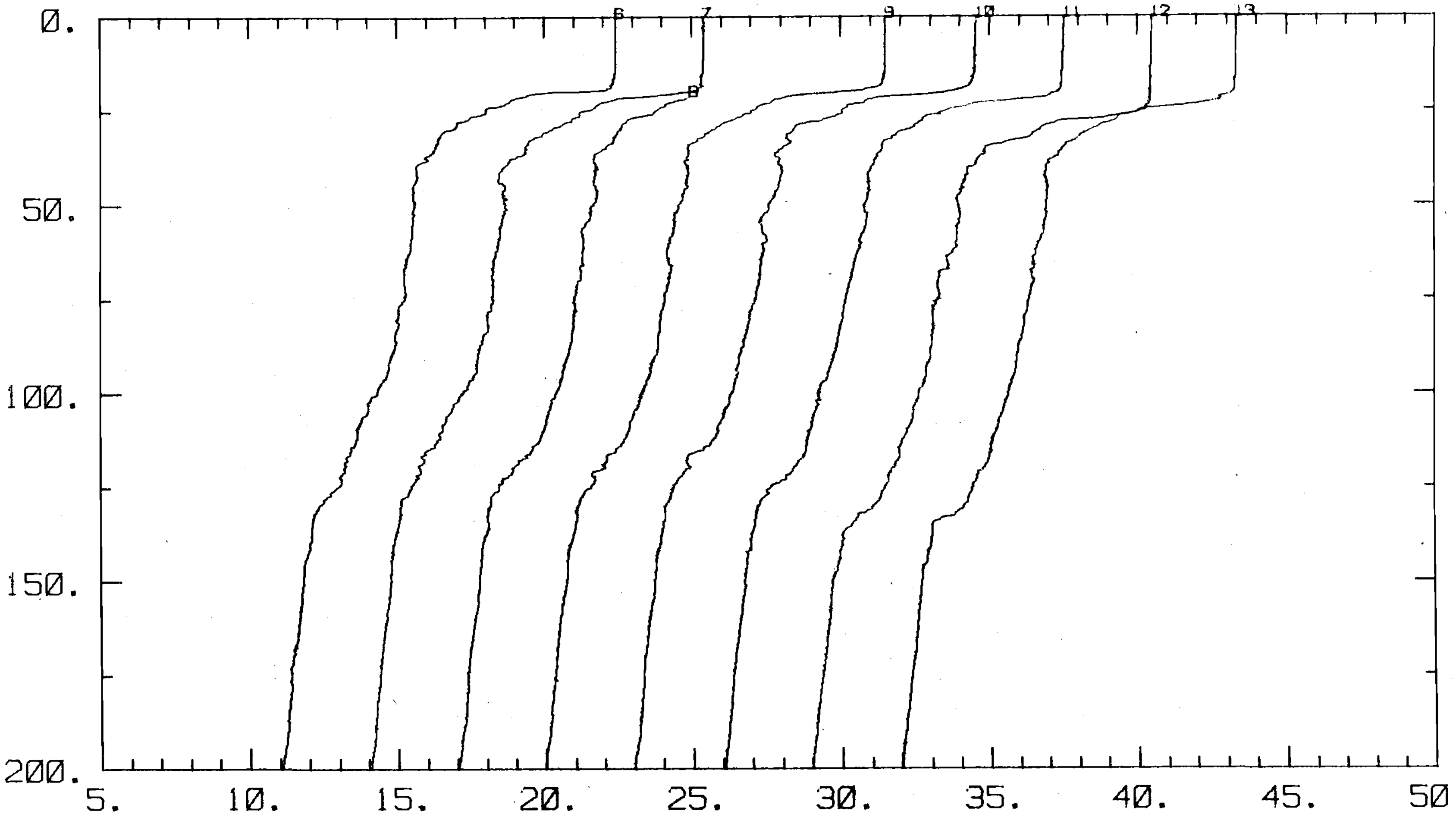
10. T °C 15. 20. 25.
-π 0. π
32. S °/∞ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

22JL82BN , 22JL82CN



SEQUENCE 17 PAGE 3

START TIME 03:30 GMT 07/22/82

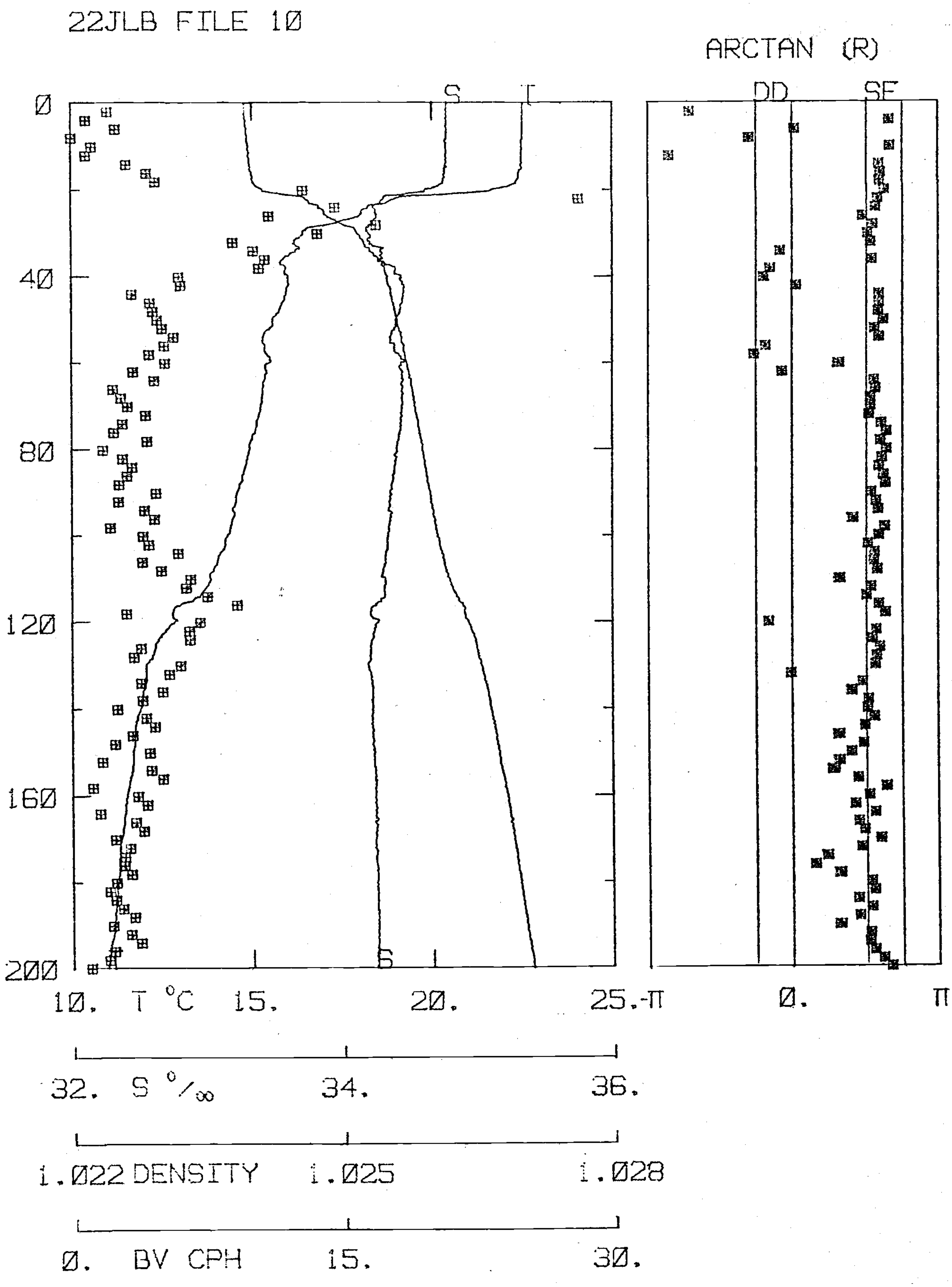
LOCATION 33°50'N 154°13'W

Profile spacing 900m

WIND SPEED 8. m/s

DIRECTION 050°

Ship's heading 190°


22JLB FILE 10
ARCTAN (R)
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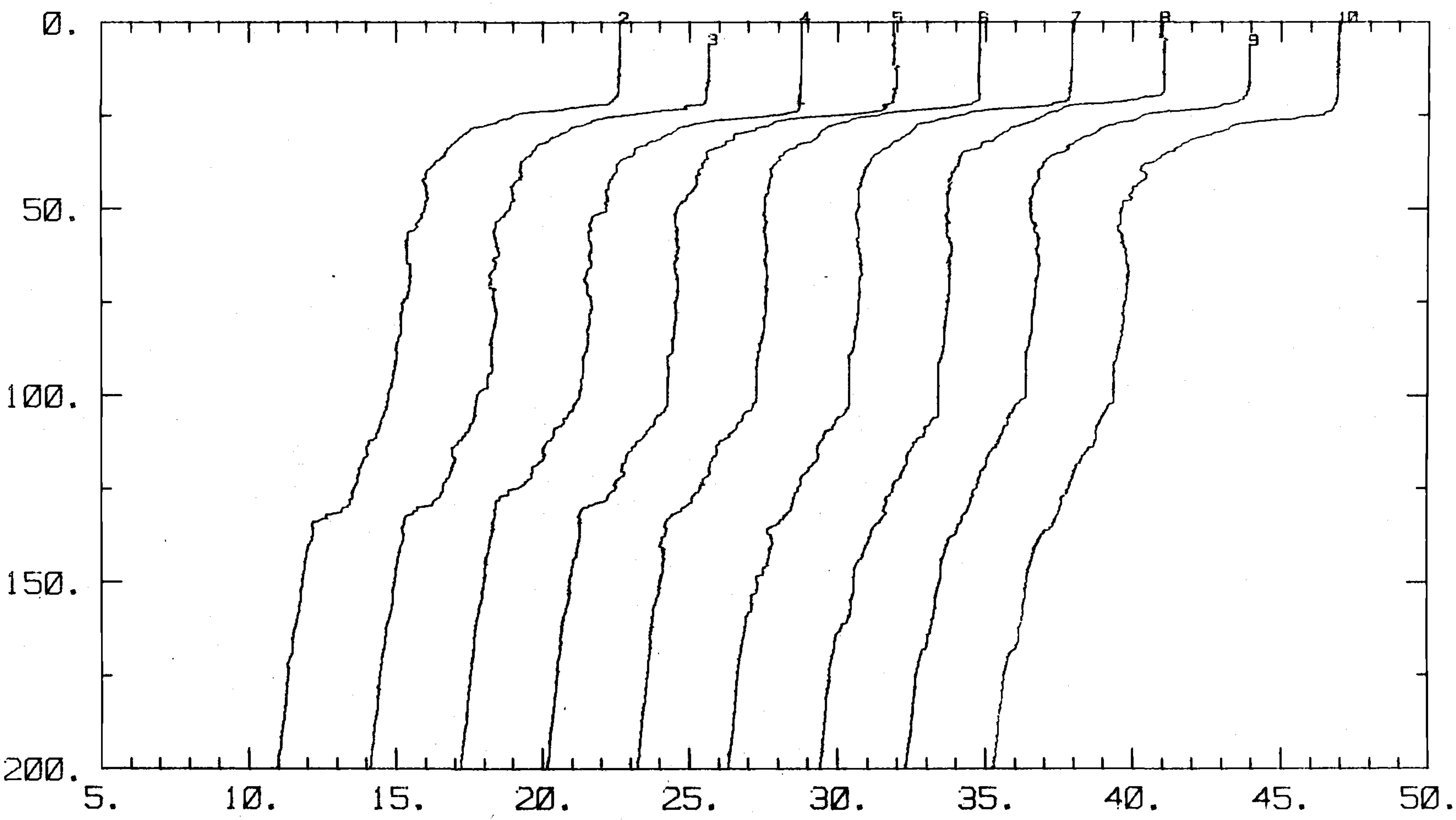
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

22JL82CN



168

SEQUENCE 17 PAGE 4

START TIME 04:24 GMT 07/22/82

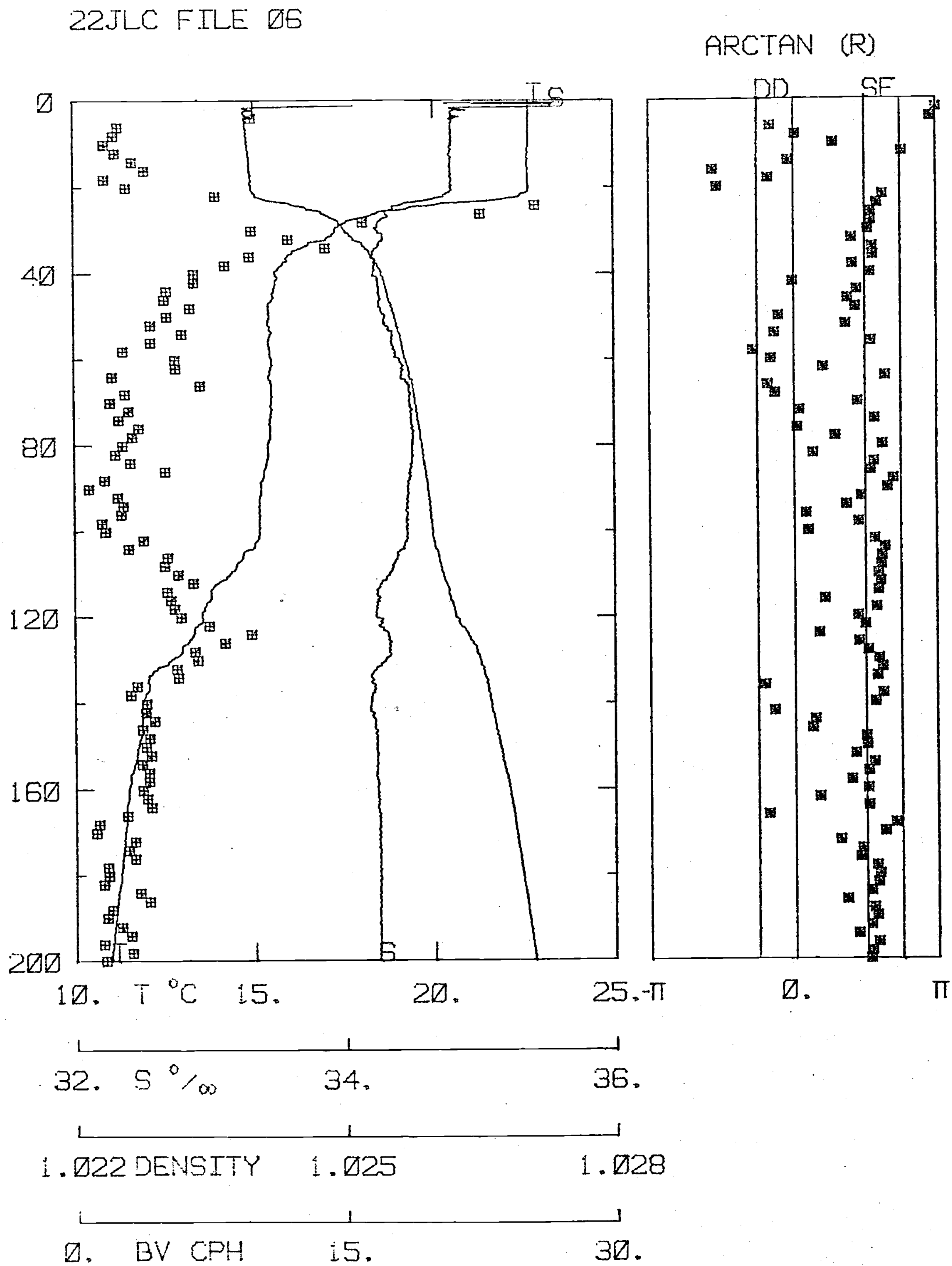
LOCATION 33°45'N 154°14'W

Profile spacing 900m

WIND SPEED 8. m/s

DIRECTION 050°

Ship's heading 190°


22JLC FILE Ø6
ARCTAN (R)
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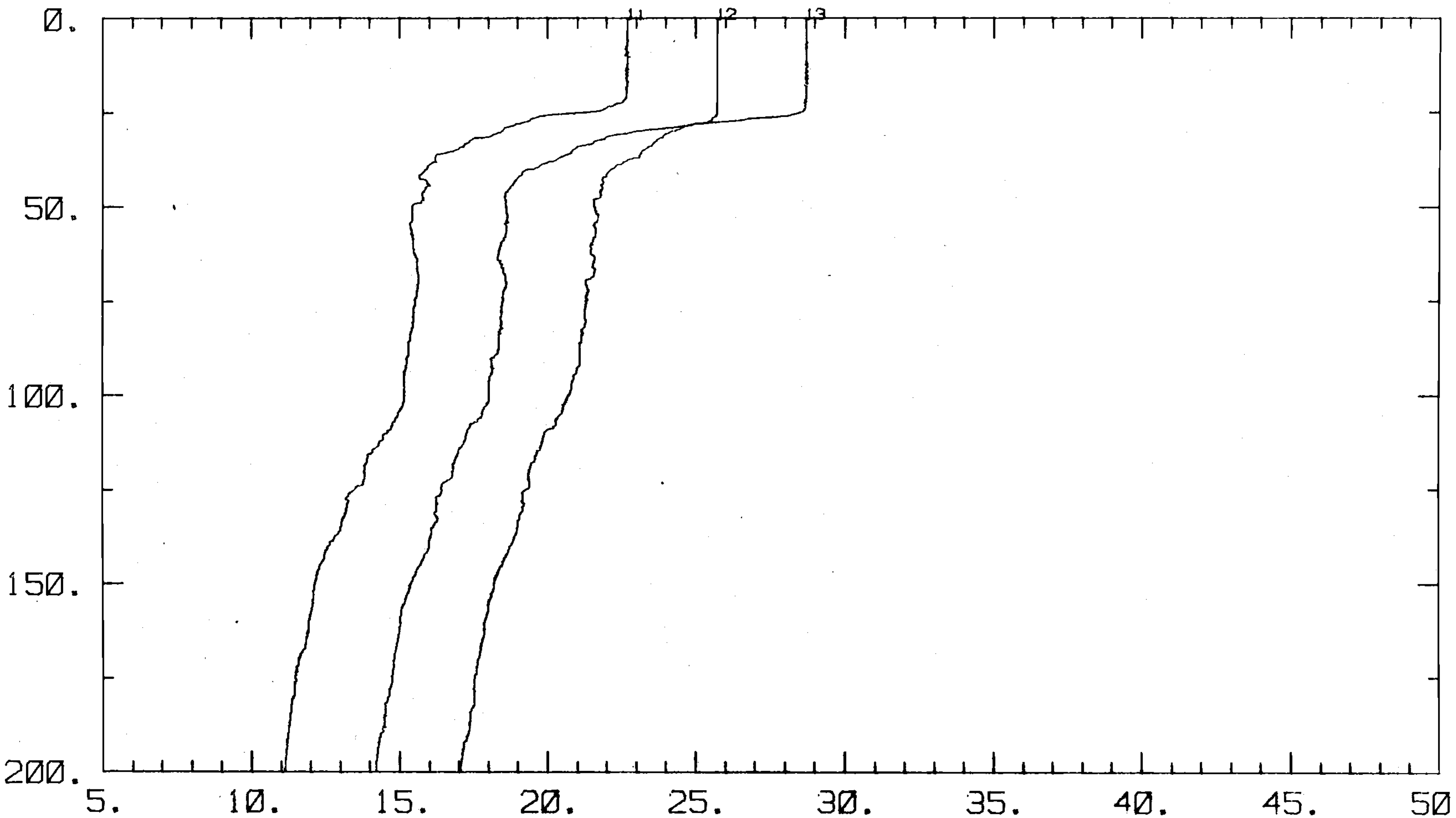
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

22JL82CN



SEQUENCE 17 PAGE 5

START TIME 05:18 GMT 07/22/82

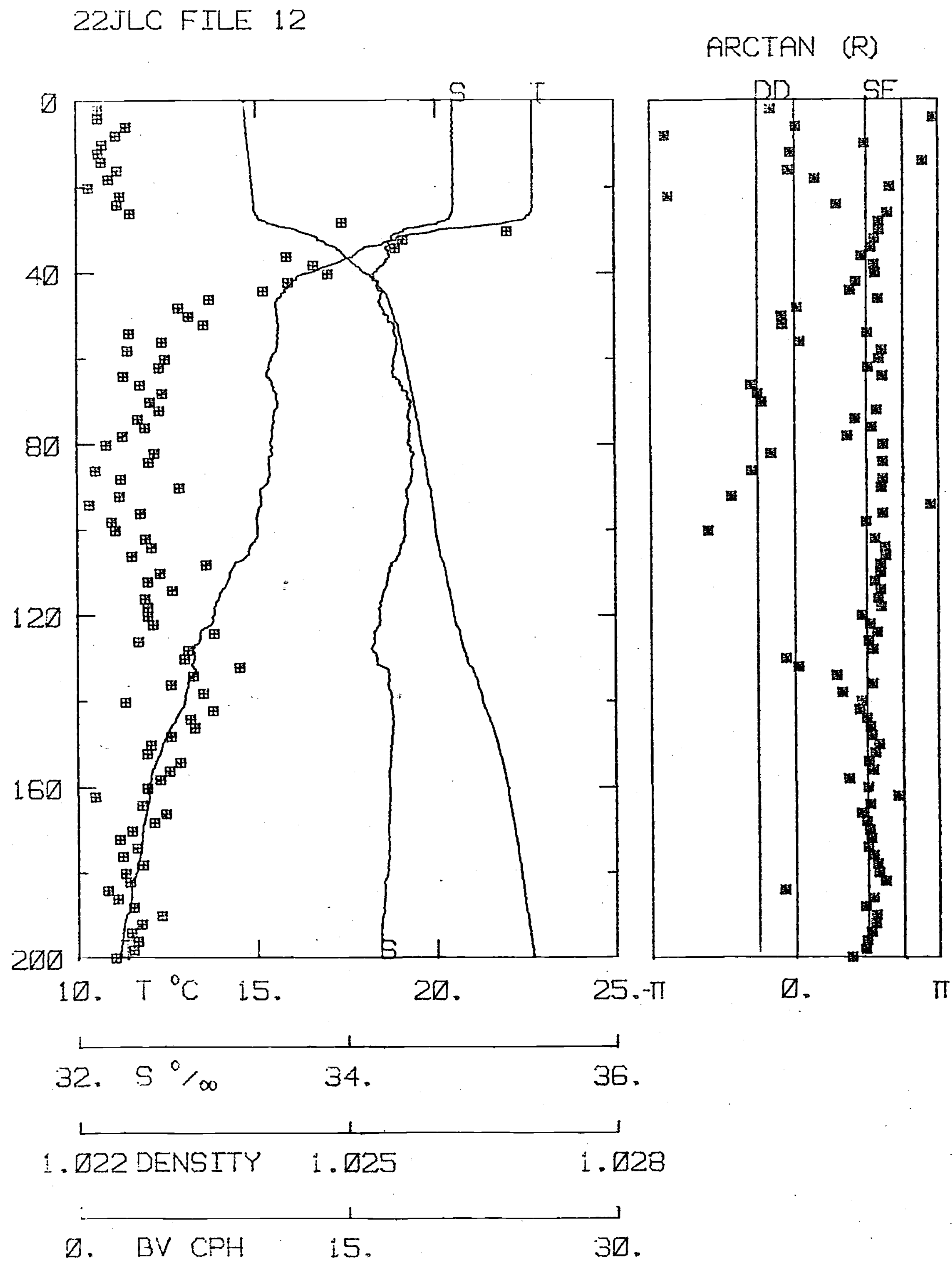
LOCATION 33°40'N 154°14'W

Profile spacing 900m

WIND SPEED 8. m/s

DIRECTION 050°

Ship's heading 190°


22JLC FILE 12
ARCTAN (R)
S T
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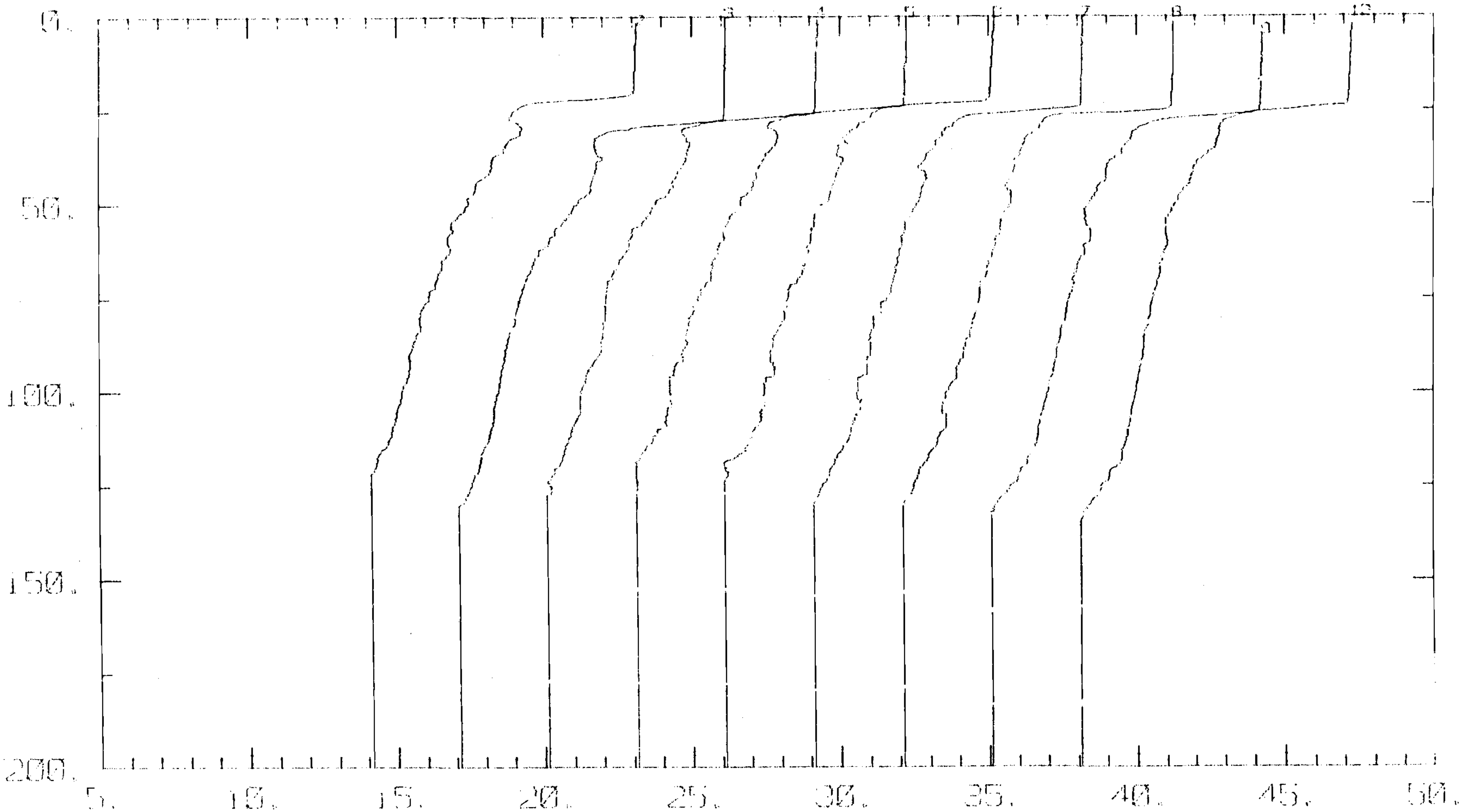
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

22JUL82DM



172

SEQUENCE 18 PAGE 1

START TIME 22:30 GMT 07/22/82

LOCATION 32°18'N 154°44'W

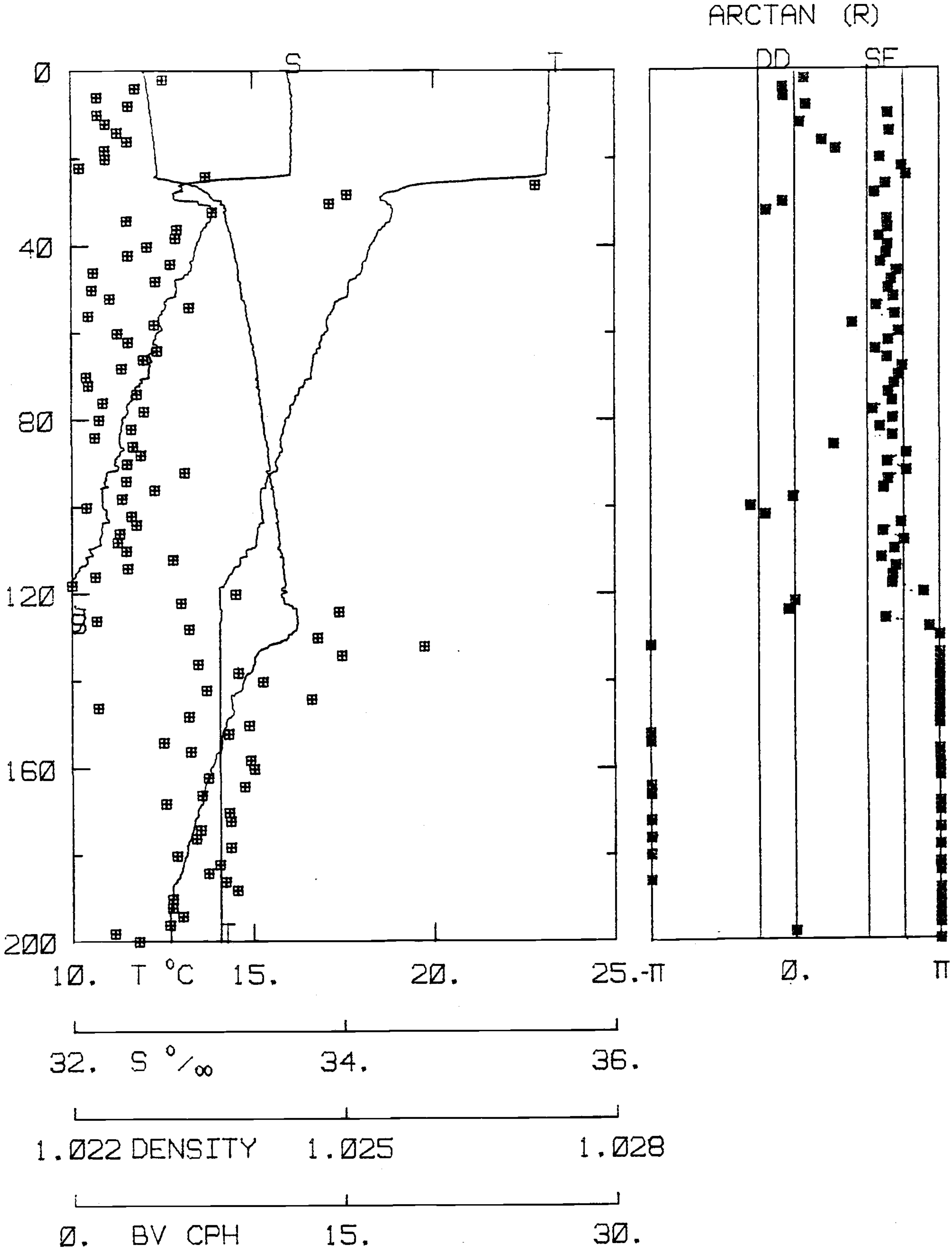
Profile spacing 900m

WIND SPEED 9. m/s

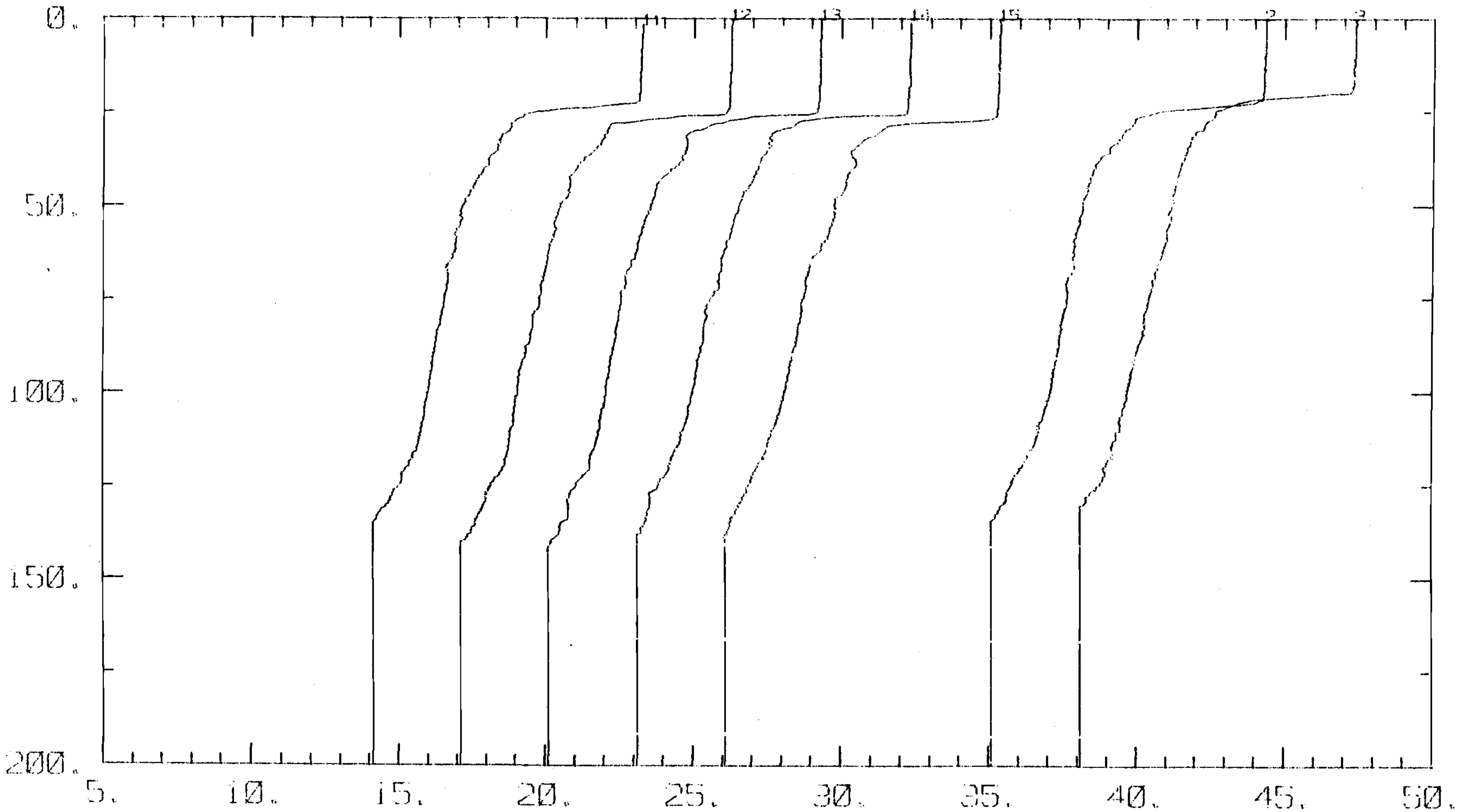
DIRECTION 060°

Ship's heading 190°

22JLD FILE Ø5



22JL82DM , 23JL82AM



SEQUENCE 18 PAGE 2

START TIME 23:24 GMT 07/22/82

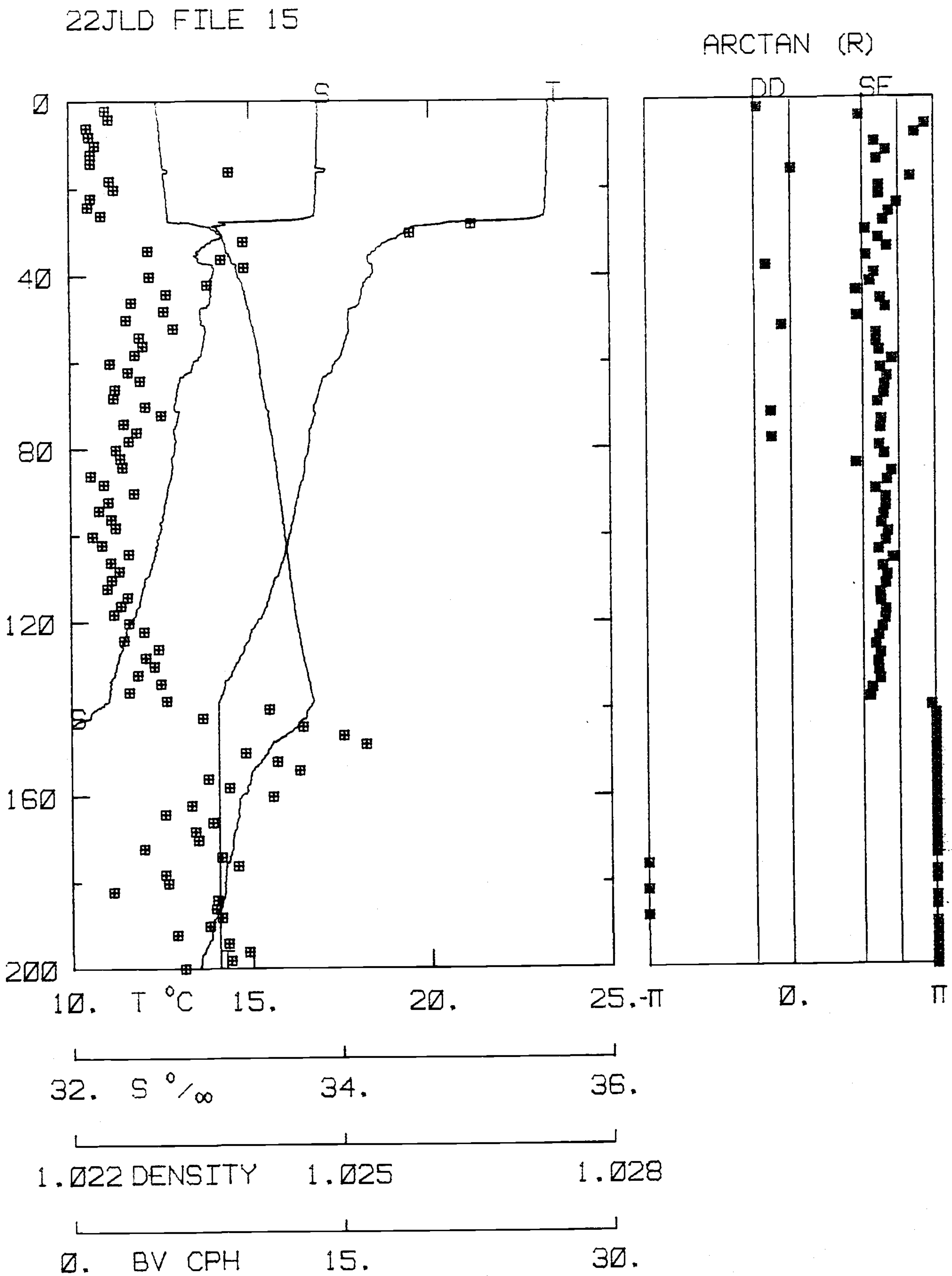
LOCATION 32°13'N 154°44'W

Profile spacing 900m

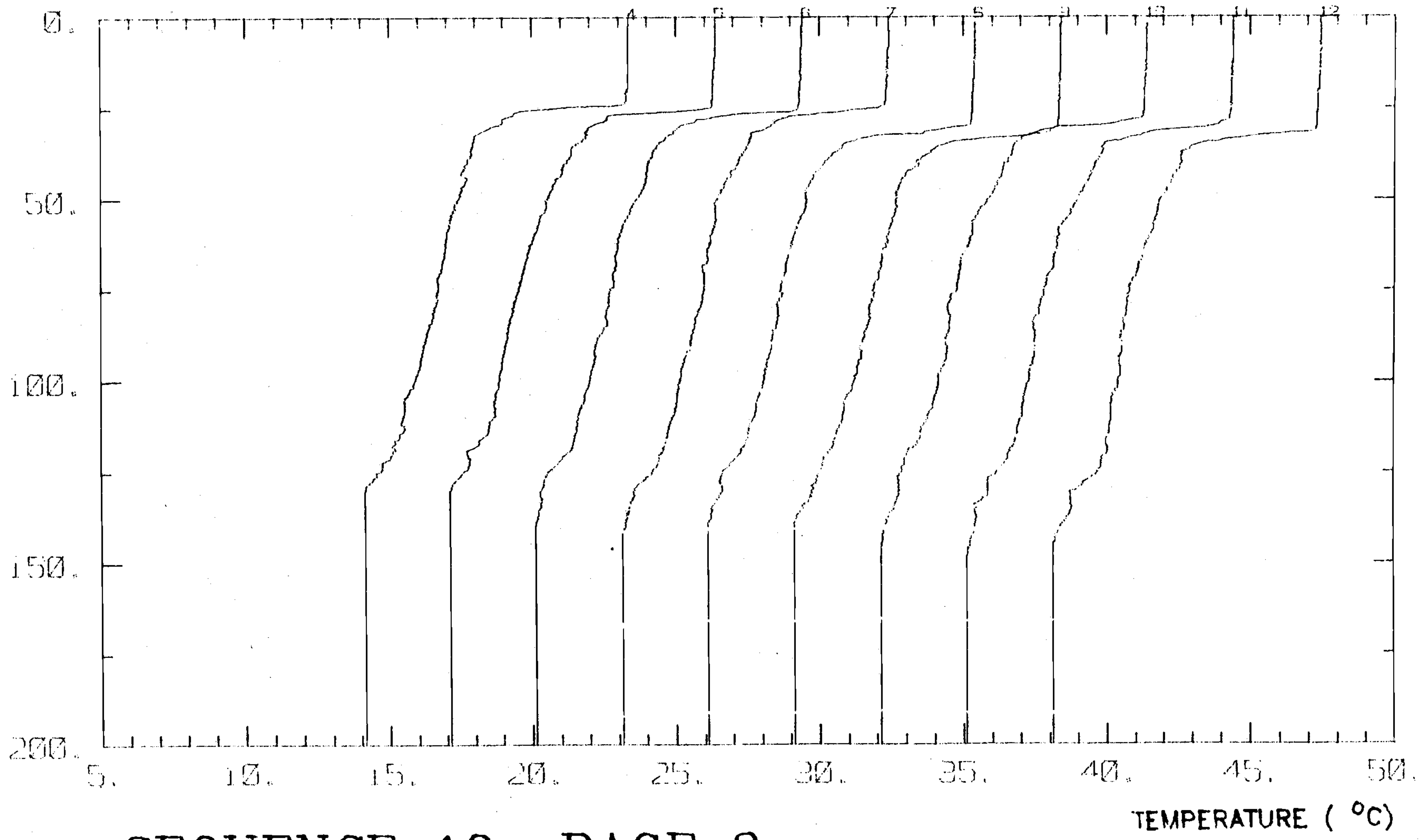
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190°


22JLD FILE 15
ARCTAN (R)
S
T
DD
SF
Ø
40
80
120
160
200
S
10. T °C 15. 20. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

23JL82AM



176

SEQUENCE 18 PAGE 3

START TIME 00:18 GMT 07/23/82

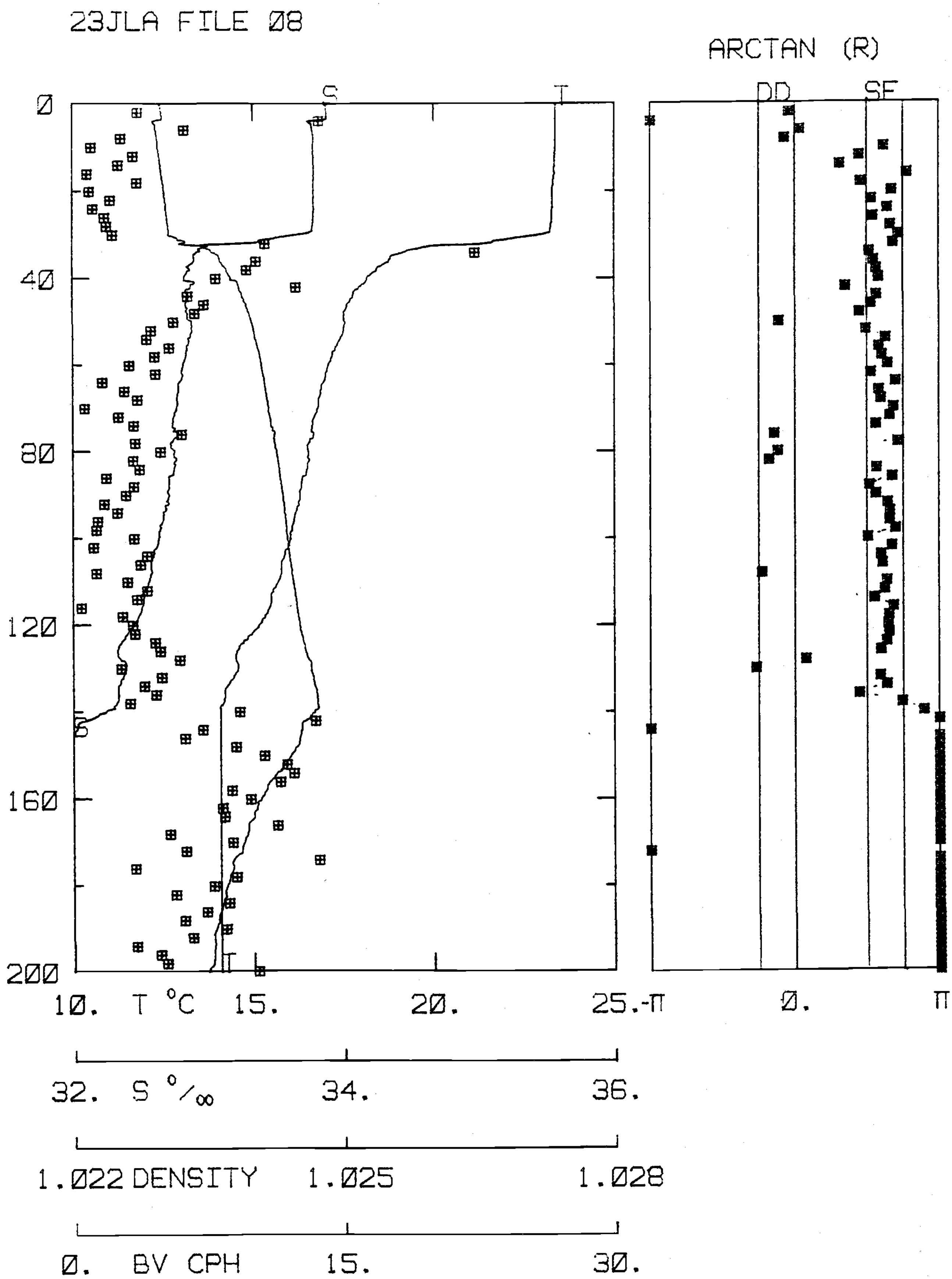
LOCATION 32°08'N 154°46'W

Profile spacing 900m

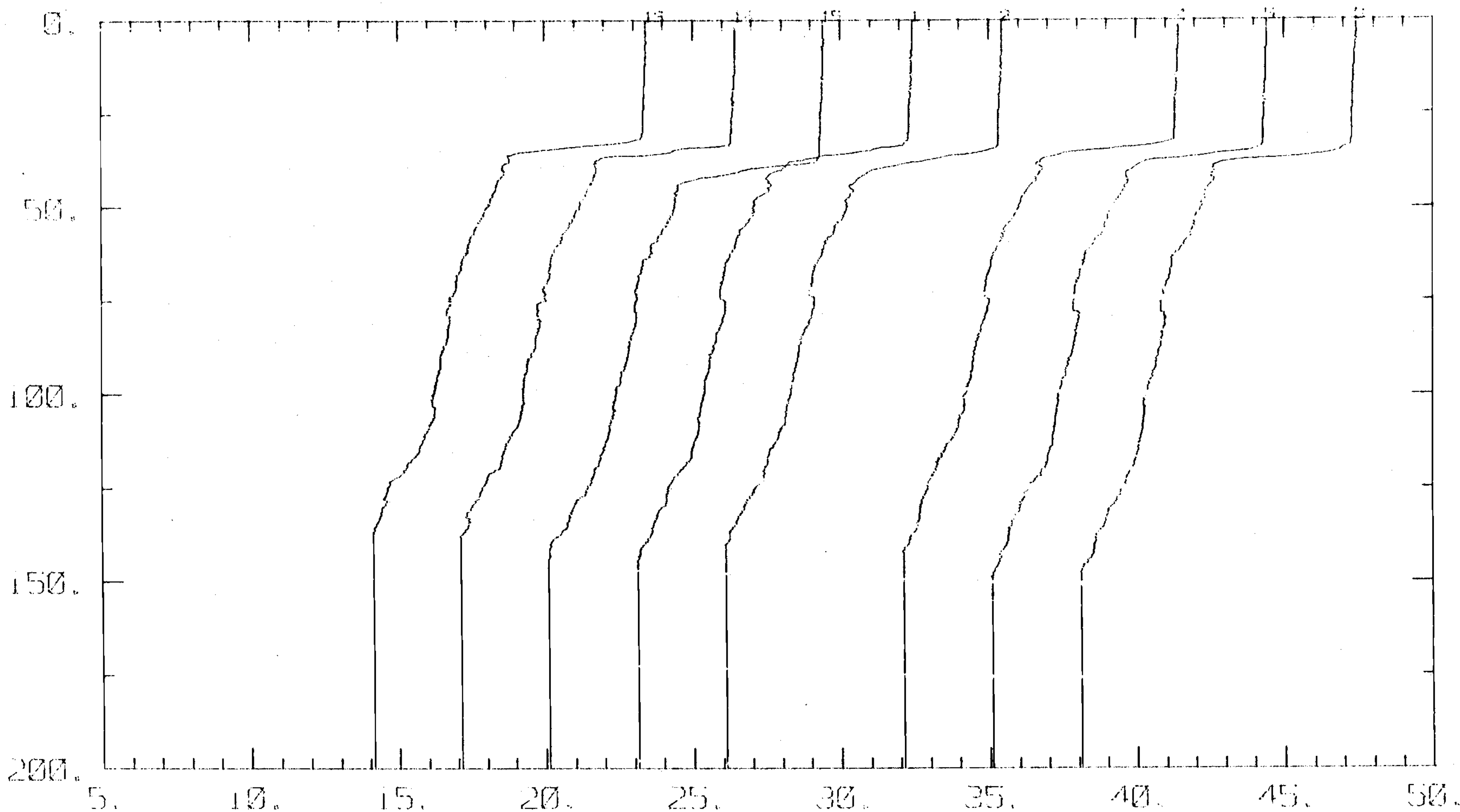
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190.°


23JLA FILE 08
ARCTAN (R)
DD
SF
S
T
0
40
80
120
160
200
10. T °C 15. 20. 25.
-π 0. π
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.

23JL82AM , 23JL82BM



TEMPERATURE (°C)

SEQUENCE 18 PAGE 4

START TIME 01:12 GMT 07/23/82

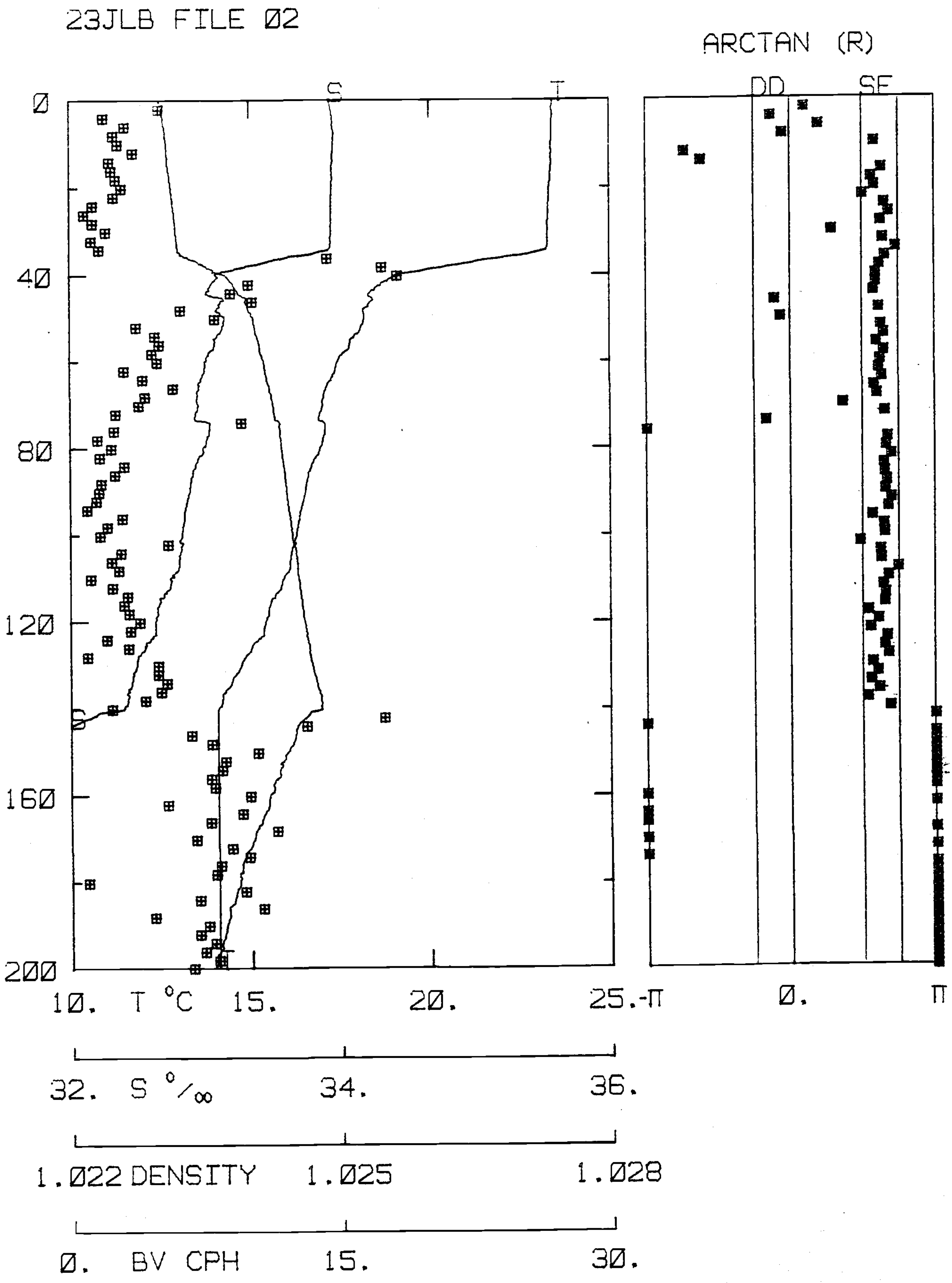
LOCATION 32°03'N 154°47'W

Profile spacing 900m

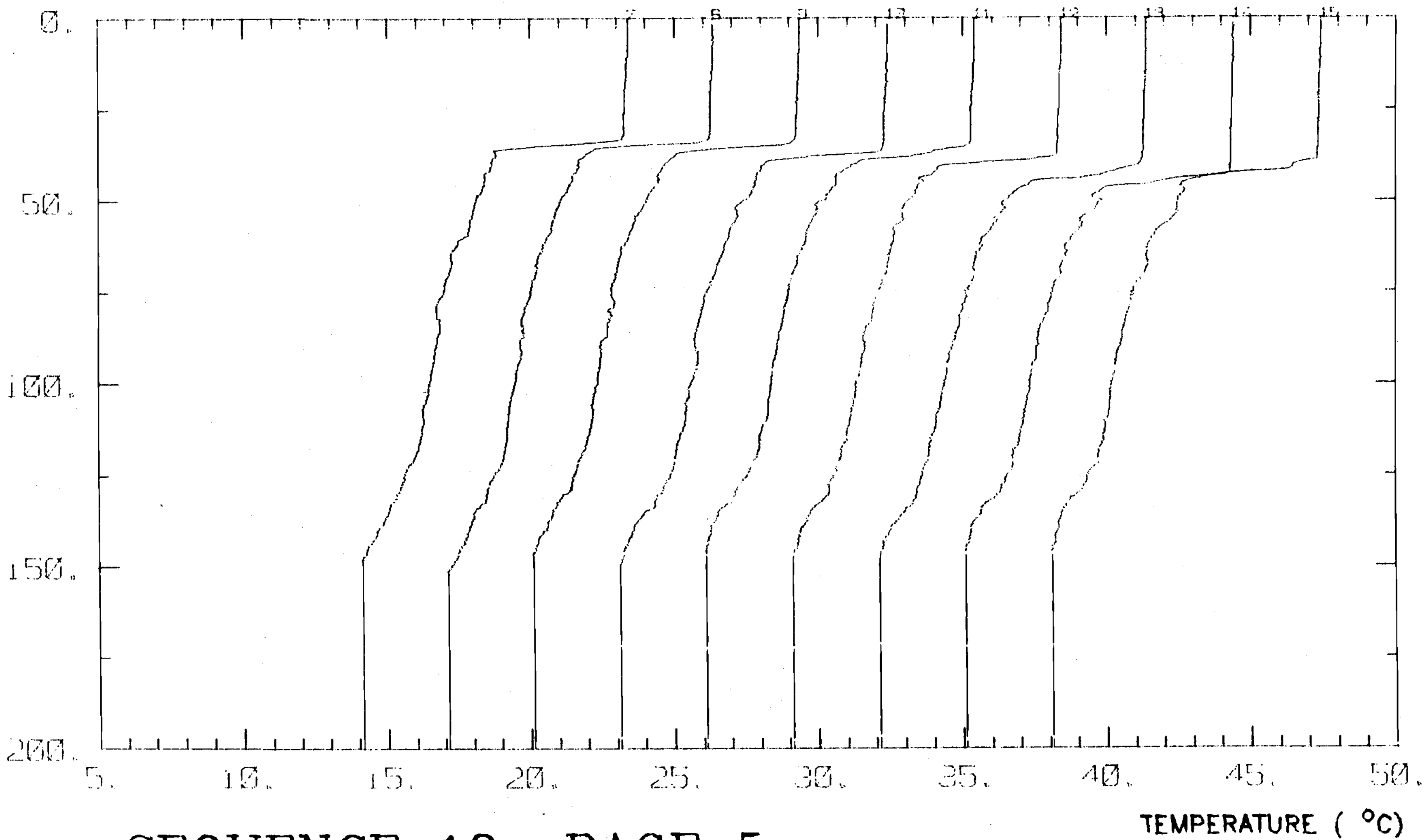
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190°


23JLB FILE Ø2
ARCTAN (R)
S
T
DD
SF
Ø
40
80
120
160
200
10. T °C 15. 20. 25.
-π Ø. π
32. S °/∞ 34. 36.
1.022 DENSITY 1.025 1.028
Ø. BV CPH 15. 30.

23JL82BM



SEQUENCE 18 PAGE 5

START TIME 02:06 GMT 07/23/82

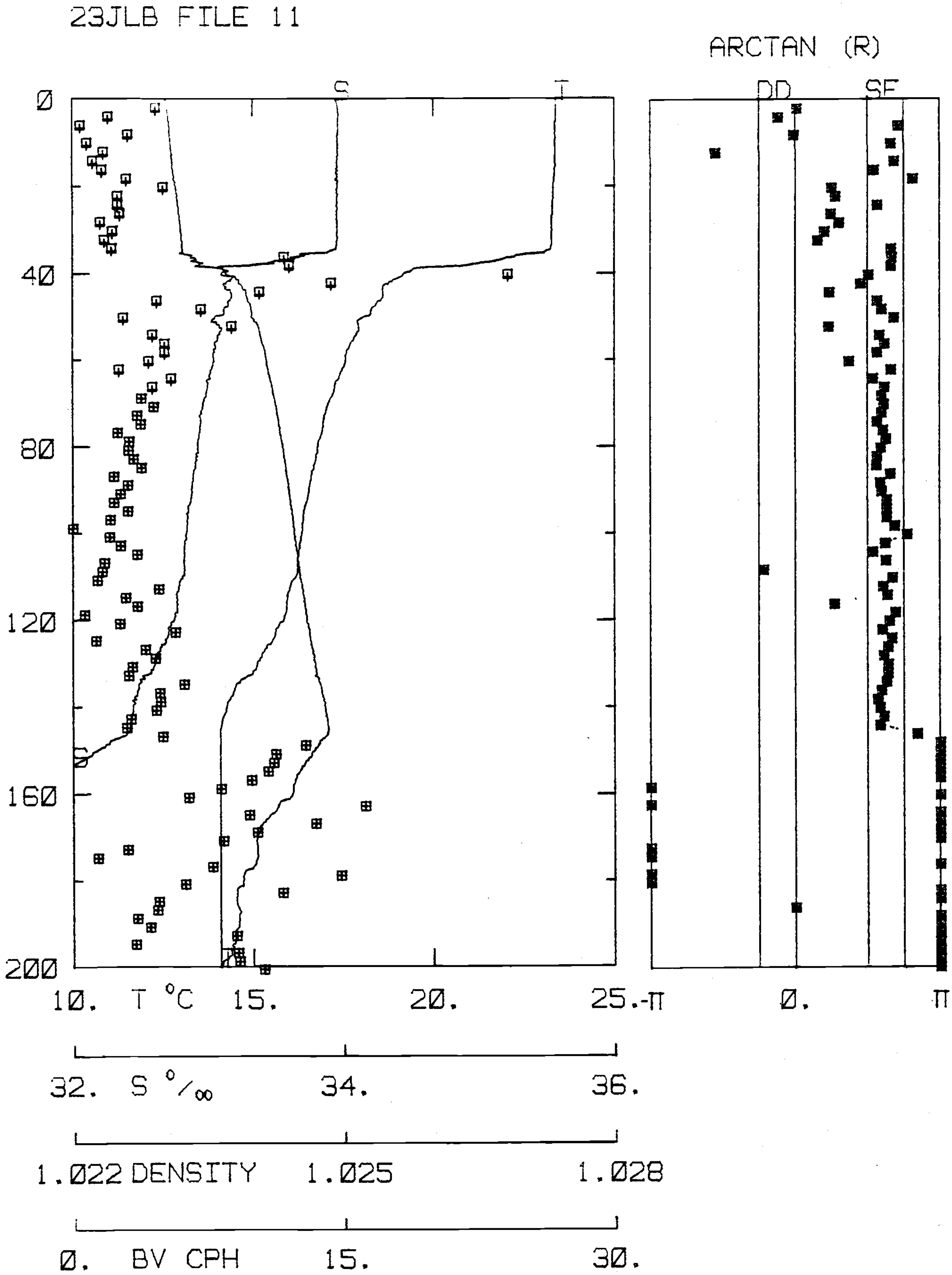
LOCATION 31°58'N 154°49'W

Profile spacing 900m

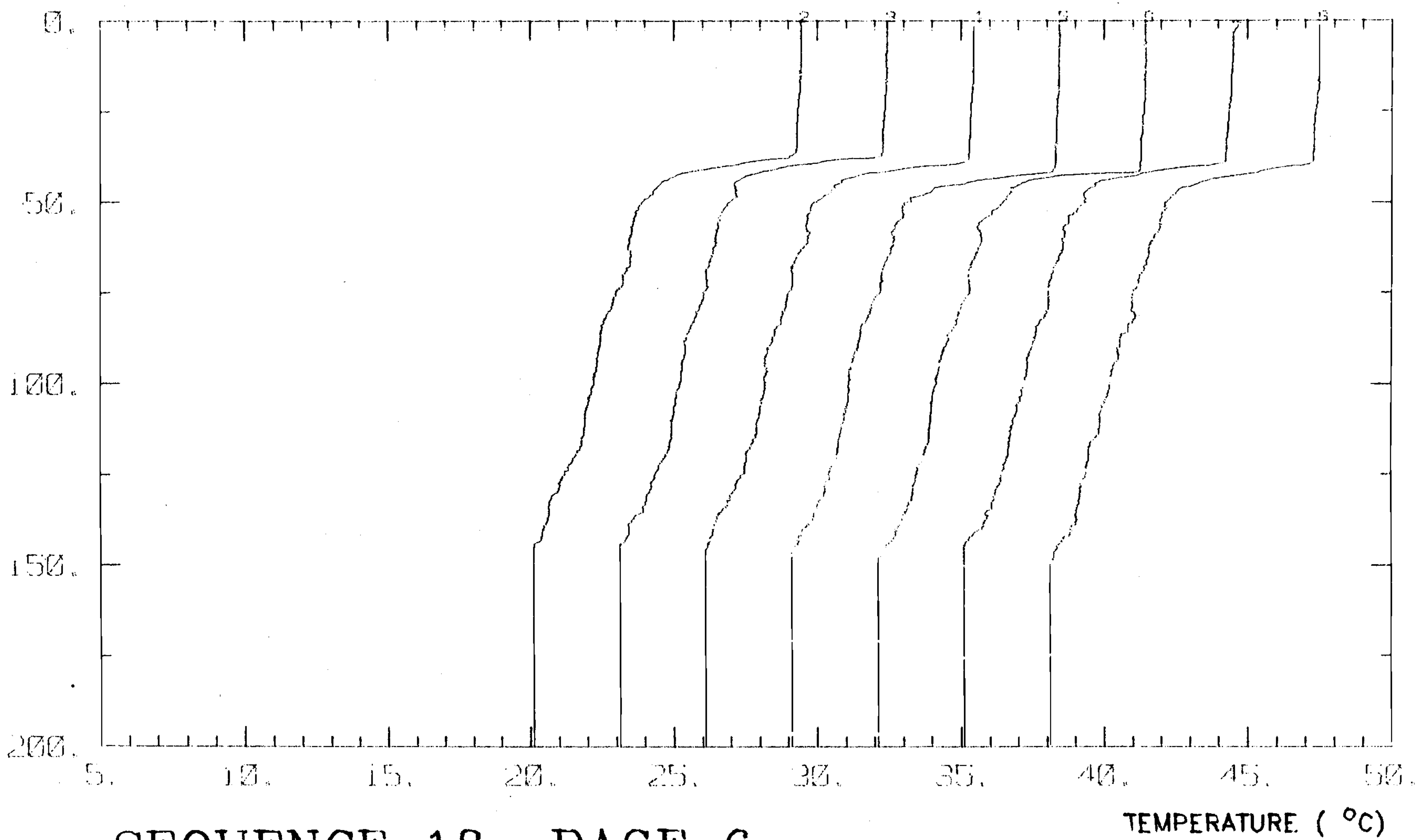
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190°


23JLB FILE 11
ARCTAN (R)
S
T
DD
SF
0
40
80
120
160
200
10. T °C 15. 20. 25.
32. S ‰ 34. 36.
1.022 DENSITY 1.025 1.028
0. BV CPH 15. 30.
-π
0.
π

23JL82CM



SEQUENCE 18 PAGE 6

START TIME 03:06 GMT 07/23/82

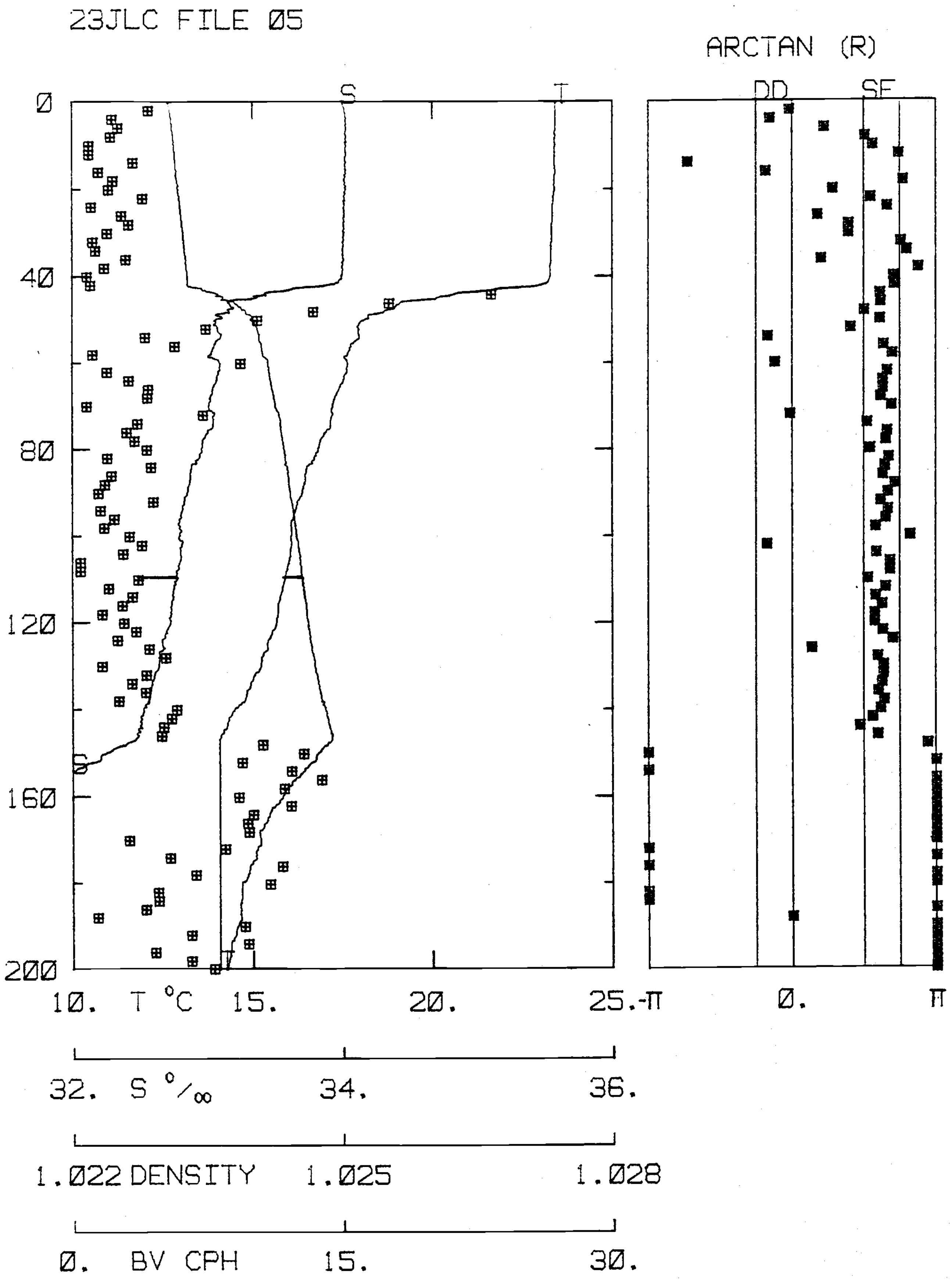
LOCATION 31°53'N 154°50'W

Profile spacing 900m

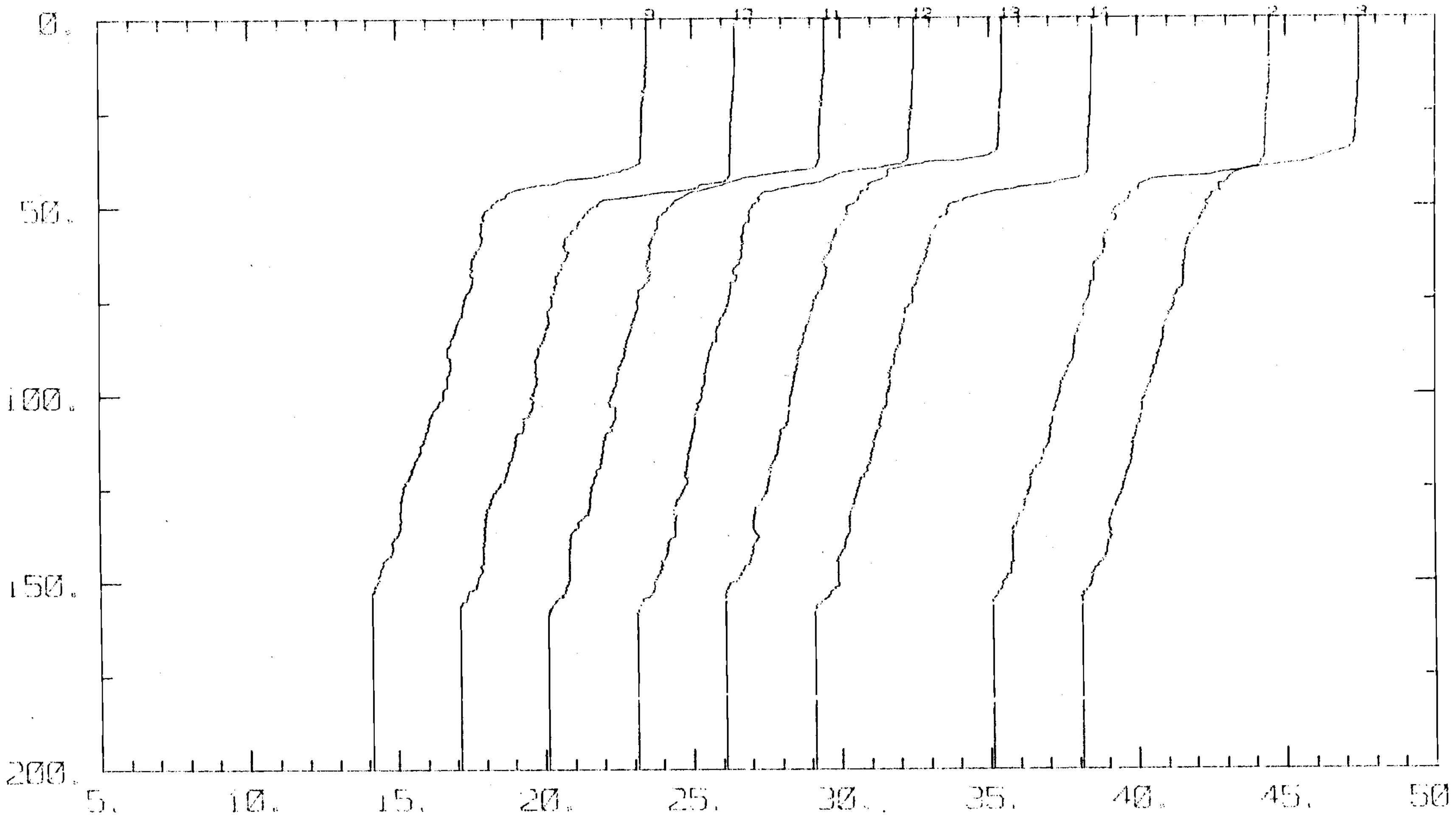
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190°


23JLC FILE Ø5
ARCTAN (R)
S
T
DD
SF
Ø
4Ø
8Ø
12Ø
16Ø
2ØØ
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

23JL82CM , 23JL82DM



184

SEQUENCE 18 PAGE 7

START TIME 03:54 GMT 07/23/82

LOCATION 31°49'N 154°51'W

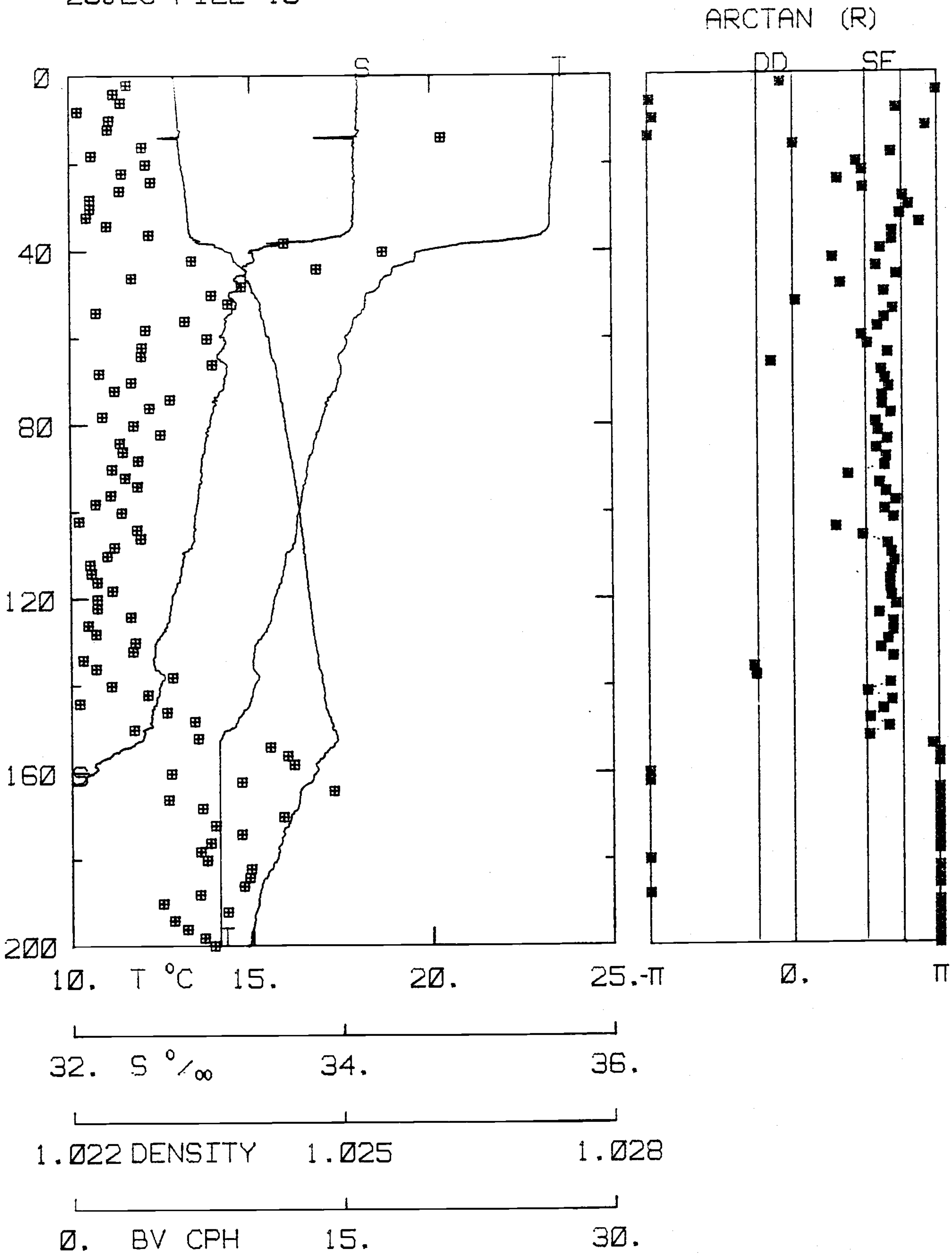
Profile spacing 900m

WIND SPEED 9. m/s

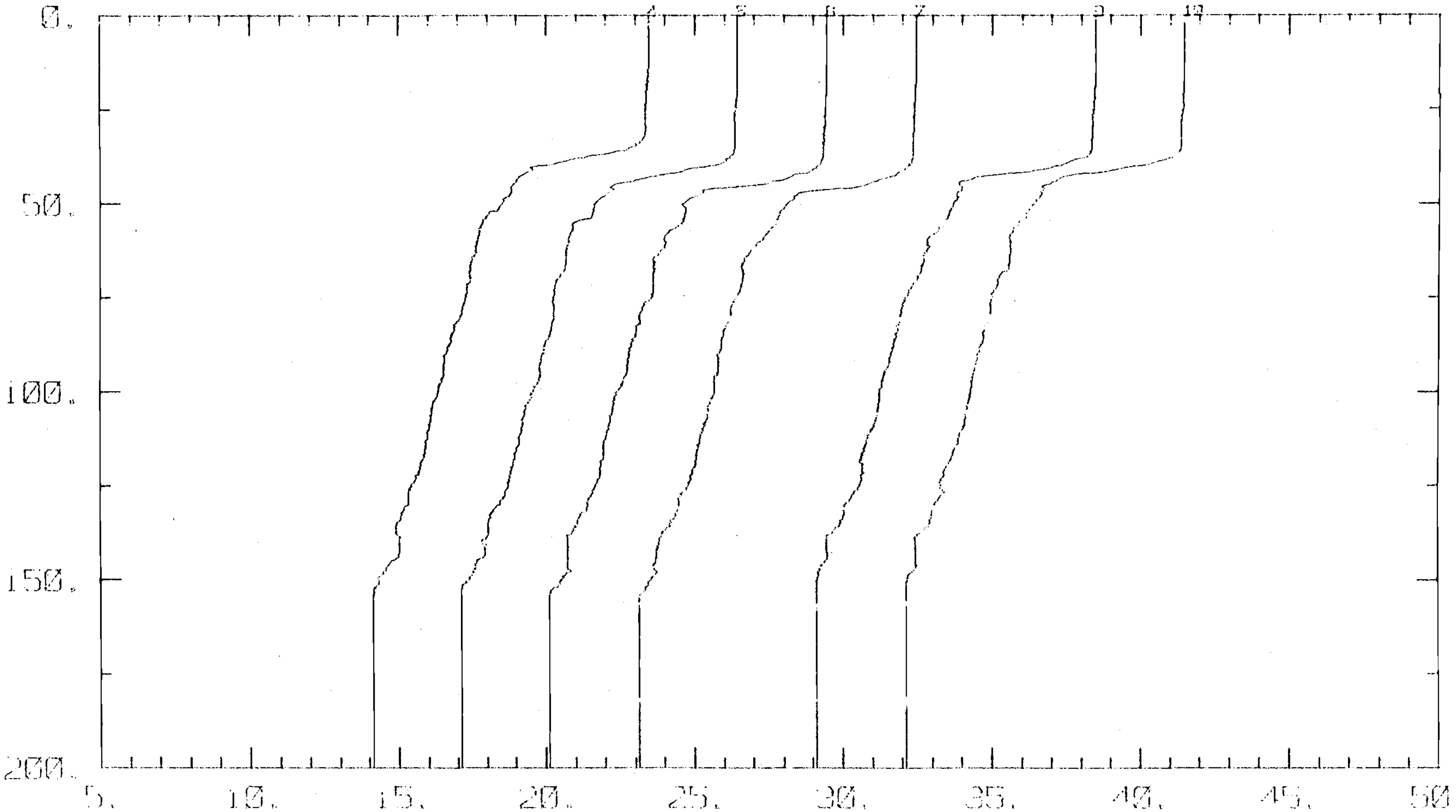
DIRECTION 060°

Ship's heading 190°

23JLC FILE 13



23JL82DM



186

SEQUENCE 18 PAGE 8

START TIME 04:48 GMT 07/23/82

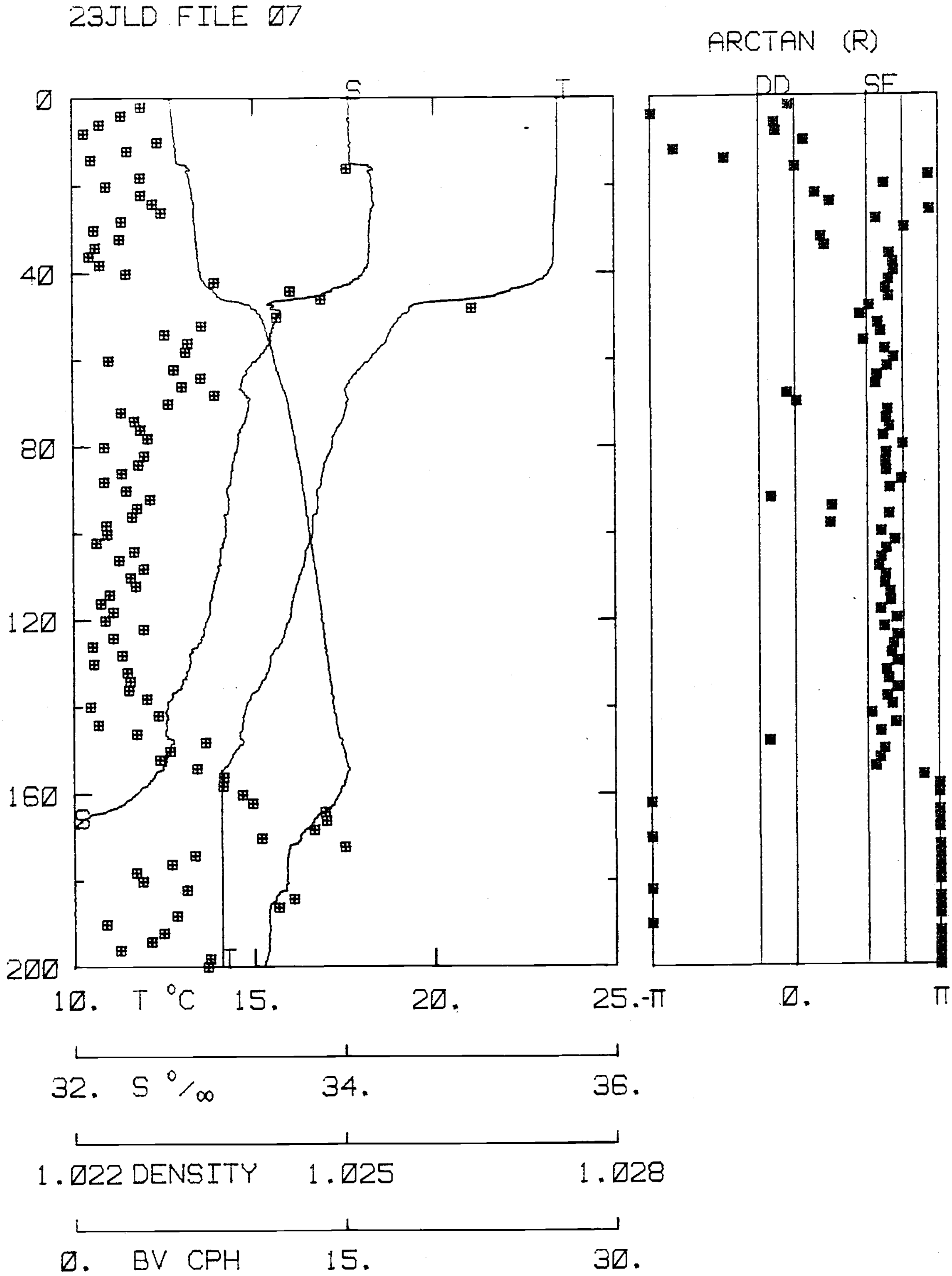
LOCATION 31°45'N 154°52'W

Profile spacing 900m

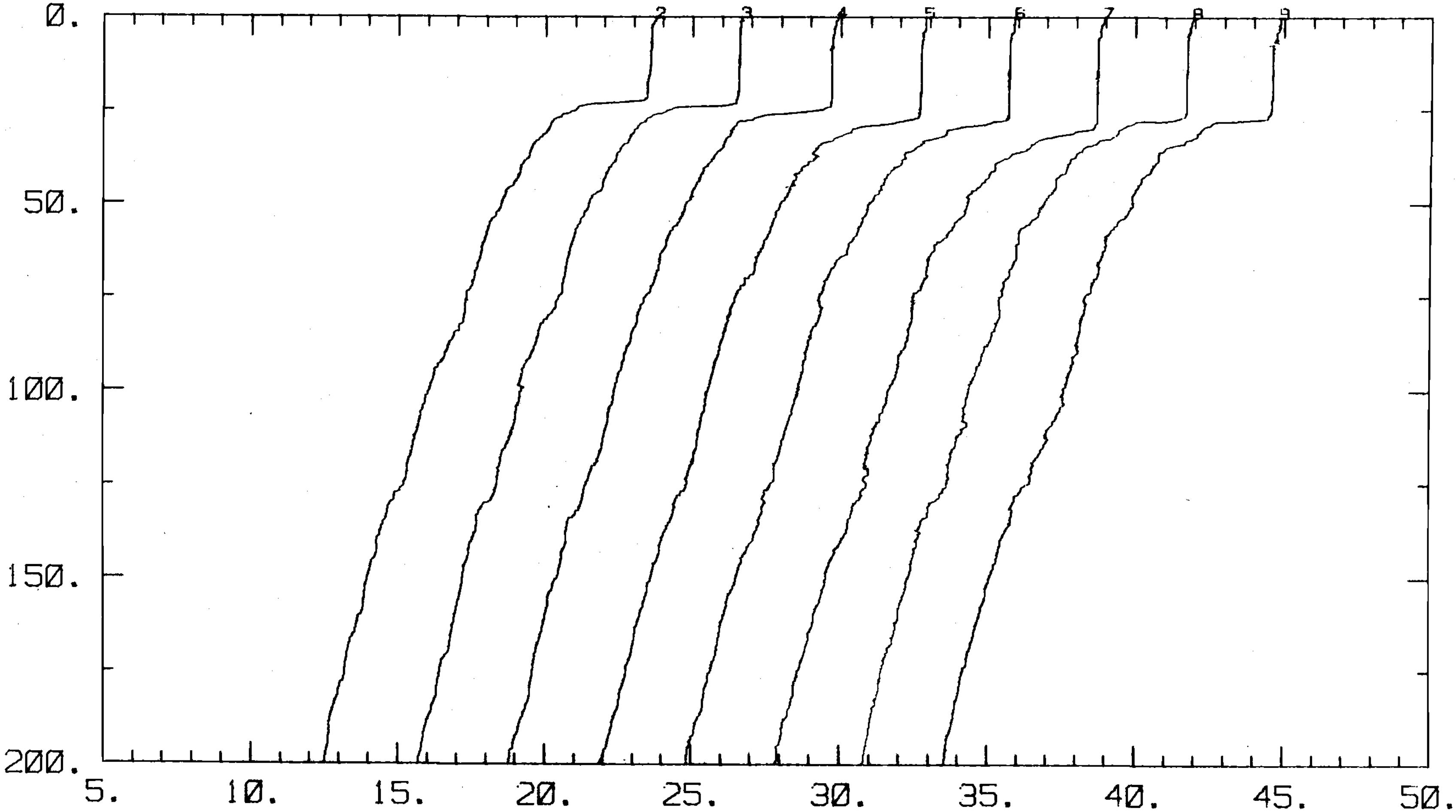
WIND SPEED 9. m/s

DIRECTION 060°

Ship's heading 190°


23JLD FILE Ø7
ARCTAN (R)
S
T
DD
SF
Ø
4Ø
8Ø
12Ø
16Ø
2ØØ
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S ‰ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

23JL82EN



188

SEQUENCE 19 PAGE 1

START TIME 22:24 GMT 07/23/82

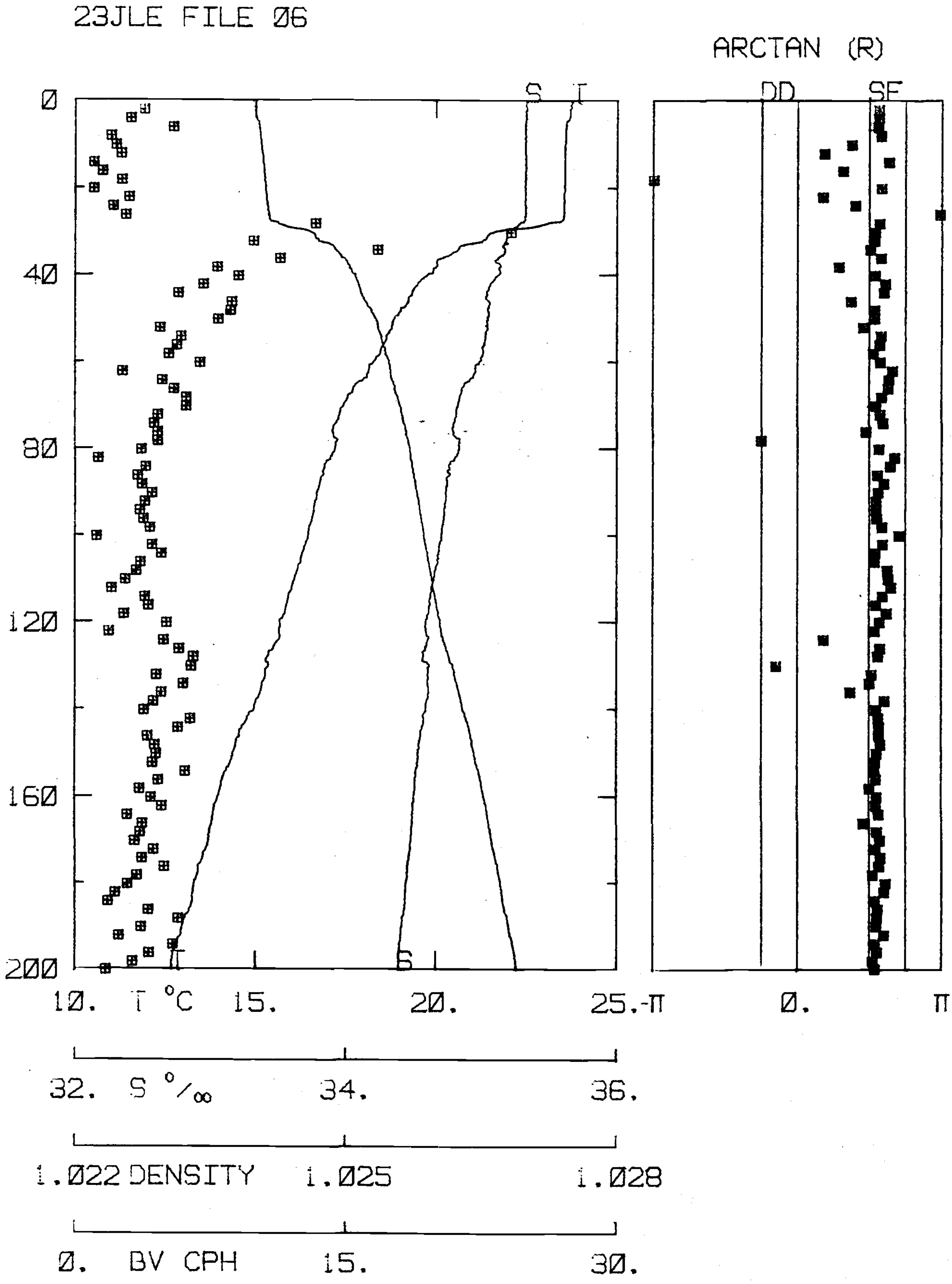
LOCATION 30°21'N 155°14'W

Profile spacing 900m

WIND SPEED 6. m/s

DIRECTION 070°

Ship's heading 200°



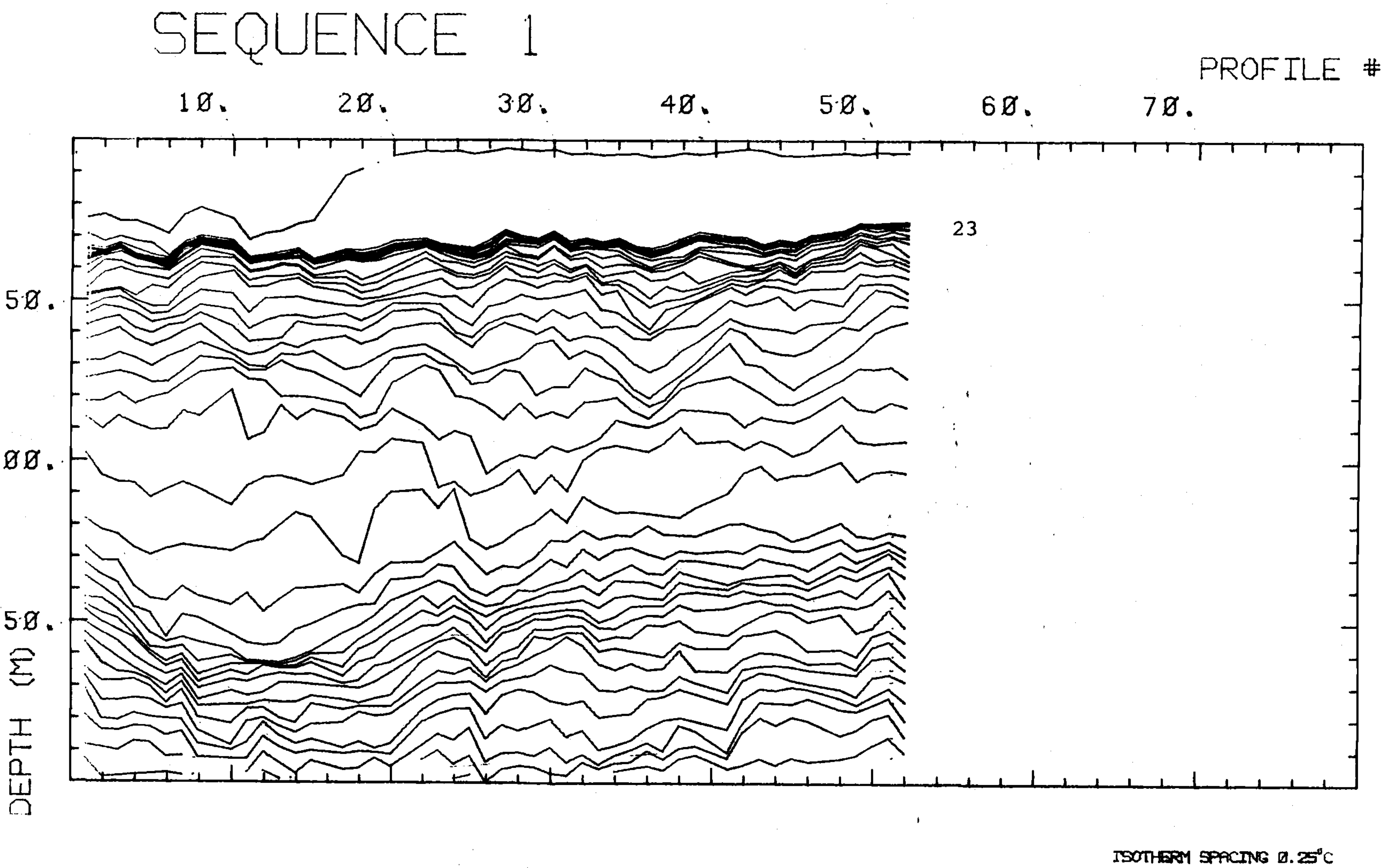
23JLE FILE Ø6
ARCTAN (R)
S
T
DD
SF
Ø
40
80
120
160
200
1Ø. T °C 15. 2Ø. 25.
-π Ø. π
32. S °/∞ 34. 36.
1.Ø22 DENSITY 1.Ø25 1.Ø28
Ø. BV CPH 15. 3Ø.

b) Plots of isotherms vs. depth

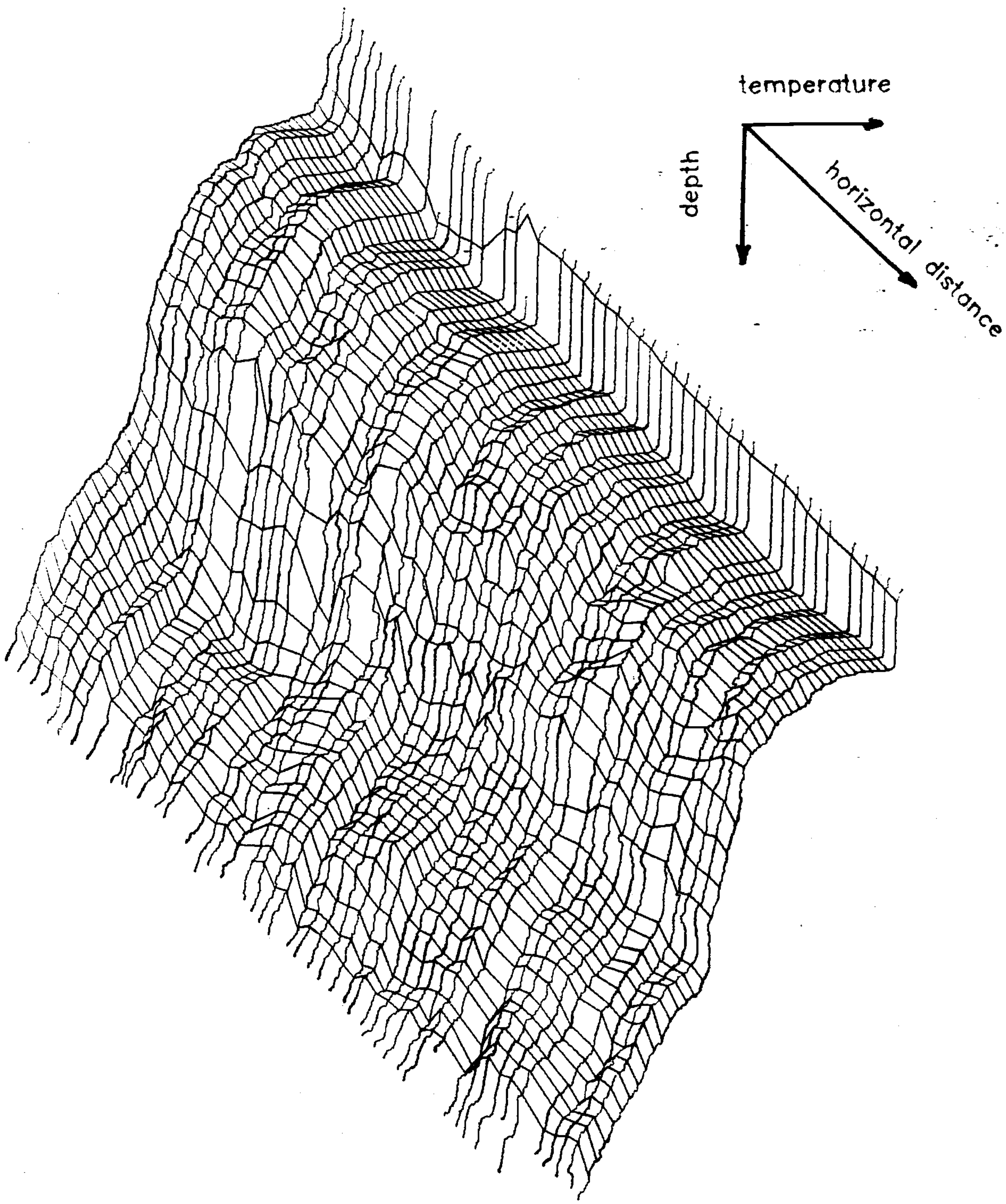
Two additional plots are presented for each sequence of profiles. Each plot is a representation of isotherms for the whole sequence. The spacing between isotherms is 0.25 or 0.50 degree Celsius, as indicated in the bottom right hand corner of the plot.

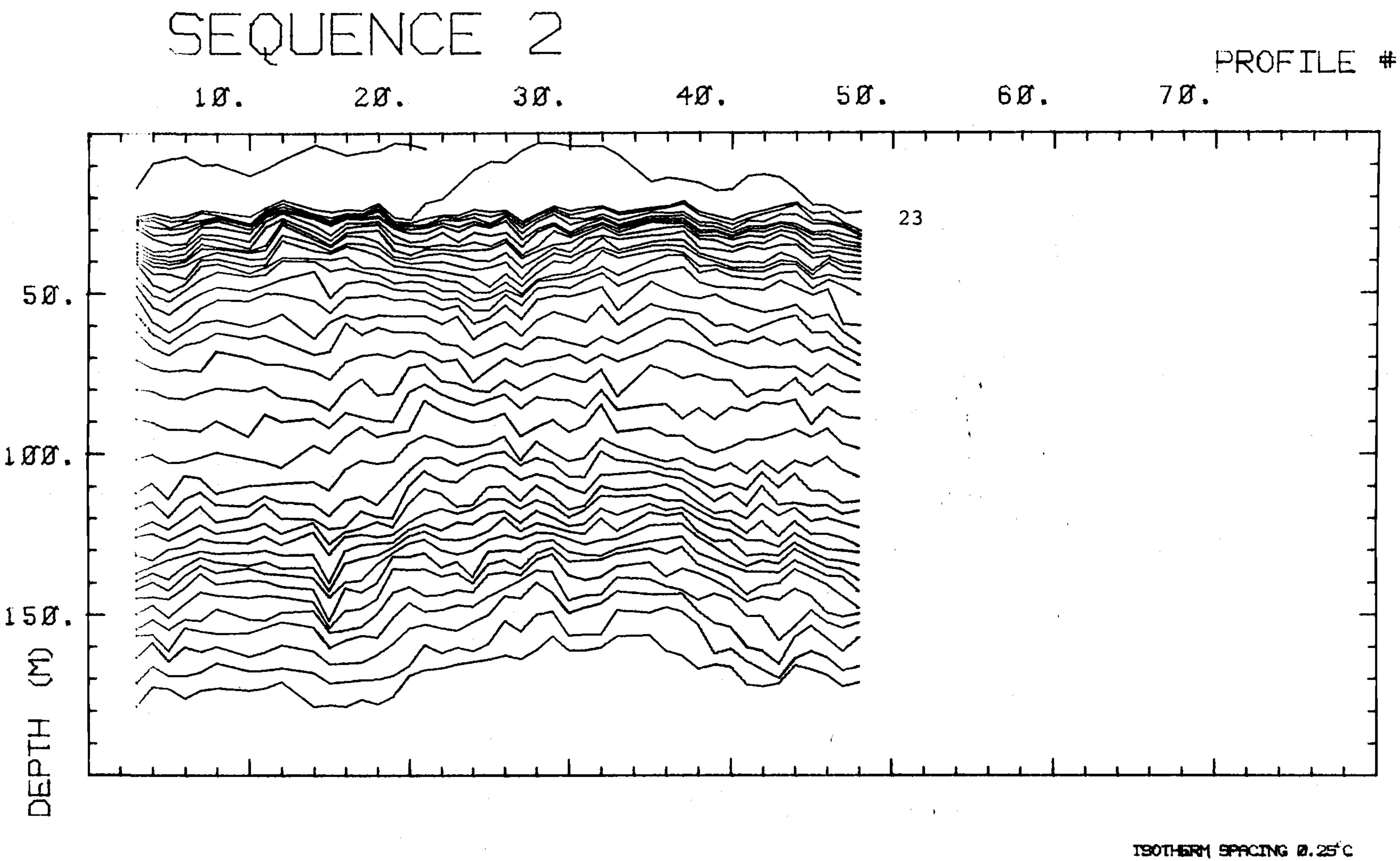
The first plot is two dimensional, depth (in meters, 50 meters per inch) versus profile number (10 profiles per inch).

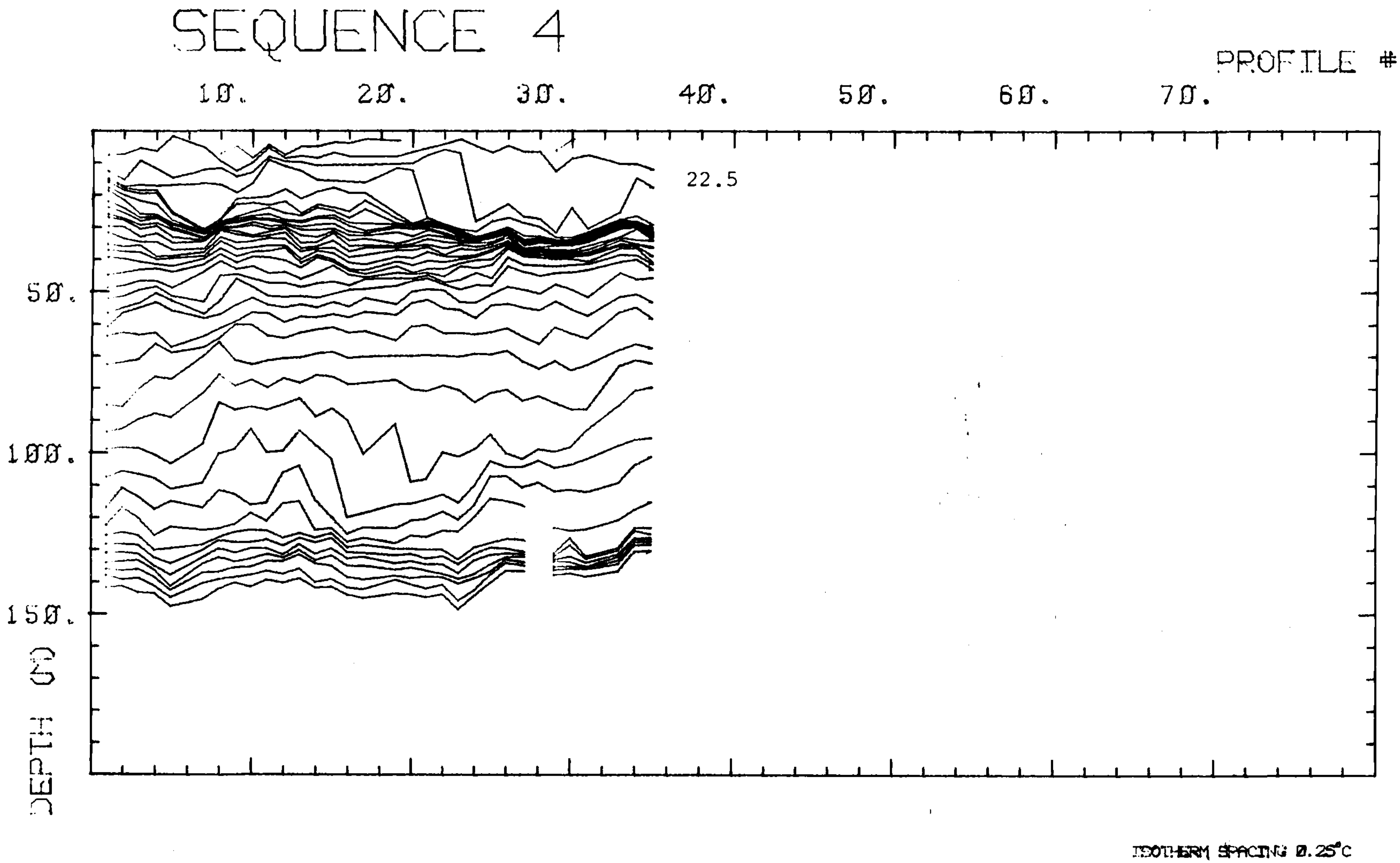
The second plot is a different representation of the same information, and the scales along the axis are the same. The "profile number" axis is directed 45 degrees below the horizontal, and thus the profiles underlying the isotherms are staggered and can be shown. The vertical axis is depth (in meters), the horizontal axis is temperature (in degrees Celsius, 5 degree Celsius per inch). This plot is not in true perspective since distances are preserved along each axis. This presentation has the advantage that distances measured from the plot are proportional to the quantities represented.

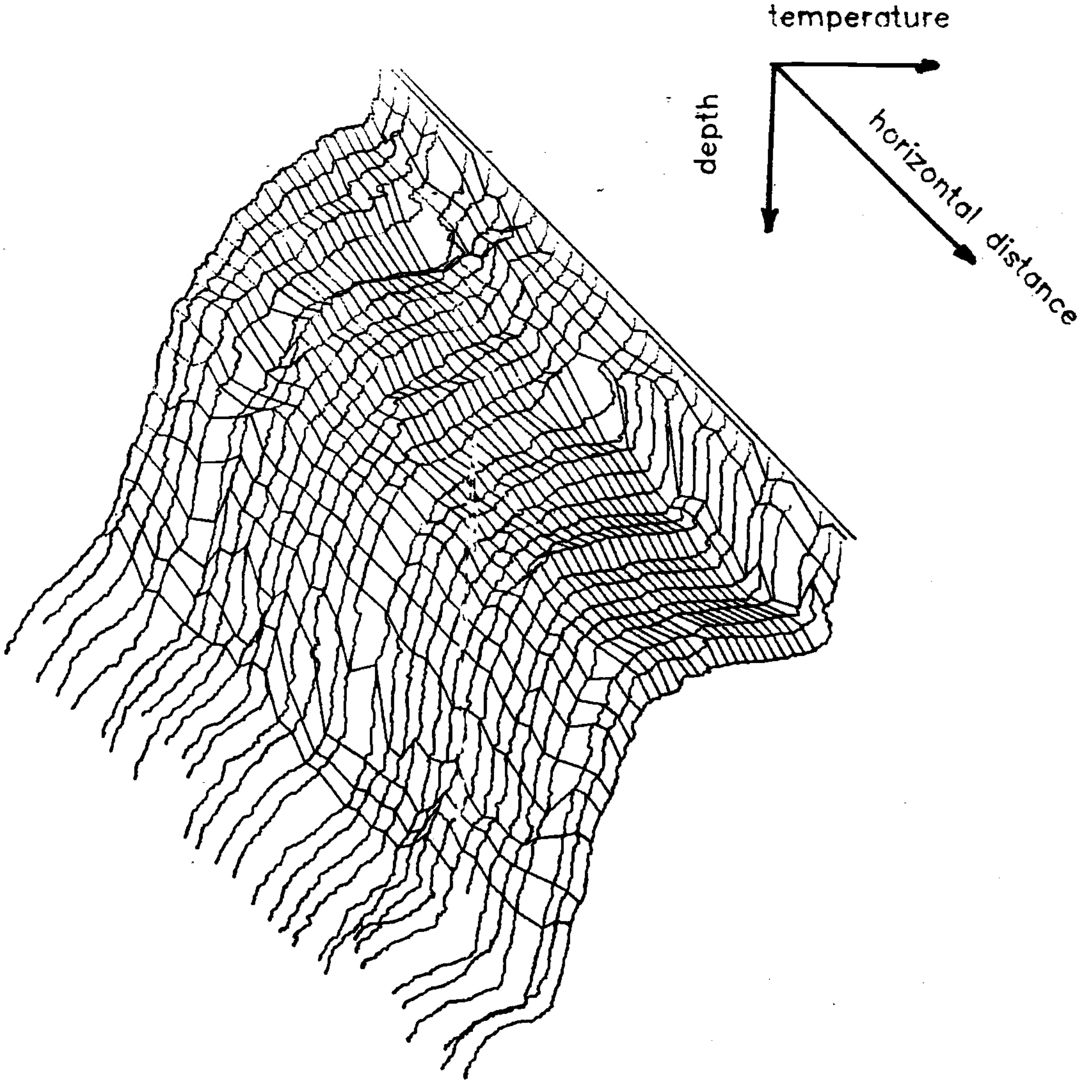

SEQUENCE 1
PROFILE #
10.
20.
30.
40.
50.
60.
70.
23
50.
100.
150.
DEPTH (M)
ISOTHERM SPACING 0.25°C

194

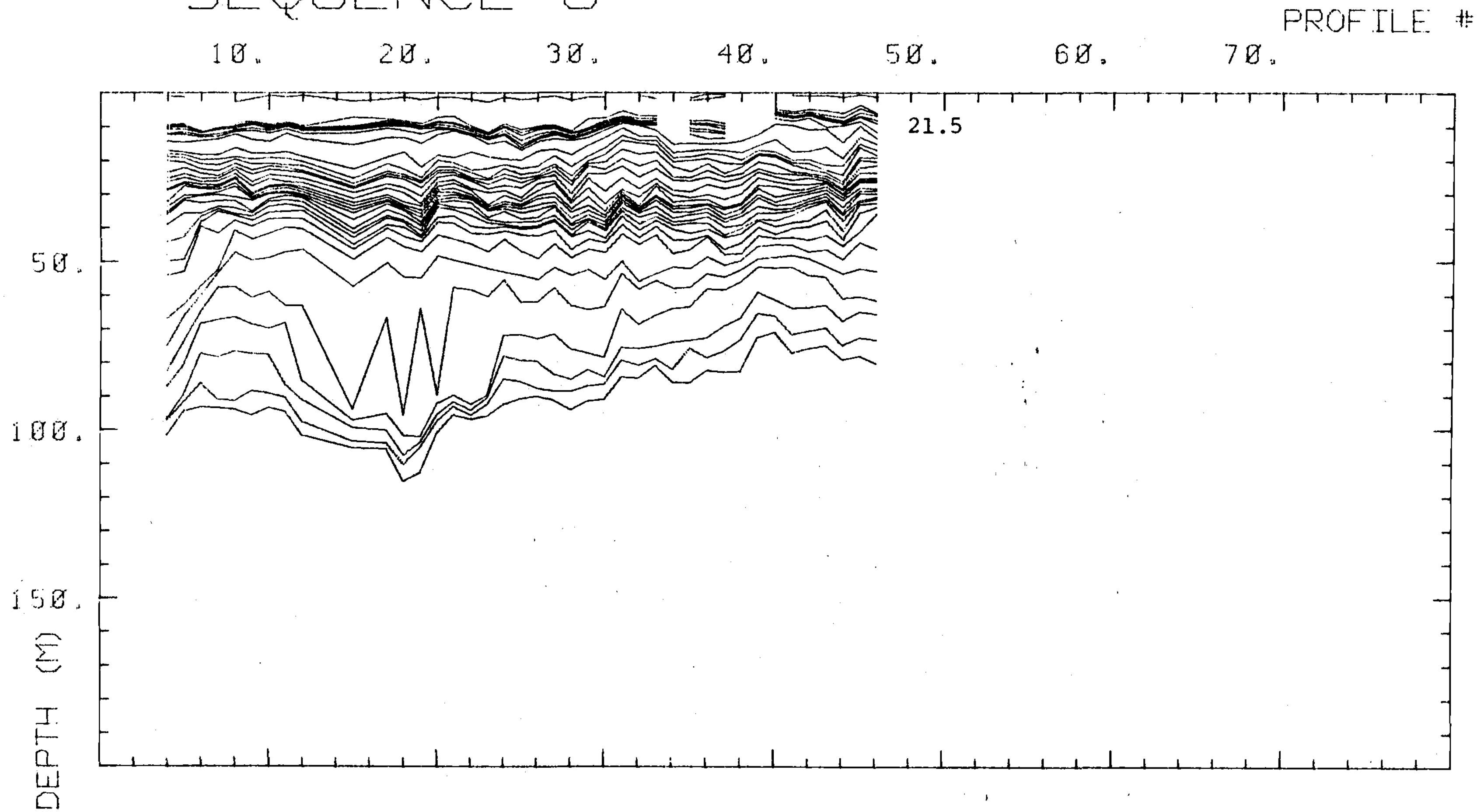

temperature
depth
horizontal distance


SEQUENCE 2
PROFILE #
1Ø.
2Ø.
3Ø.
4Ø.
5Ø.
6Ø.
7Ø.
23
5Ø.
1ØØ.
15Ø.
DEPTH (M)
ISOTHERM SPACING Ø.25°C

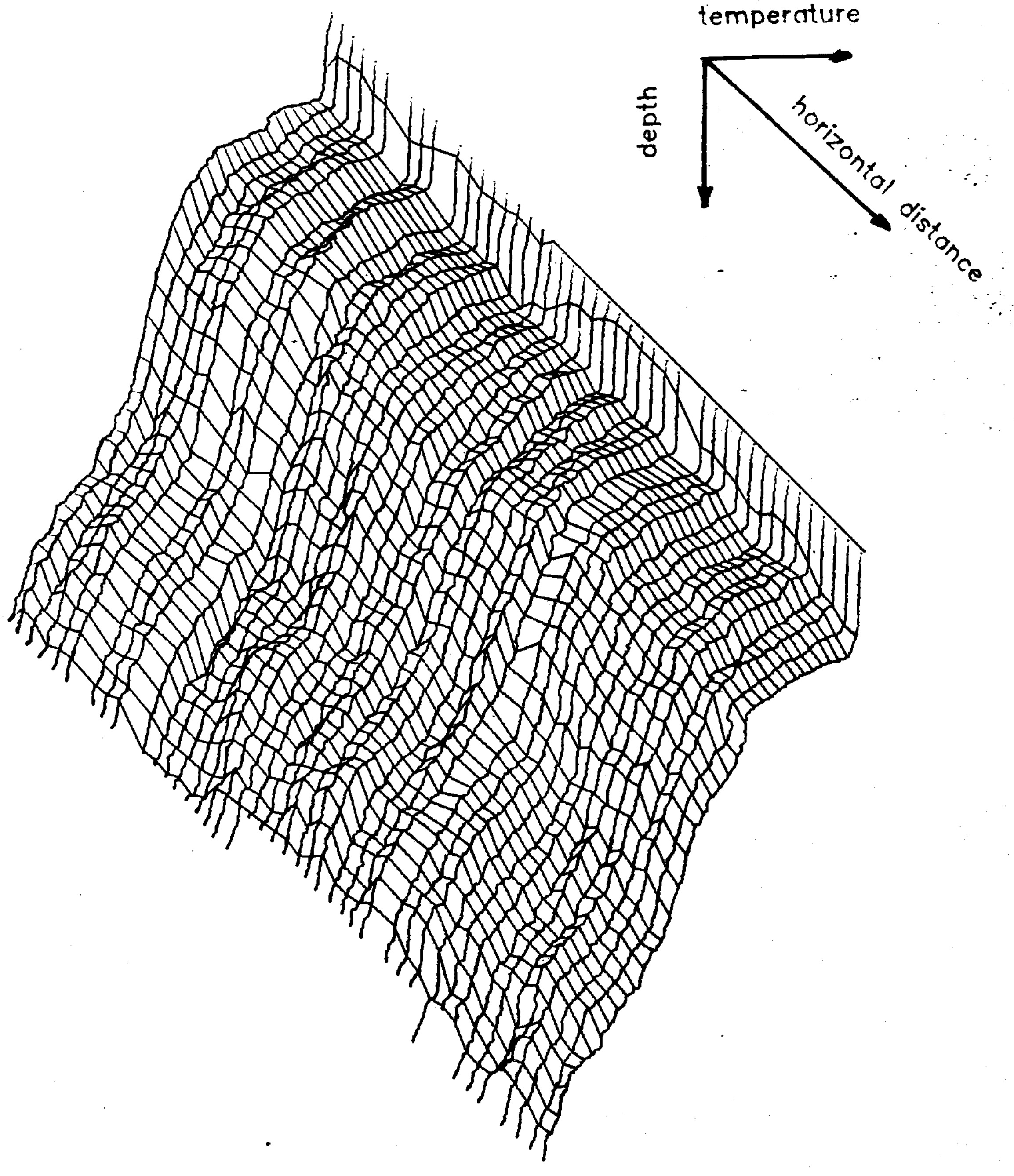

SEQUENCE 4
PROFILE #
10.
20.
30.
40.
50.
60.
70.
22.5
50.
100.
150.
DEPTH (M)
ISOTHERM SPACING 0.25°C


temperature
depth
horizontal distance

SEQUENCE 6

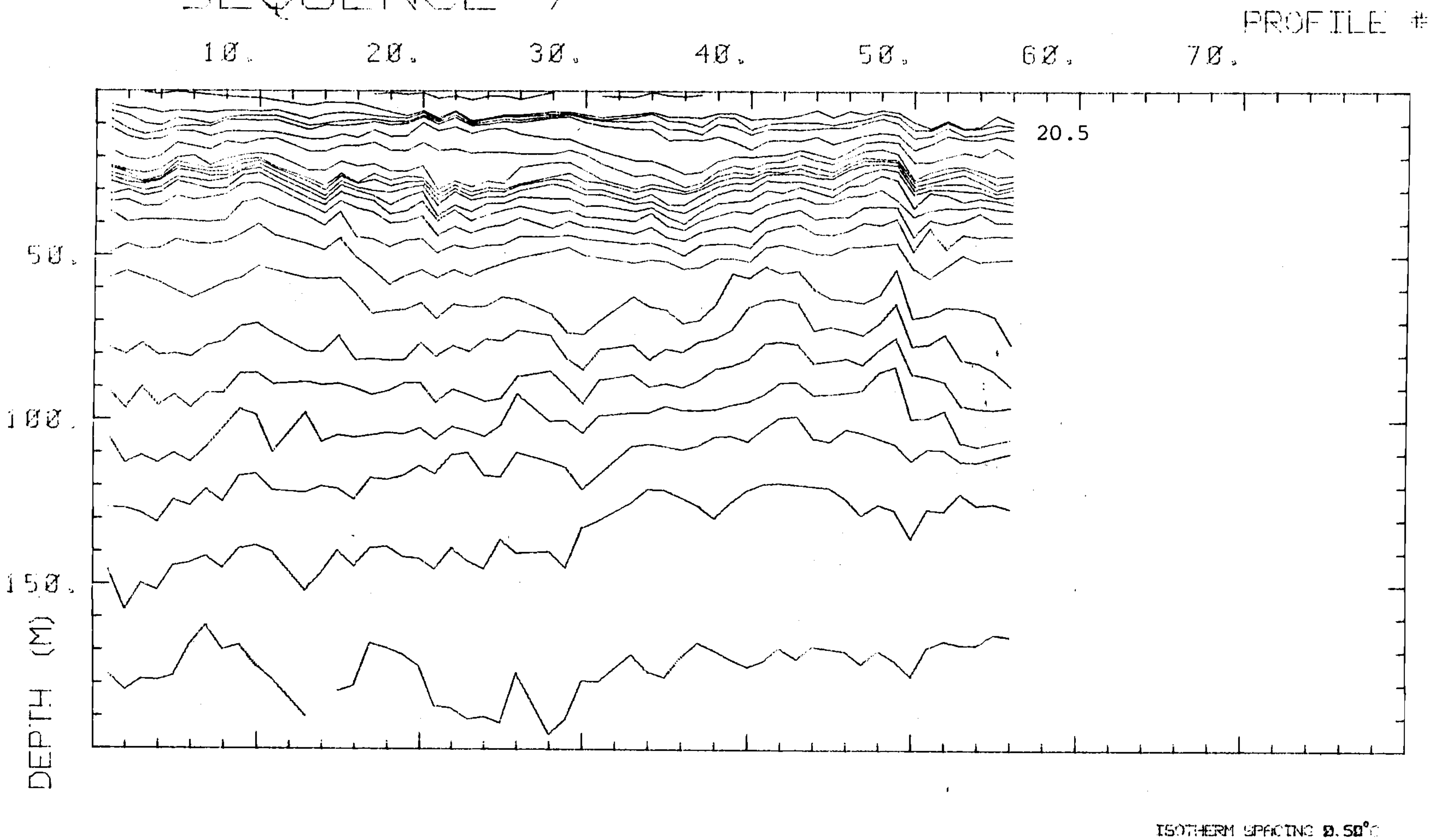


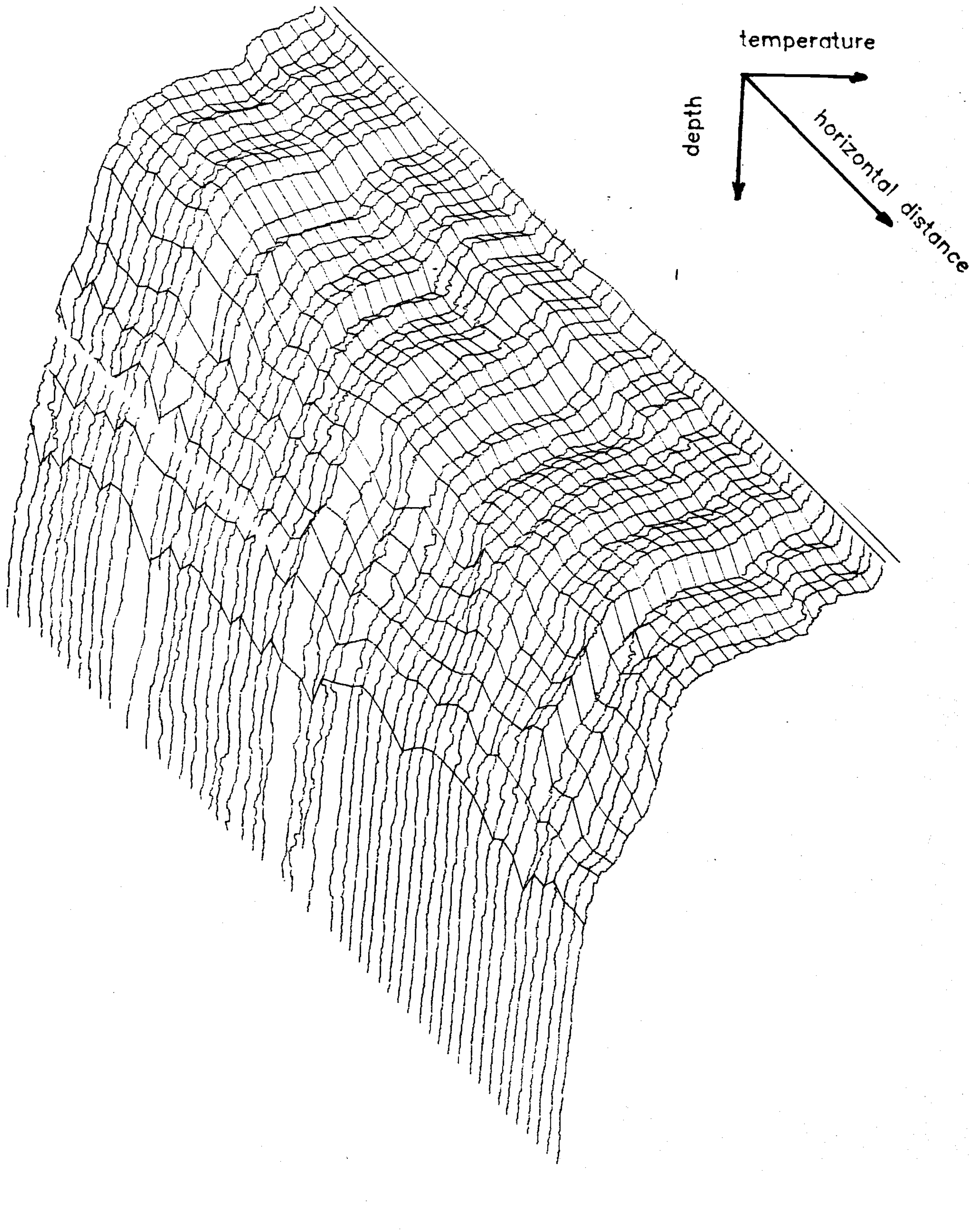
ISOTHERM SPACING 0.25°C



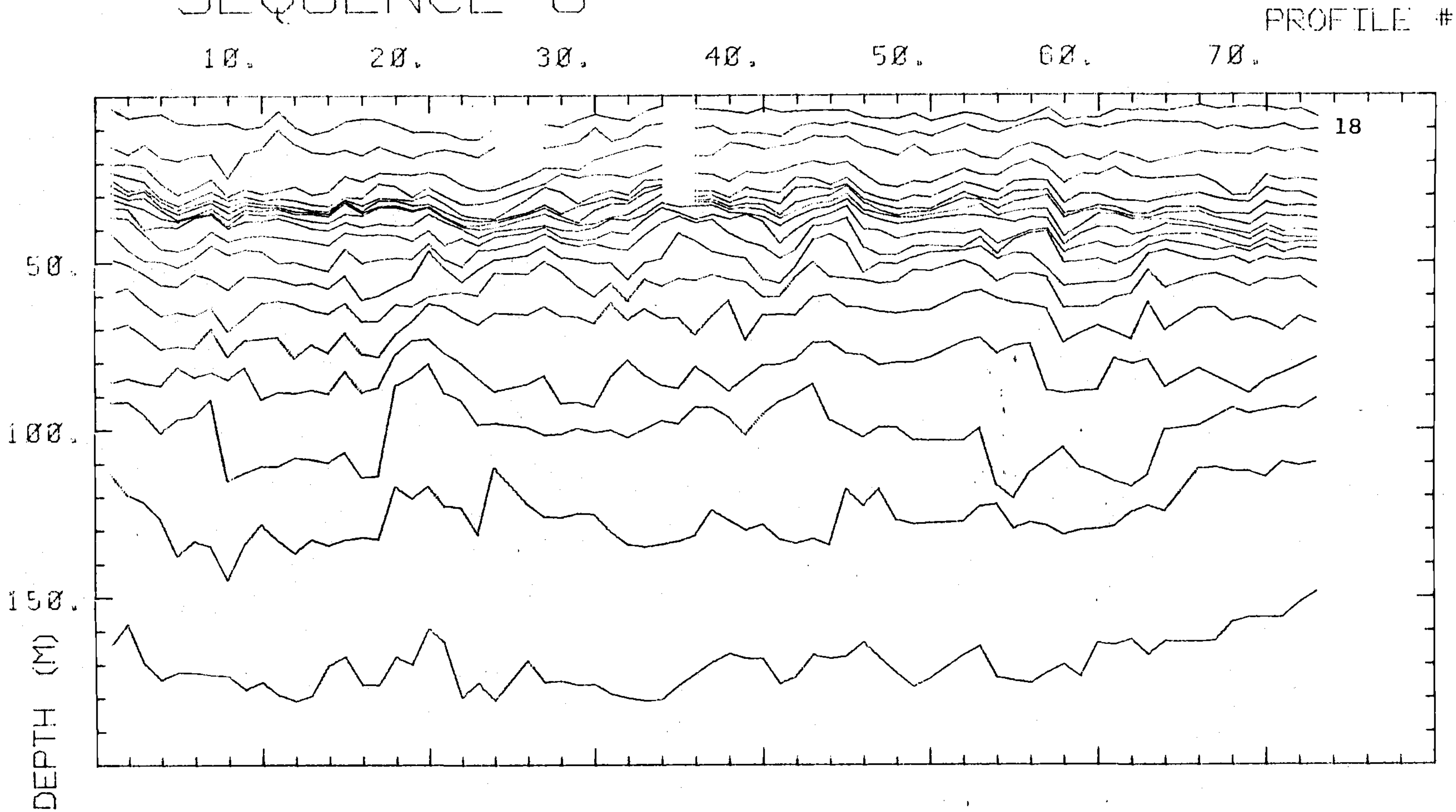
temperature
depth
horizontal distance

SEQUENCE 7

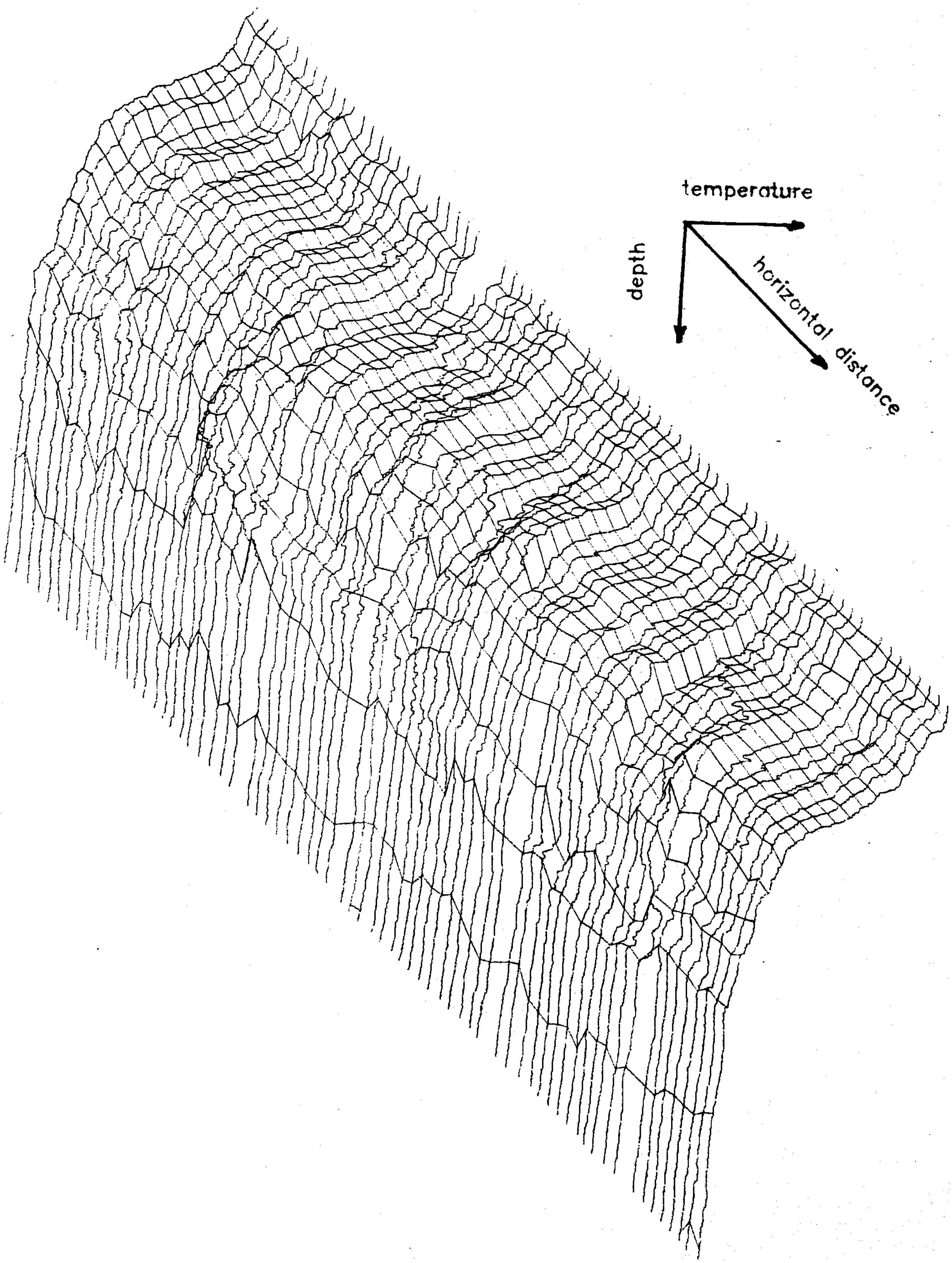

PROFILE #
10.
20.
30.
40.
50.
60.
70.
20.5
50.
100.
150.
DEPTH (M)
ISOTHERM SPACING 0.50°C


temperature
depth
horizontal distance

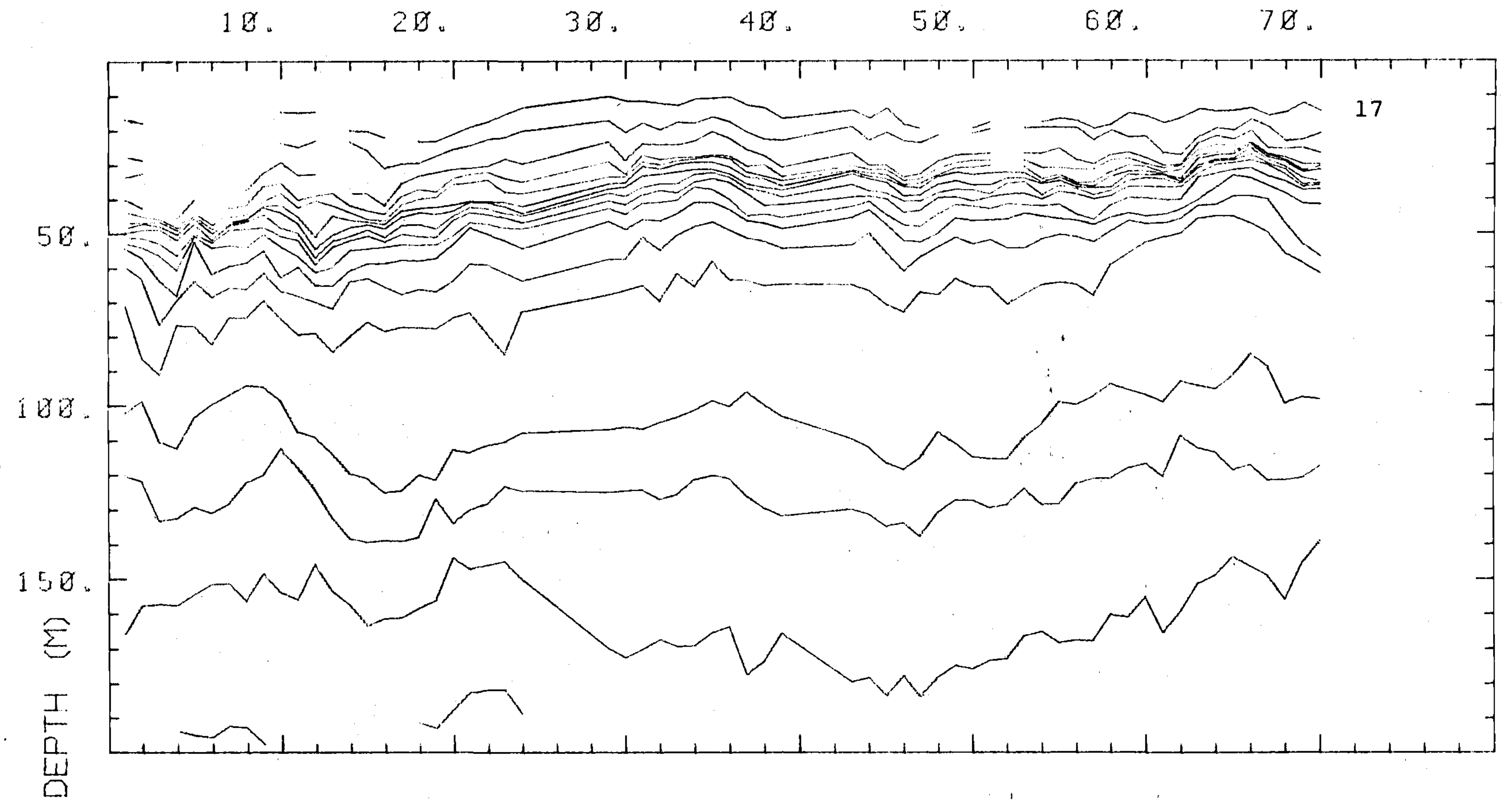
SEQUENCE 8



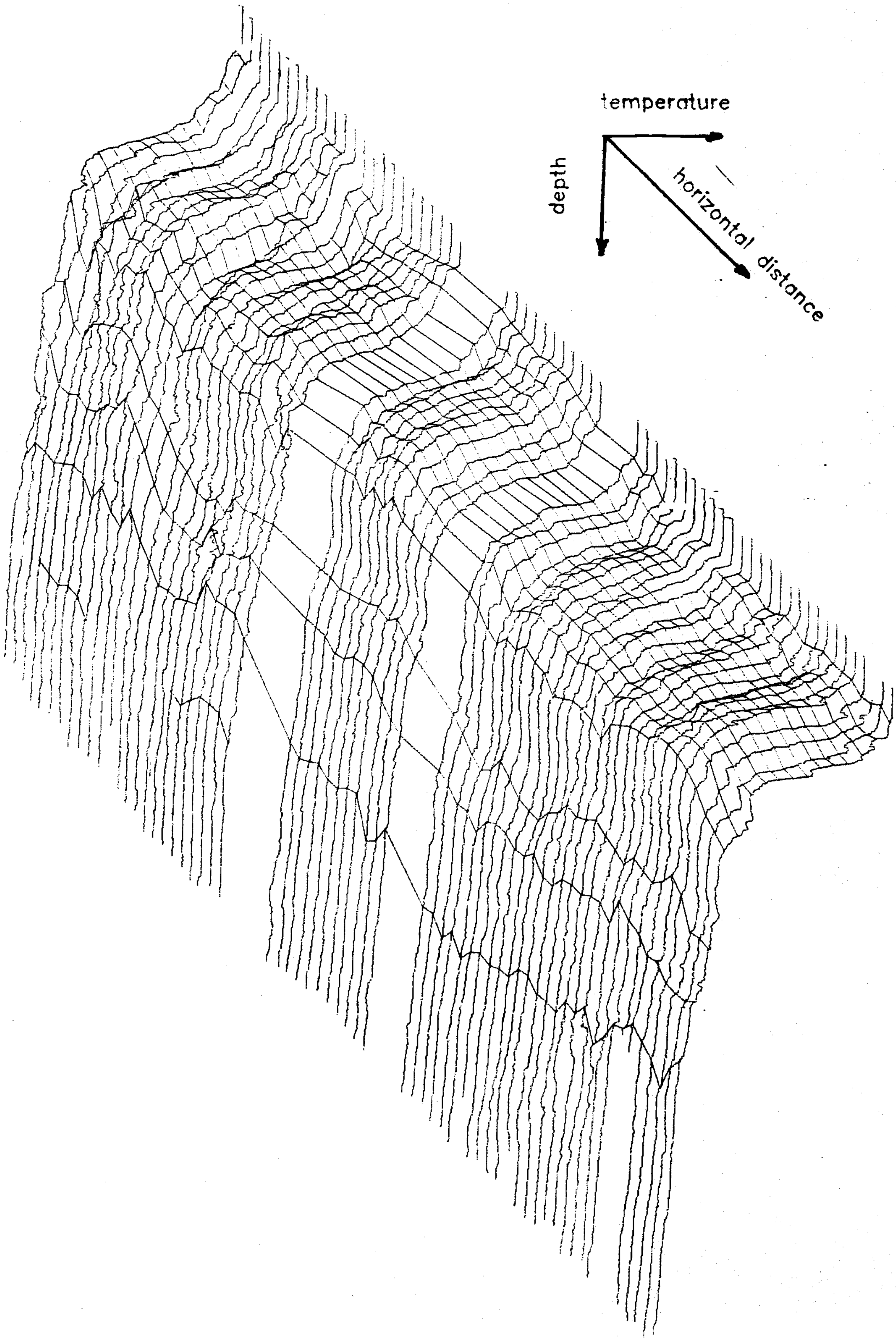
ISOTHERM SPACING Ø.5Ø°C


temperature
depth
horizontal distance

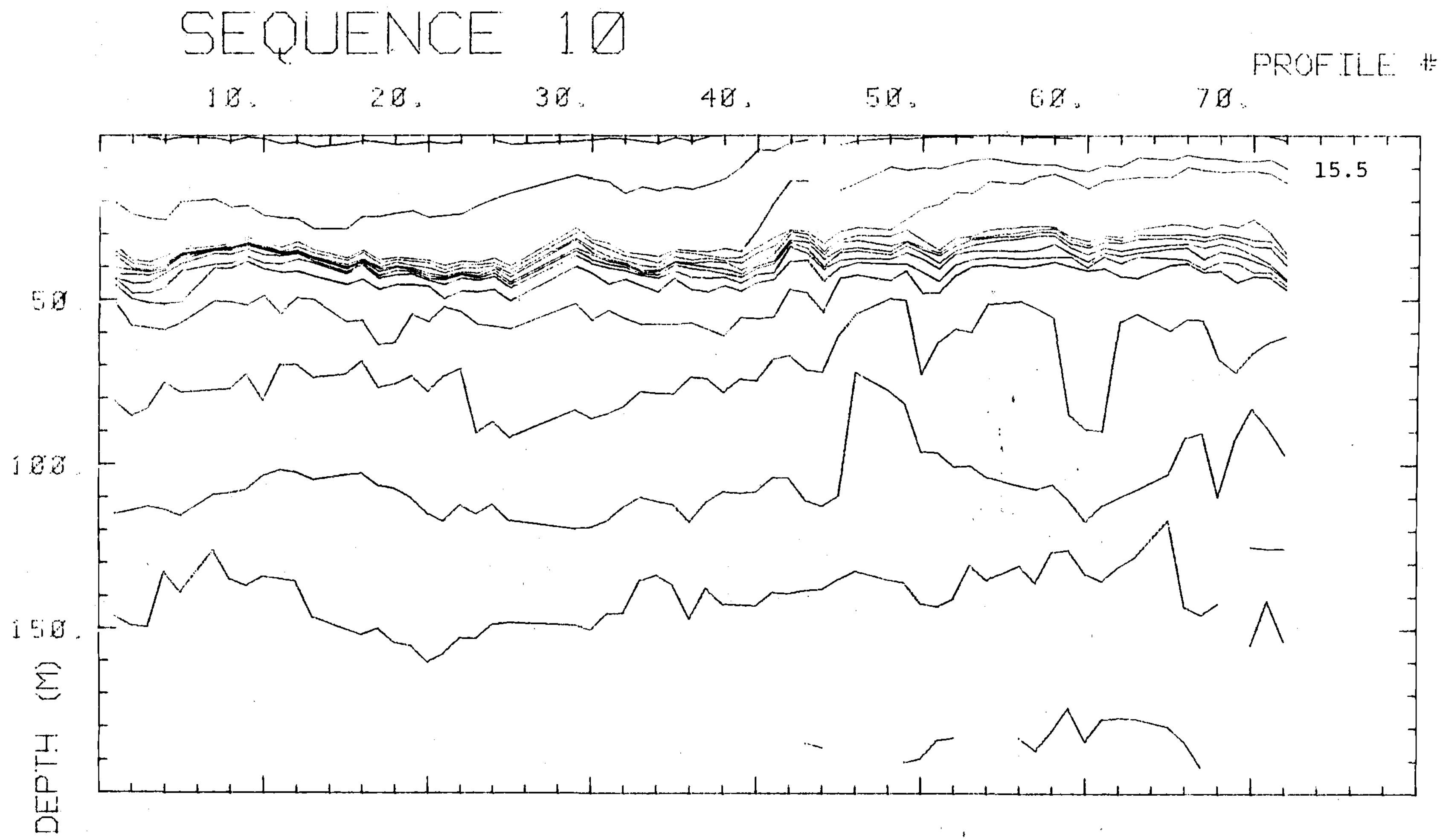
SEQUENCE 9



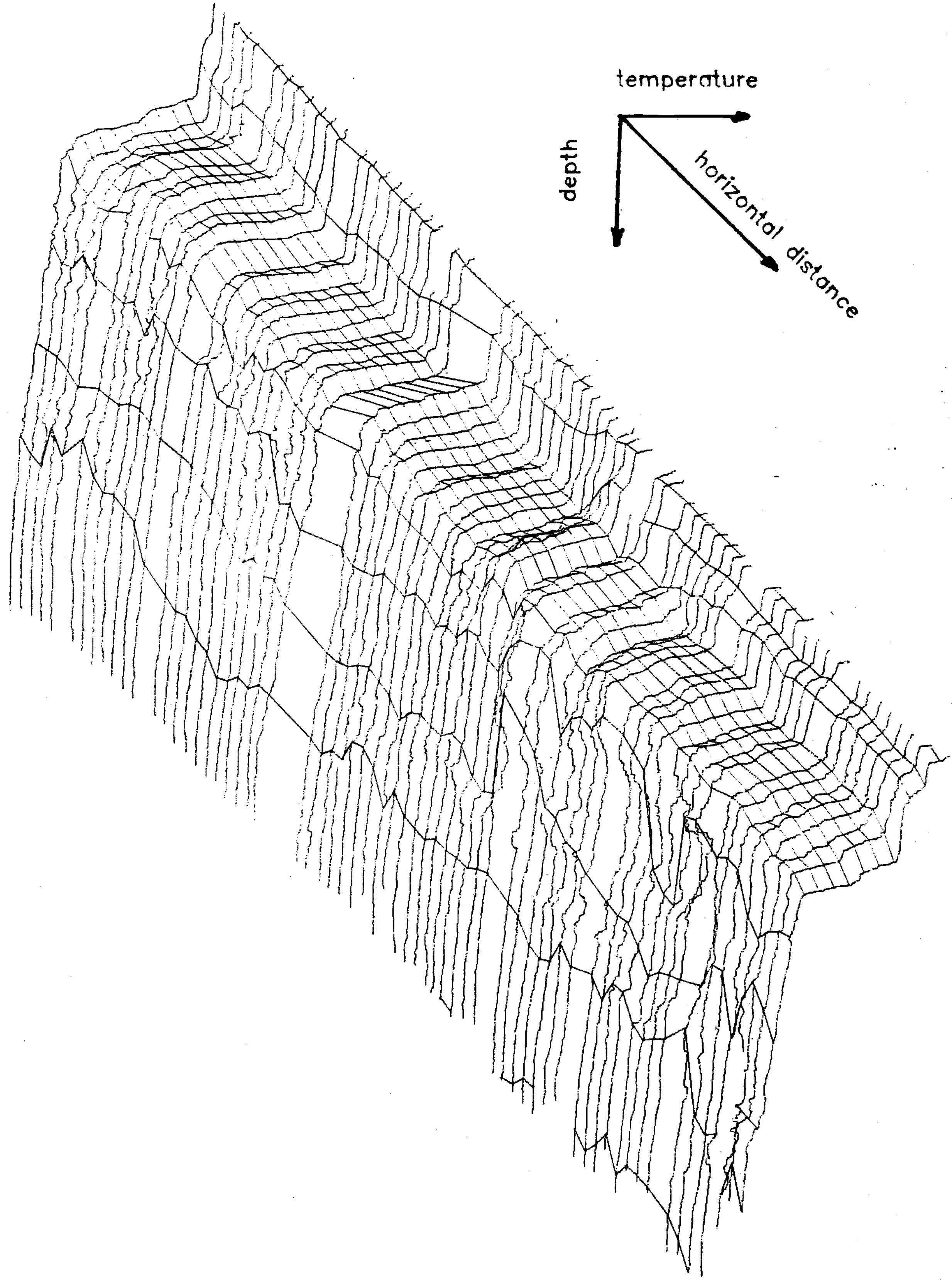
ISOTHERM SPACING 0.50°C



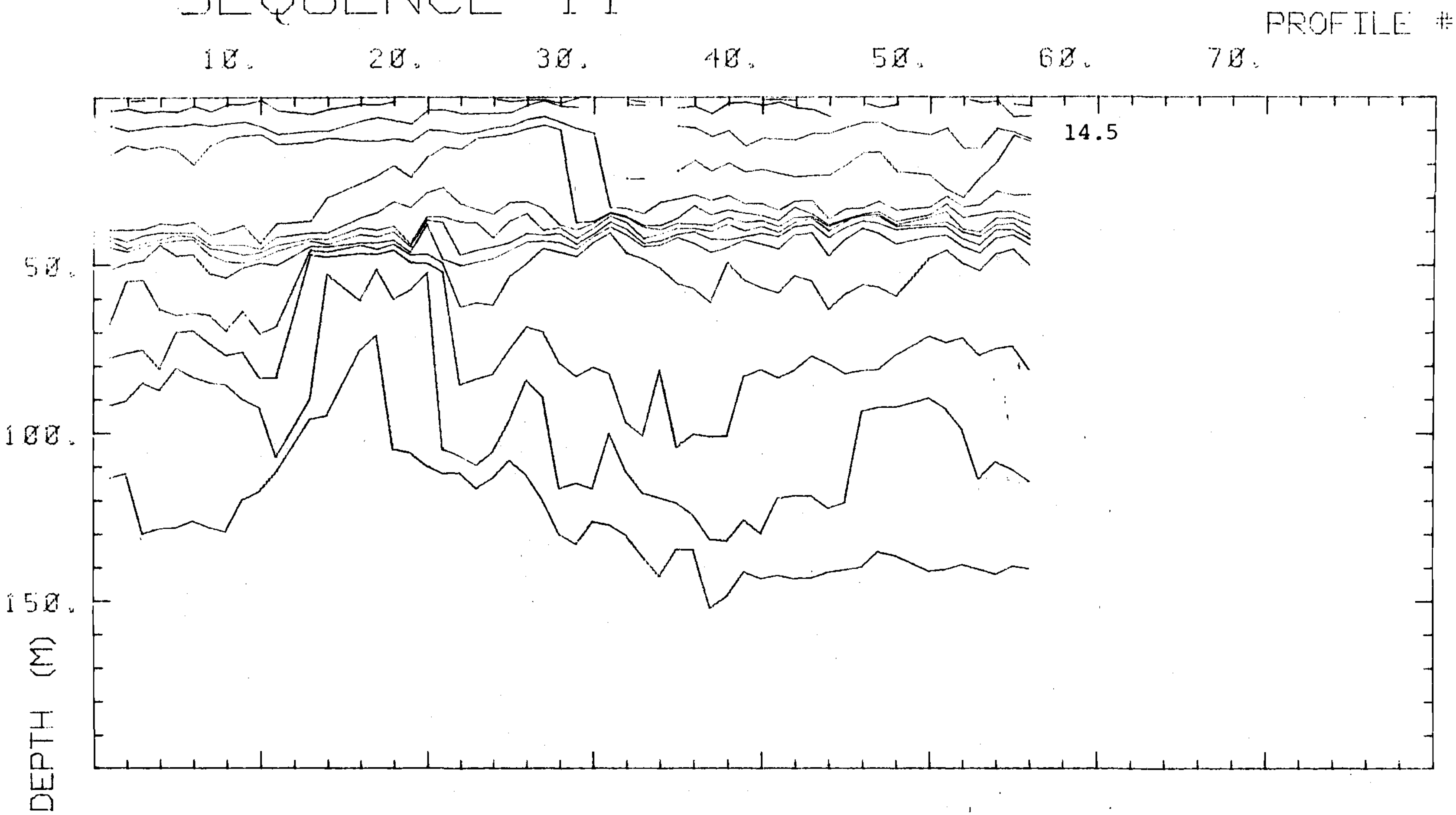
temperature
depth
horizontal distance



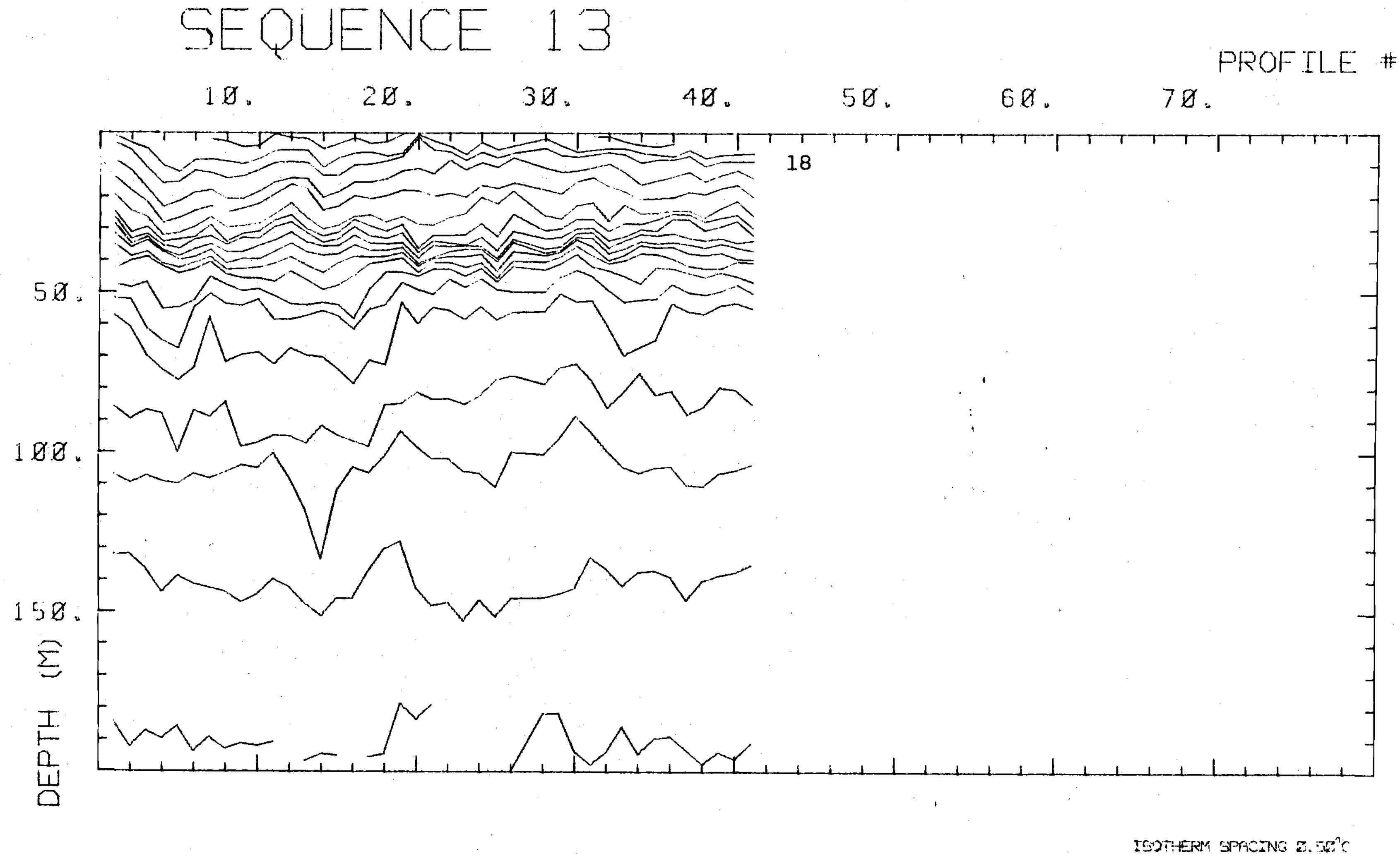
ISOTHERM SPACING 0.[illegible]0°C

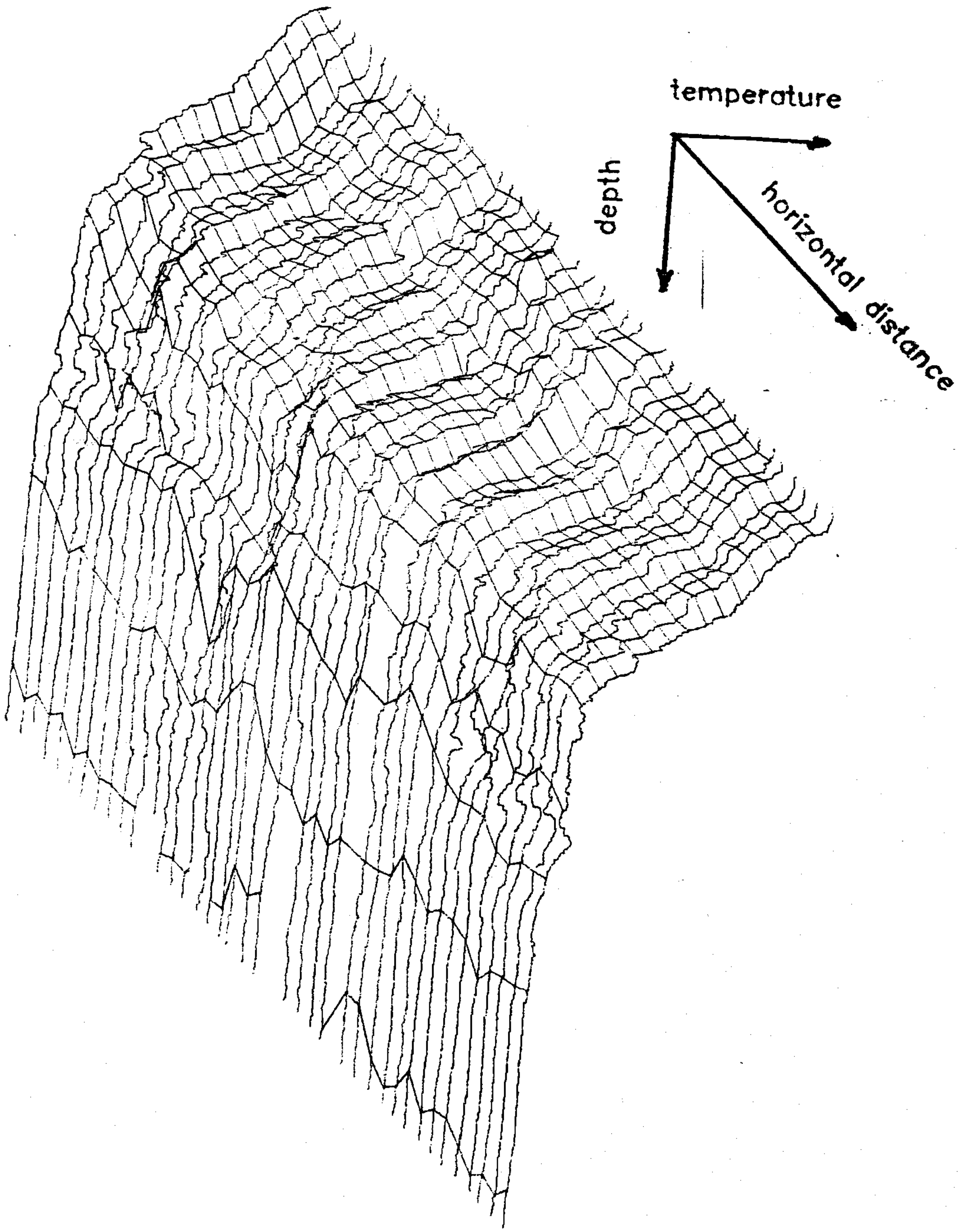

temperature
depth
horizontal distance

SEQUENCE 11

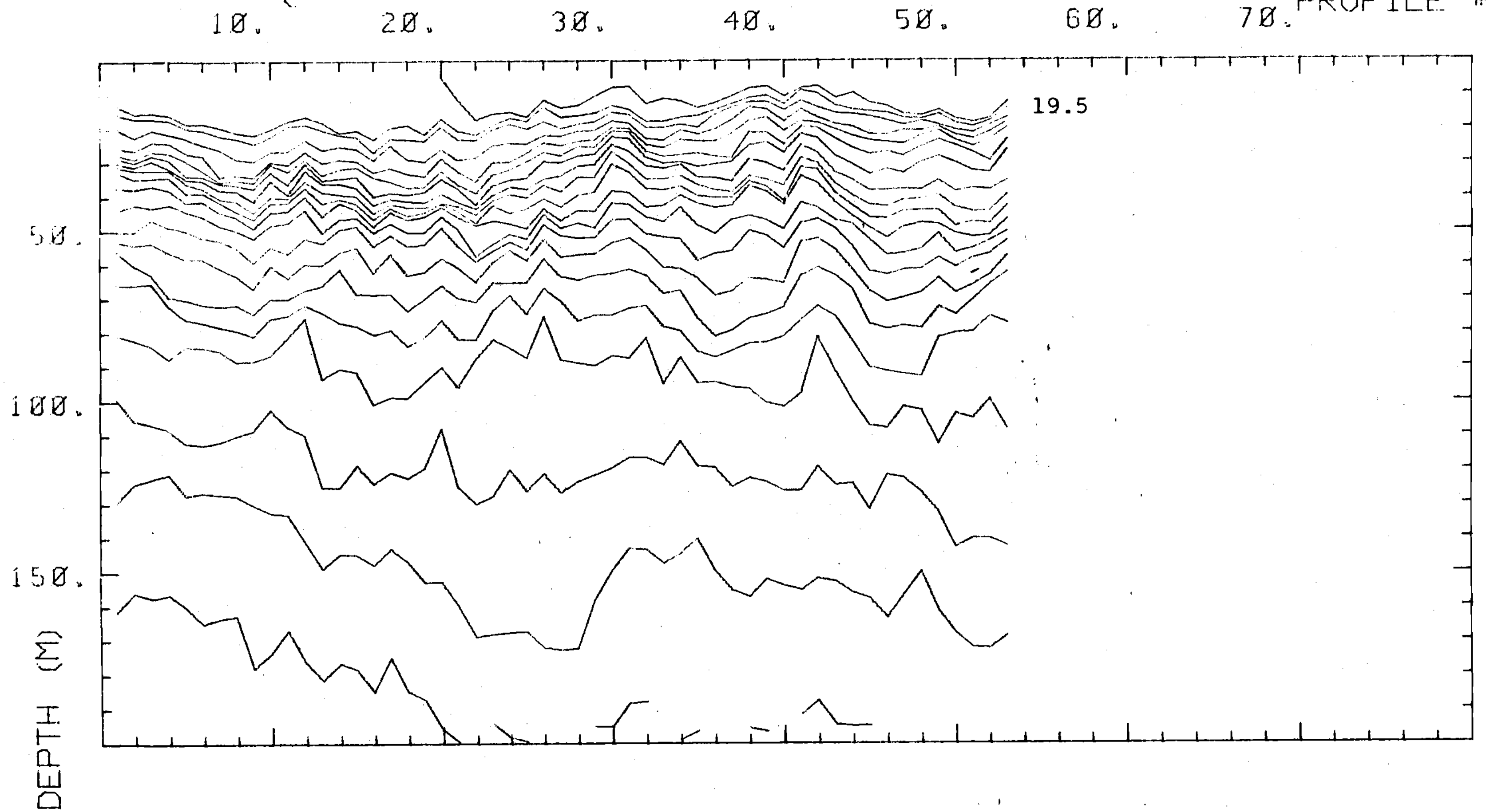


ISOTHERM SPACING Ø.5Ø°C

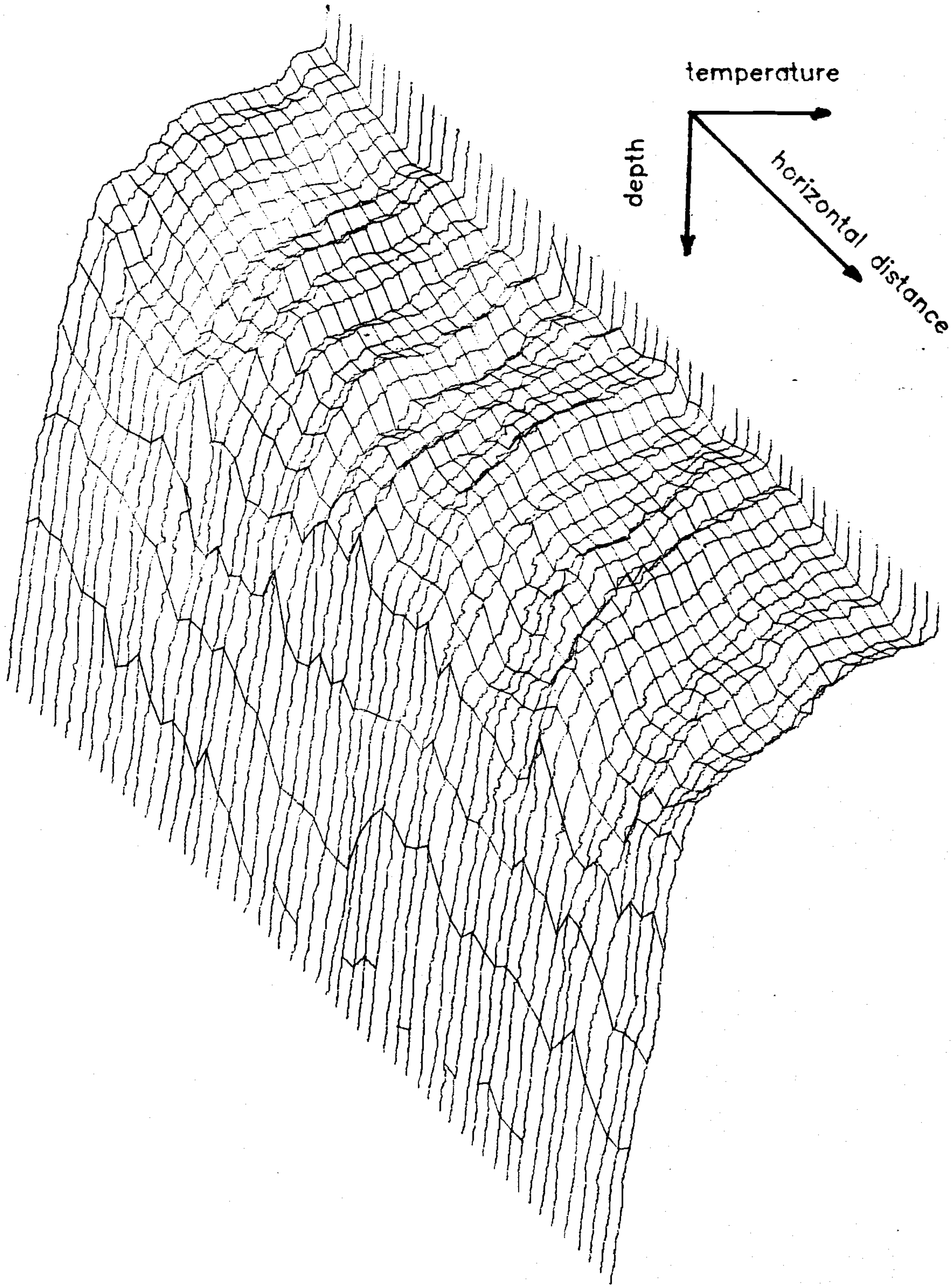

SEQUENCE 13
PROFILE #
10.
20.
30.
40.
50.
60.
70.
18
50.
100.
150.
DEPTH (M)
ISOTHERM SPACING 0.50°C


temperature
depth
horizontal distance

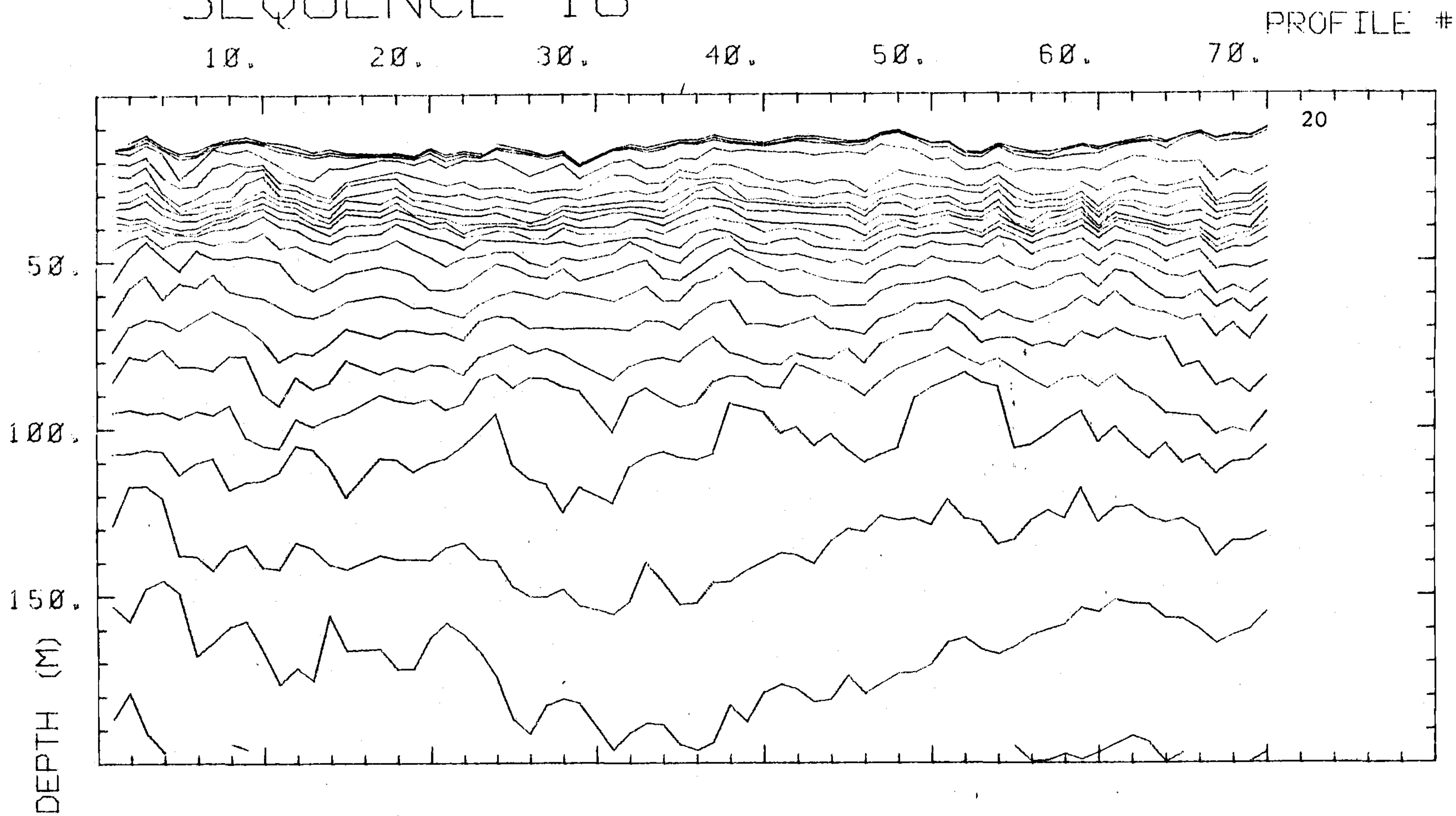
SEQUENCE 15



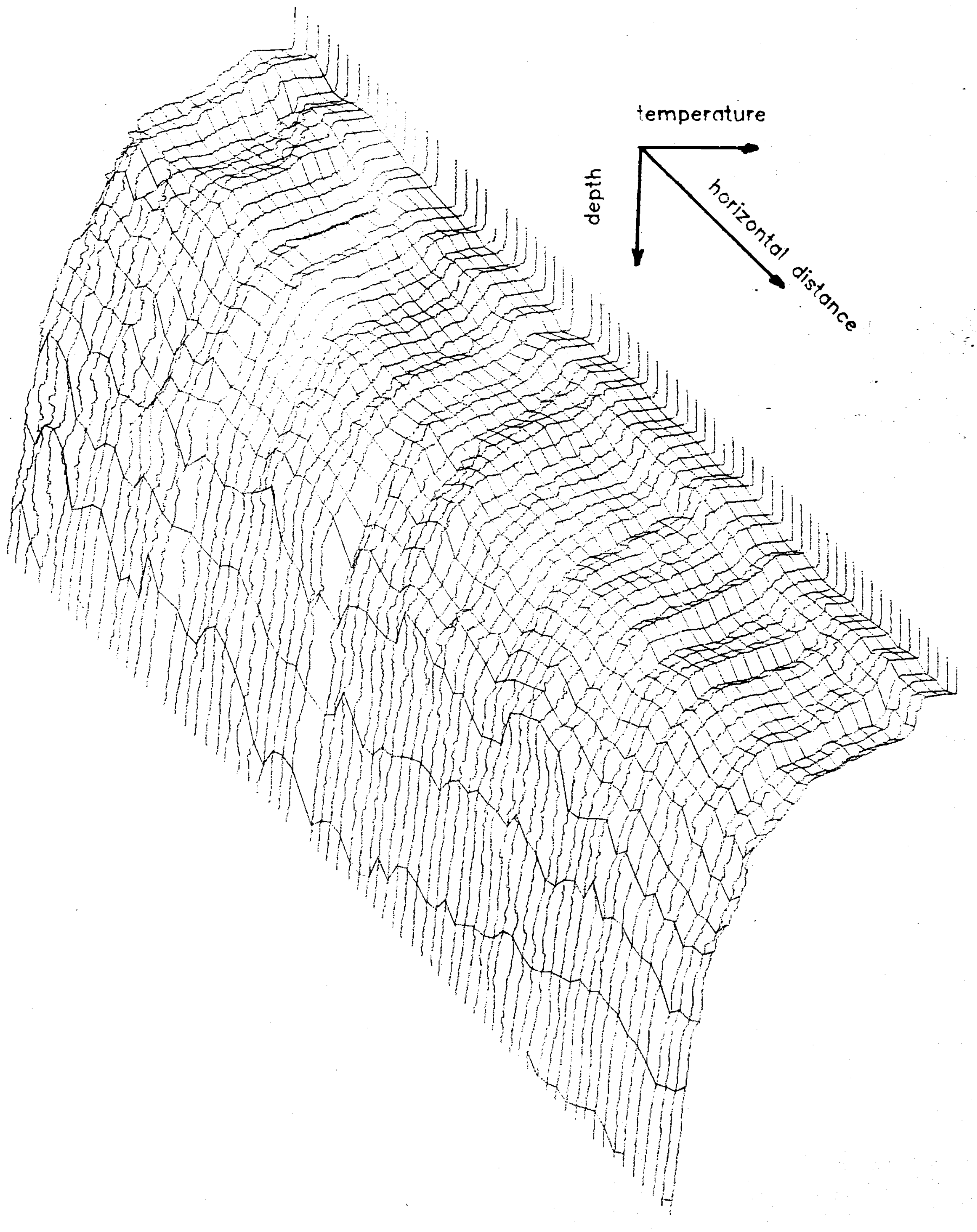
ISOTHERM SPACING 0.50°C


temperature
depth
horizontal distance

SEQUENCE 16

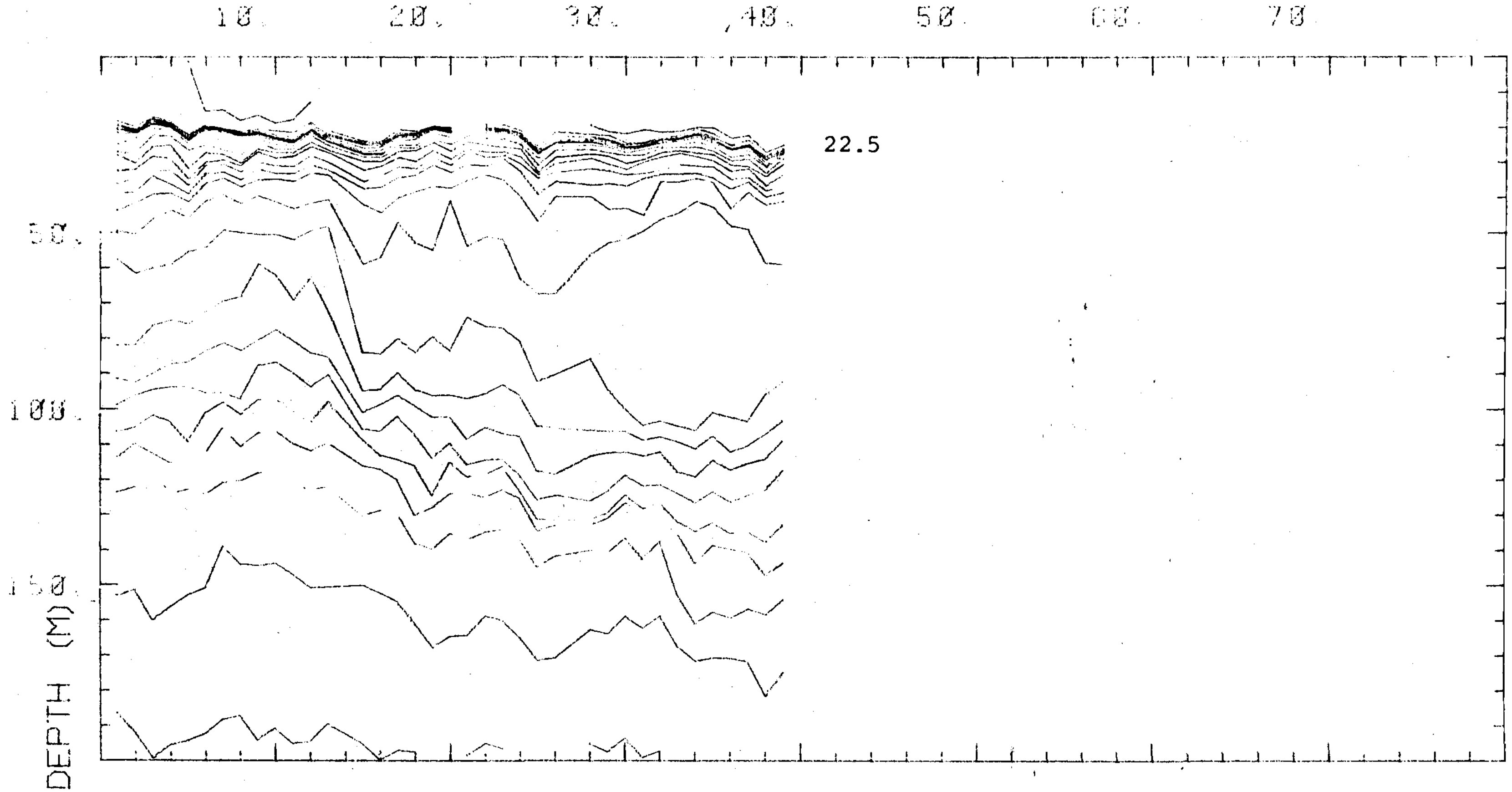


ISOTHERM SPACING 2.50°C

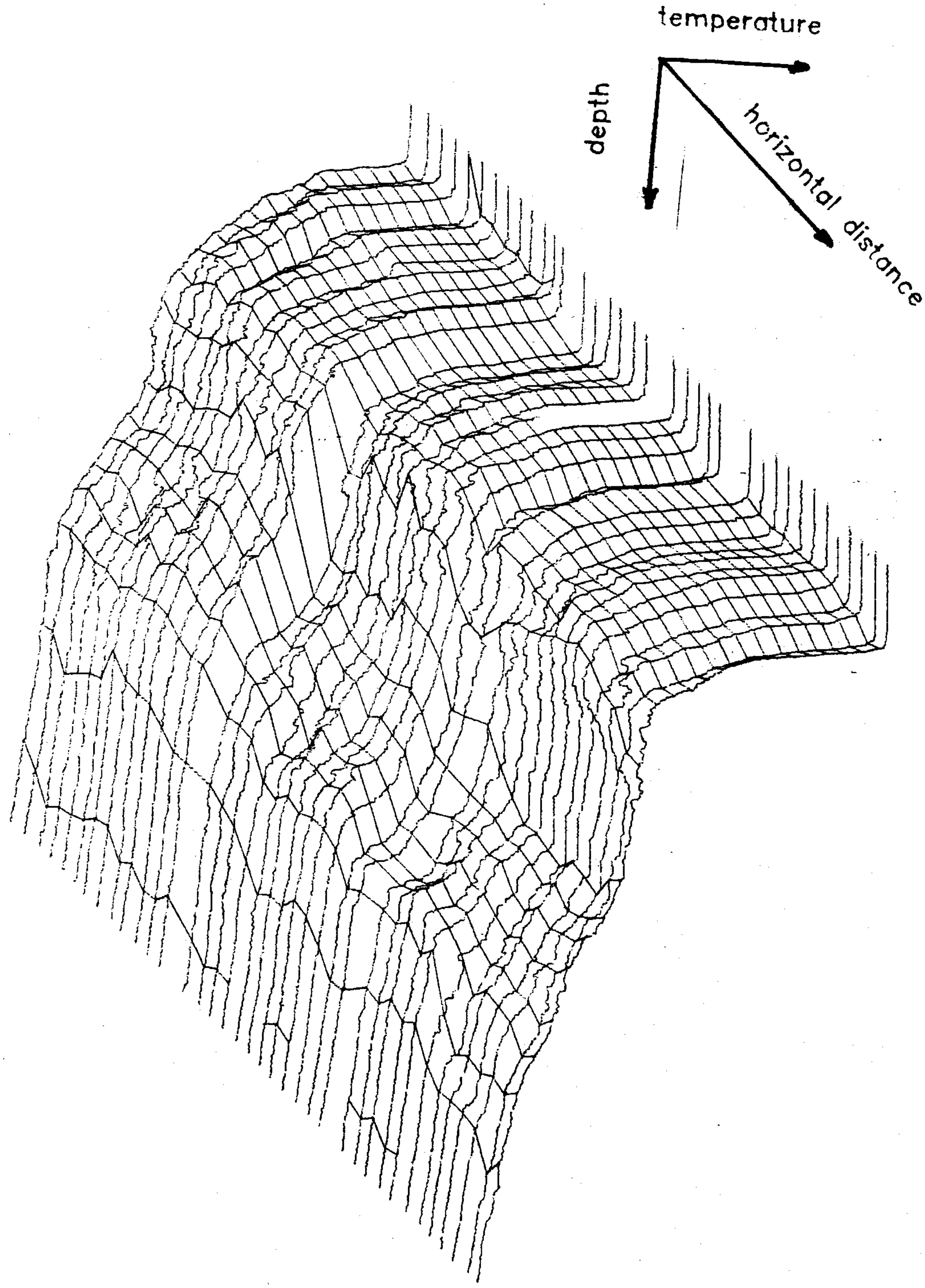

temperature
depth
horizontal distance

SEQUENCE 17

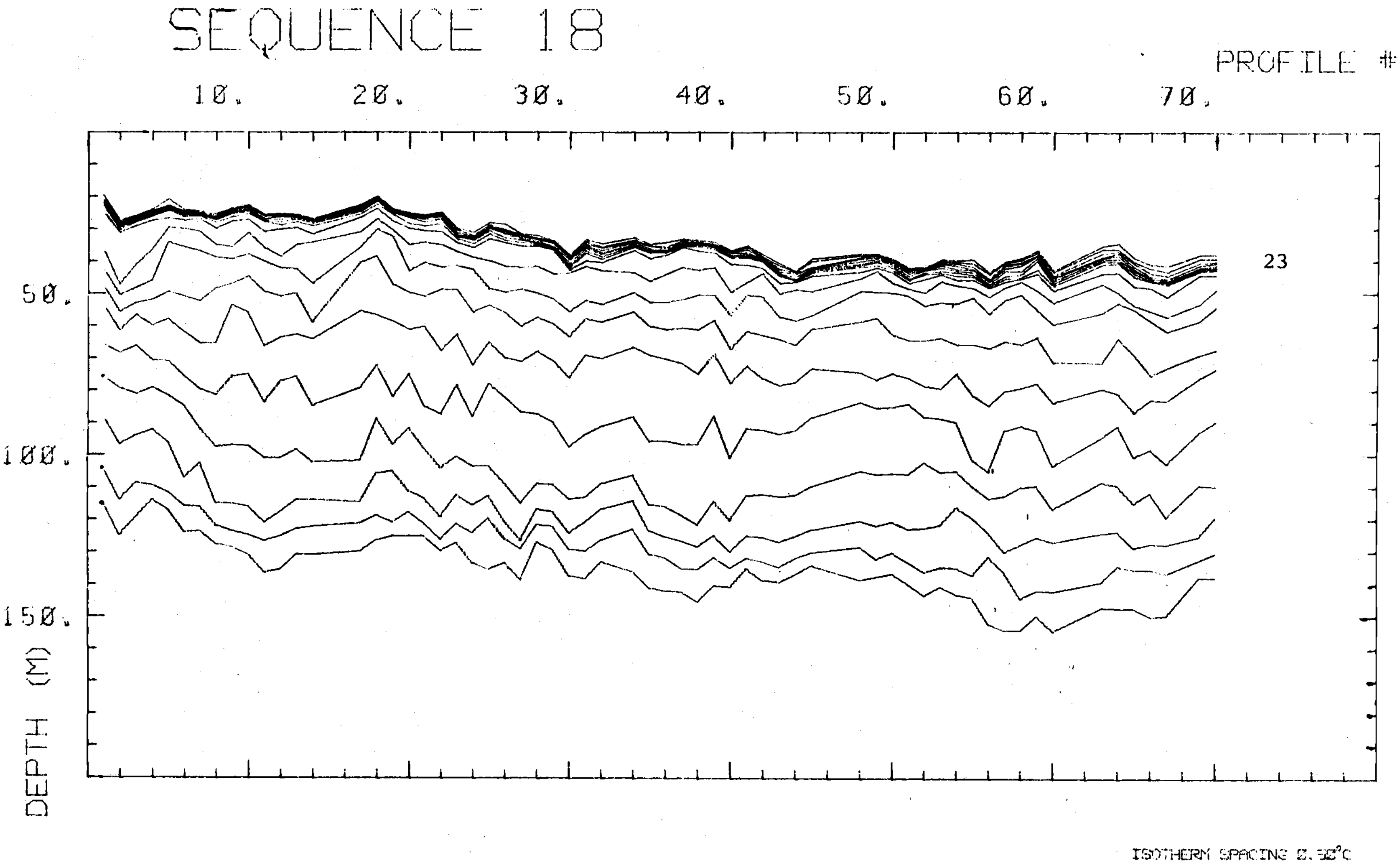
PROFILE #

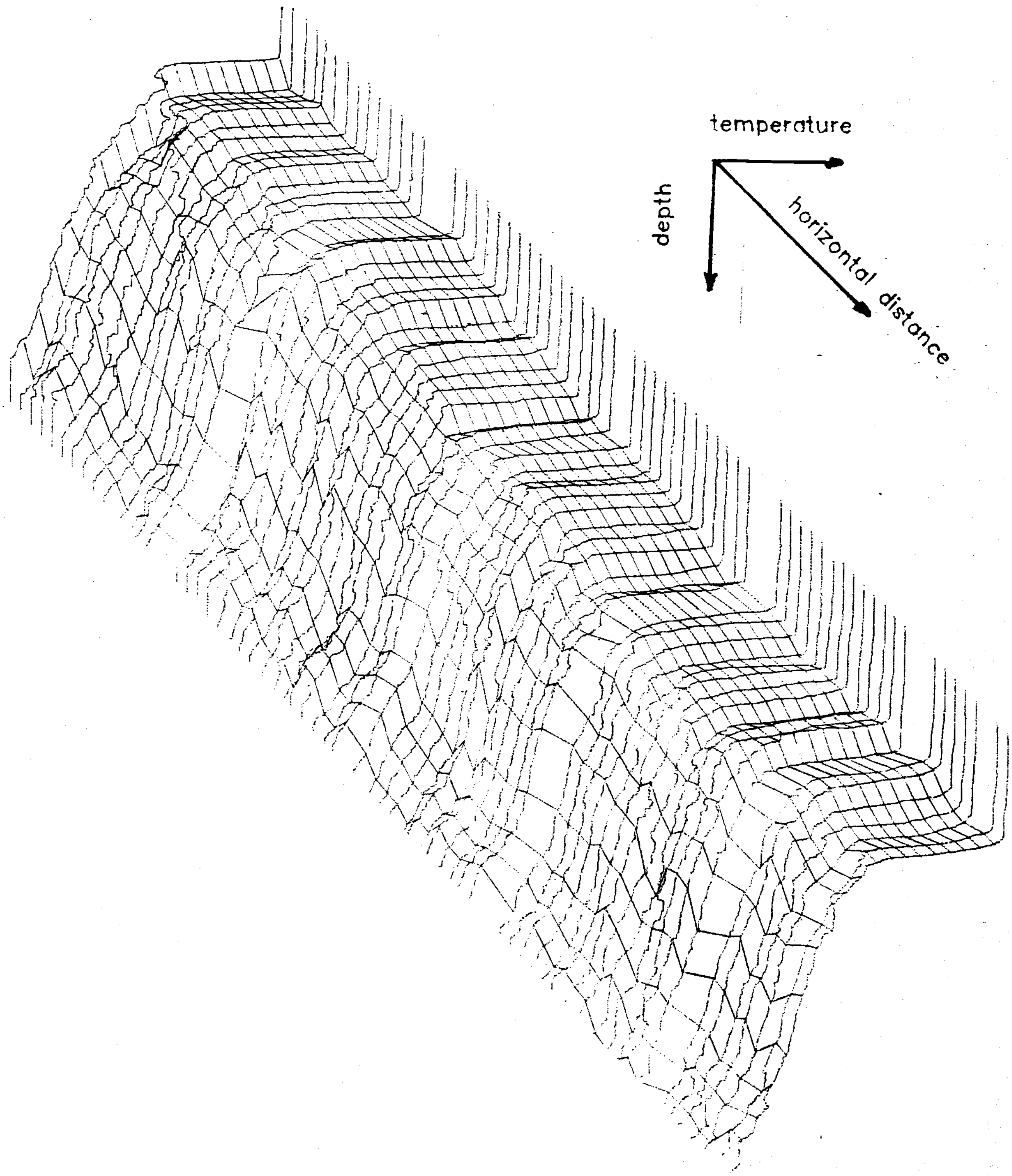


ISOTHERM SPACING 0.50°C


temperature
depth
horizontal distance

220


SEQUENCE 18
PROFILE #
10.
20.
30.
40.
50.
60.
70.
23
50.
100.
150.
DEPTH (M)
ISOTHERM SPACING 0.50°C


temperature
depth
horizontal distance

IV. The RAPID SAMPLING VERTICAL PROFILER

a) Electronics

The RSVP circuitry is mounted on a "motherboard" (Figures IV-a-1 - IV-a-3) which makes it possible to remove or replace individual modules easily. These modules may be potted in epoxy resin to protect the electronics. Unpotted modules were used successfully to depths of 240 m on the FRONTS 82 cruise. In the form used, the motherboard provides space for two dual thermistor modules or one dual thermistor module and a signal isolation module, a conductivity module, voltage regulator, pressure module and either batteries or a DC/DC converter. All of the units on FRONTS 82 were configured with one thermistor module, conductivity, pressure and a module to provide isolation for the conductivity signal (Figure IV-a-4).

Besides providing a backbone for the electronics of the RSVP, the motherboard provides for the direction of power (Figure IV-a-5) and signal (Figure IV-a-6) through the unit. Connectors at the top of the board provide an interface between the probe electronics and the data link (Figure IV-a-7, Table IV-a-1). Additional signals such as battery and regulator voltage are brought out through these connectors. These are used for onboard instrument check out and are not used with the data link.

POWER:
Two methods of providing power to the units were used on FRONTS 82. The first (that used in the past) is four 9 v alkaline "transistor" batteries mounted within the instrument case just in front of the motherboard (Figure IV-a-8). These batteries work well under pressures as great as 2000 PSI. They will last for at least 10 hours of continuous use at the temperatures of the subarctic oceans. Since power to the unit is turned off whenever the data link is unplugged, the time between battery changes is much longer.

The development of data link/retrieval line with 16 or more conductors has made it possible to power the units with DC power from the surface. With this improvement it has become possible to use an instrument throughout a cruise without opening it. In this mode a high isolation DC to DC converter (Figure IV-a-9) replaces the batteries. This unit provides two isolated DC power sources (Figures IV-a-10, IV-a-11), one used to power the conductivity, the other the temperature, pressure and signal isolation module.

In either mode the conductivity module is powered separately to prevent interference between it and the other modules. The temperature circuitry is supplied by a voltage regulator module (Figures IV-a-12, IV-a-13). The conductivity uses unregulated power.

TEMPERATURE:
The temperature circuit used in this instrument has been discussed in detail (Caldwell and Dillon,1981). It is a simple DC bridge (Figure IV-a-14) with the variation in resistance of a thermistor used to measure temperature. Each temperature module (Figure IV-a-15) comprises two identical bridge circuits. On the FRONTS 82 cruise the module was used in the redundant mode, one thermistor used with two independent circuits. A jumper on the motherboard (Figure IV-a-16) allows the selection of this mode or the use of two thermistors. Redundant recording of the signal has been used in the past to remove the incoherent noise, originating primarily in the first stage operational amplifiers, from the temperature signal. For FRONTS 82 one temperature channel was contaminated by 60 cycle noise on board the ship and this technique has not been used.

Details of the design requirements leading to the selection of components are discussed by Caldwell and Dillon (1981). Briefly, low-noise and low-drift OP-7 operational amplifiers from Precision Monolithics and low-drift Vishay resistors are used to keep electronic noise as low as possible.

CONDUCTIVITY:
The conductivity circuit (Figures IV-a-17, IV-a-18) of the RSVP is identical with that discussed by Caldwell and Dillon (1981). In principle this circuit is similar to others used to drive four electrode conductivity cells in that a feedback loop keeps the voltage across the receiver electrodes constant, the driver electrodes supplying whatever current is required. Additional requirements for use in the RSVP include small size, low power consumption and the ability to operate under pressures to at least 300 decibars and yet have small temperature sensitivity.

The cell is driven by a 3 kHz oscillator passing from electrode A to electrode D (Figure IV-a-19). Direct current is prevented from degrading the electrodes by capacitors in series with each. After passing through electrode D, the current is sensed by an operational amplifier in a current-sensing mode. The output of this current-to-voltage circuit is rectified, amplified, and offset to yield a DC output centered about zero in ocean waters. A voltage change of 0.2 volts corresponds roughly to a salinity change of 1 ppt or a temperature change of 1 degree C.

The heart of this circuit is the feedback control loop. The voltage across the receiver electrodes (B and C of Figure IV-a-19) is amplified by a high impedance differential amplifier, rectified and compared to a reference voltage. The output of this rectifier-integrator controls the amplitude of the oscillator through an FET current sink. Thus the oscillator supplies whatever current is required to maintain the amplified output of the receiver electrodes at a level determined by the reference.

Component selection is discussed by Caldwell (1981). Important considerations include avoidance of or compensation for changes in components with temperature and pressure. The capacitors used to protect the receiver electrodes (C1 and C2) and the blocking capacitor C3 are critical. Electrocube series 652A capacitors are used wherever the value of capacitance is important. Low-drift Vishay resistors must be used in the differential amplifier and rectifier preceding the comparison of voltage level with the reference. The diodes in the rectifier are a serious source of temperature sensitivity. This effect is minimized by the configuration and choice of component values. Additionally the use of an identical rectifier in the output circuit tends to balance this effect. Residual temperature sensitivity is compensated for by a thermistor (T1) mounted on the circuit board. Op-7 operational amplifiers are used wherever dc drifts are damaging, that is in the rectifiers and output amplifiers. OP-12 operational amplifiers, also from Precision Monolithics are used otherwise as they consume much less current.

PRESSURE:
Because the case is fluid filled and this fluid transmits the pressure from the water outside, the pressure transducer can be mounted directly on the circuit board. Two different pressure circuits were used on the FRONTS 82 cruise. The first (Figures IV-a-20, IV-a-22a) converts the voltage output of the transducer to an oscillating output with frequency dependent upon the pressure. The frequency varies from 500 Hz at atmospheric pressure to 1300 Hz at full range. This signal is added to the thermistor signal in the probe and is extracted from it again in the shipboard system.

The frequency modulated system was required when the limiting factor was the number of conductors in the data link. The development of the new line with 16 or more conductors has allowed us to test a DC pressure module (Figures IV-a-21, IV-a-22b). This circuit amplifies the pressure signal and transmits it to the surface on a separate channel.

SIGNAL ISOLATION:

It is necessary to isolate the conductivity circuit electronically from the other modules to prevent contamination of the signal via a capacitive path from the data link to the sensor. In addition to using isolated power, the output of the conductivity module is isolated and related to the signal common by a simple differential amplifier circuit (Figures IV-a-23, IV-a-24).

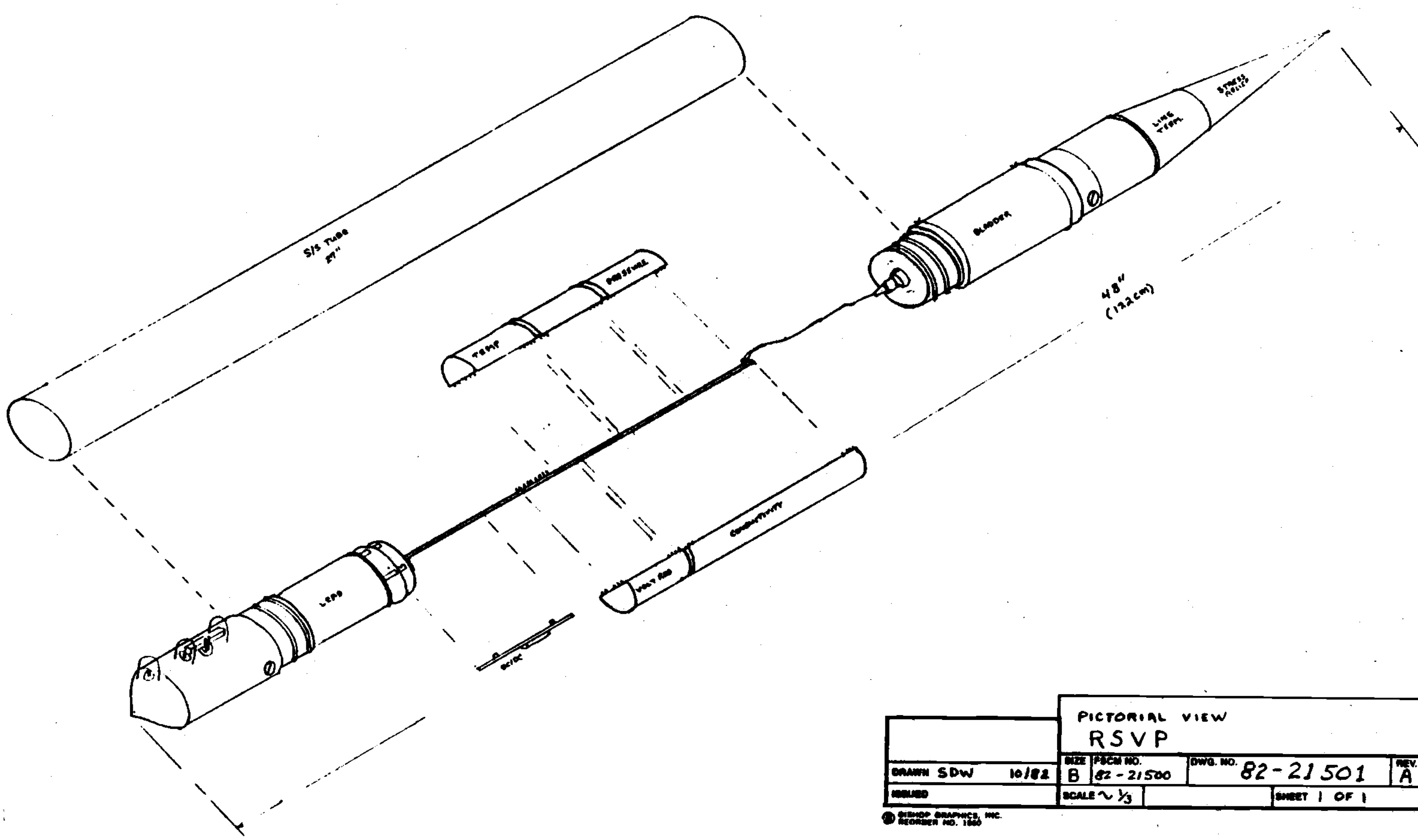


Figure IV-a-1. Pictorial view of the RSVP probe showing the motherboard, potted modules and the location of sensors (dwg no. 82-21501).

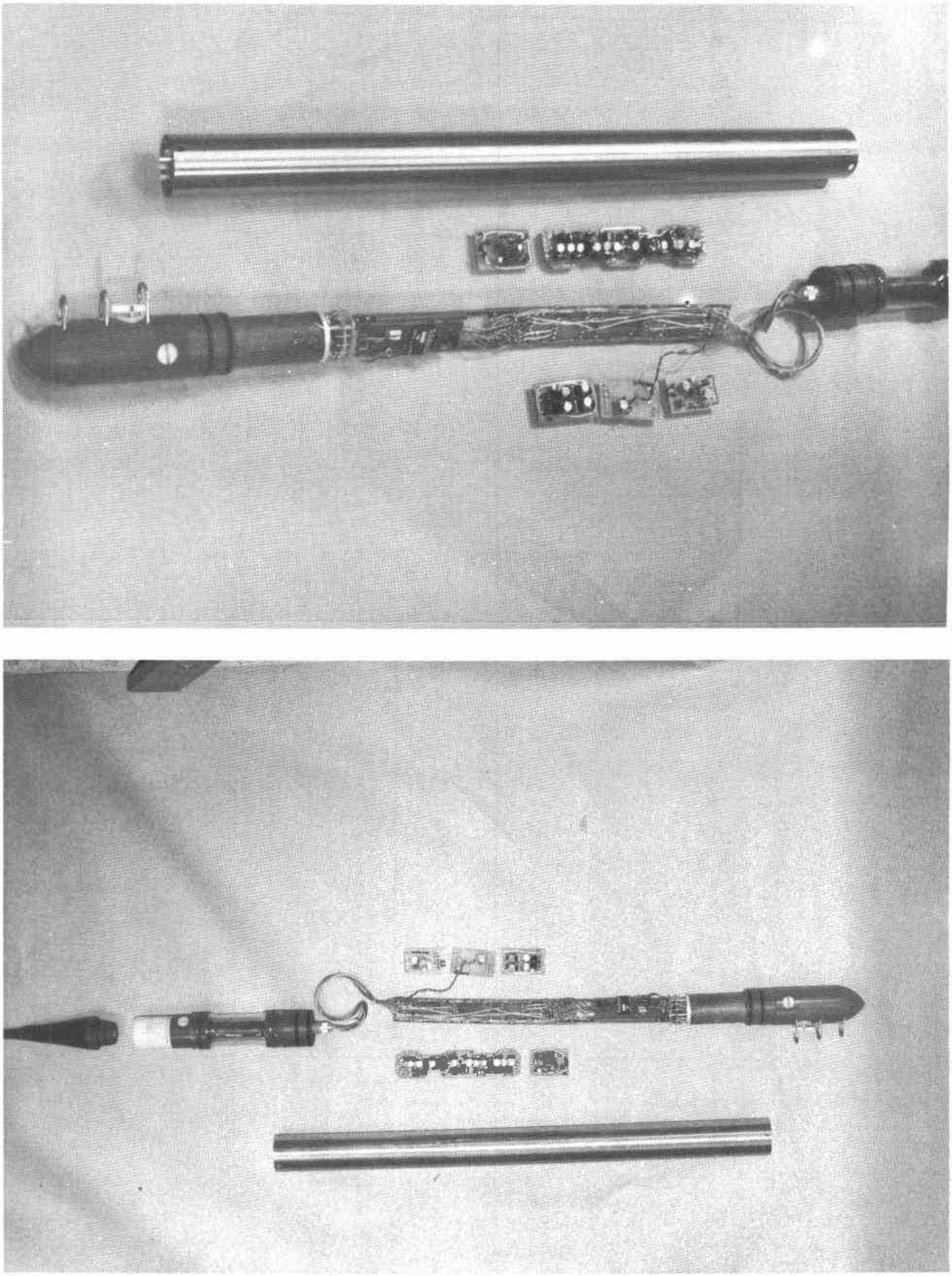
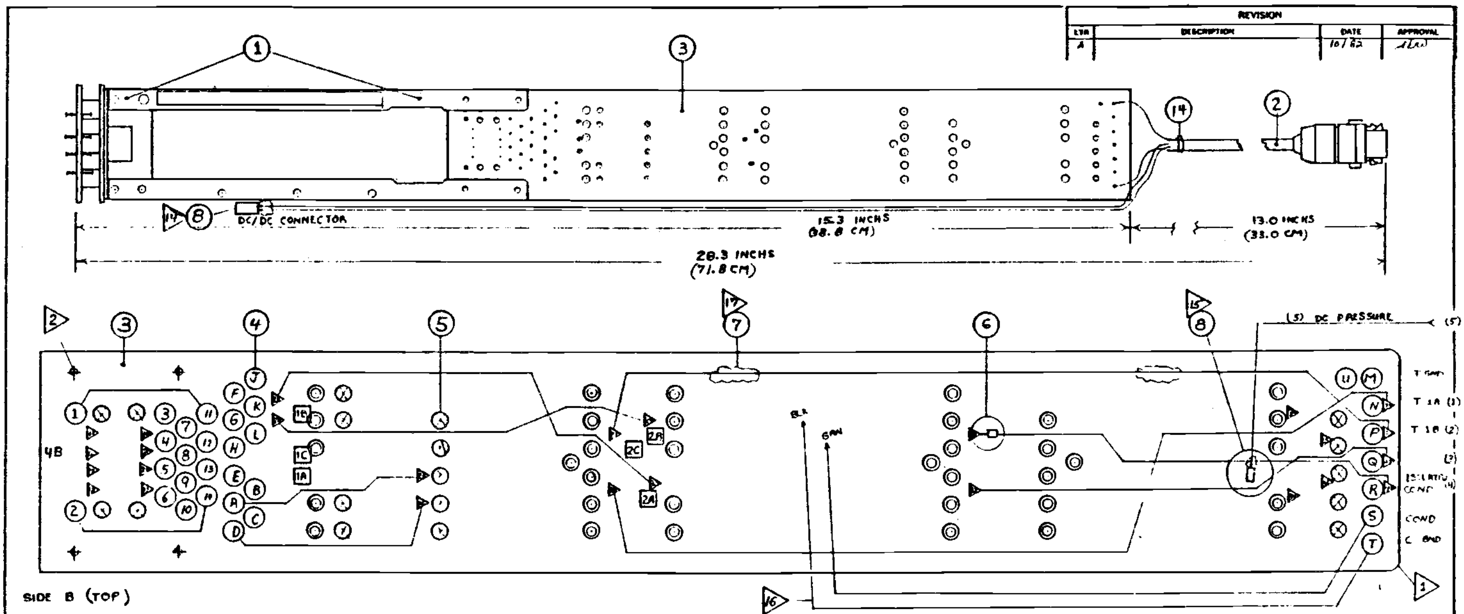


Figure IV-a-2. Photographs of the open RSVP unit.



NOTES:

1. SLIGHTLY ROUND CORNERS, FILE SMOOTH ALL EDGES (ITEM 3).
2. DRILL, 4 PLACES, .104 INCH DIA (BIT #37) FOR RAIL MOUNTING ON PWB.
3. DRILL, 33 PLACES, .063 INCH DIA (BIT #52) FOR STAND-OFF TERMINAL (ITEM 4) MOUNTING ON PWB.
4. DRILL, 53 PLACES, .081 INCH DIA (BIT #46) FOR SOCKET PIN (ITEM 5) MOUNTING ON PWB.
5. MOUNT, RIVIT AND SOLDER STANDOFF TERMINALS (ITEM 4) ON SIDE LABELED -B- ON PWB, 33 PLACES.
6. MOUNT AND SOLDER SOCKET PINS (ITEM 5) 35 PLACES, ON PWB SIDE LABELED -B- (TOP).
7. MOUNT AND SOLDER SOCKET PINS (ITEM 5).18 PLACES, ON PWB SIDE LABELED -A- (BOTTEM).
8. TRIM TAILS OF SOCKET PINS (ITEM 5), TO WITHIN .090 INCH OF PWB. FILE SMOOTH.
9. MOUNT ALL JUMPER WIRES PER WIRE LIST, ON SIDE B.
10. MOUNT NOSE ASSEMBLE (ITEM 1). ATTACH WIRES FROM NOSE ASSI TO MOTHER BOARD.
11. MOUNT AND SOLDER OUTPUT CABLE WIRING ASSEMBLE (ITEM 2).
12. IF SELECTED? MOUNT AND SOLDER BATTERY CABLES (ITEM 9) PER
    A. MOUNT BATTERYS PER 82-21742, ITEMS 12 AND 13.
    B. MOUNT CLAMP ASSY (ITEM 11) PER 82-21742.
13. IF SELECTED? MOUNT AND SOLDER DC/DC POWER UNIT (ITEM 10) PER 82-21777.
14. CUT A DUAL SOCKET CONNECTOR FROM STRIP (ITEM 8), AND SOLDER TO DC/DC OUTPUT CABLE WIRES. COAT SOLDER JOINTS WITH EPOXY (ITEM 7).
15. CUT A SINGLE SOCKET CONNECTOR FROM STRIP (ITEM 8) AND SOLDER TO DC PRESSURE OUTPUT CABLE WIRE. COAT SOLDER JOINT WITH EPOXY (ITEM 7).
16. SOLDER WIRES FROM ISOLATION MODULE, GREEN AND BLACK, TO MOTHER BOARD TERMINALS (S) AND (T).
17. TAC OUTPUT AND JUMPER WIRES DOWN TO MOTHER BOARD WITH DABS OF QUICK SET EPOXY (ITEM 7). BE CAREFUL AROUND SOCKETS AND TERMINALS.

9 WIRE TABLE

WIRE FROM	SOLDER TO
Hole No. 1	Hole No. 11
2	14
23	30
24	29
A	25
B	26
27	38
28	37
31	40
32	39
S	Green
T	Black

	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	NOTE
	3	14	278-1632	WIRE TIES	18F
	4	13	71	BATTERY CLIPS NOT SHOWN	18E
	4	12	MN 1604	BATTERY, 9V	18D
	1	11	82-21746	CLAMP ASSY	
	1	10	82-21769	DC/DC POWER UNIT	
	4	9	82-21745	BATTERY CABLE ASSY NOT SHOWN	
	1	8		STRIP CONNECTOR, SOCKET	18C
	—	7	——	EPOXY, QUICK SET	
	12	6	# 24 AWG	WIRE, TEFLON INSUL.	
	53	5	SC-3W3-63	SOCKET PINS	18B
	33	4	2020E	STANDOFF TERMINALS	18A
	1	3		PWB, MOTHER BOARD	
	1	2	82-21563	OUTPUT CABLE WIRING ASSY	
	1	1	82-21520	NOSE ASSY	

PARTS LIST

MOTHERBOARD ASSY

DRAWN SDW 10/82
ISSUED
SIZE C | FSCM NO 82-21500 | DWG NO 82-21561 | REV A
SCALE —— | SHEET 1 OF 1

Figure IV-a-3. Motherboard assembly diagram (dwg no. 82-21561).

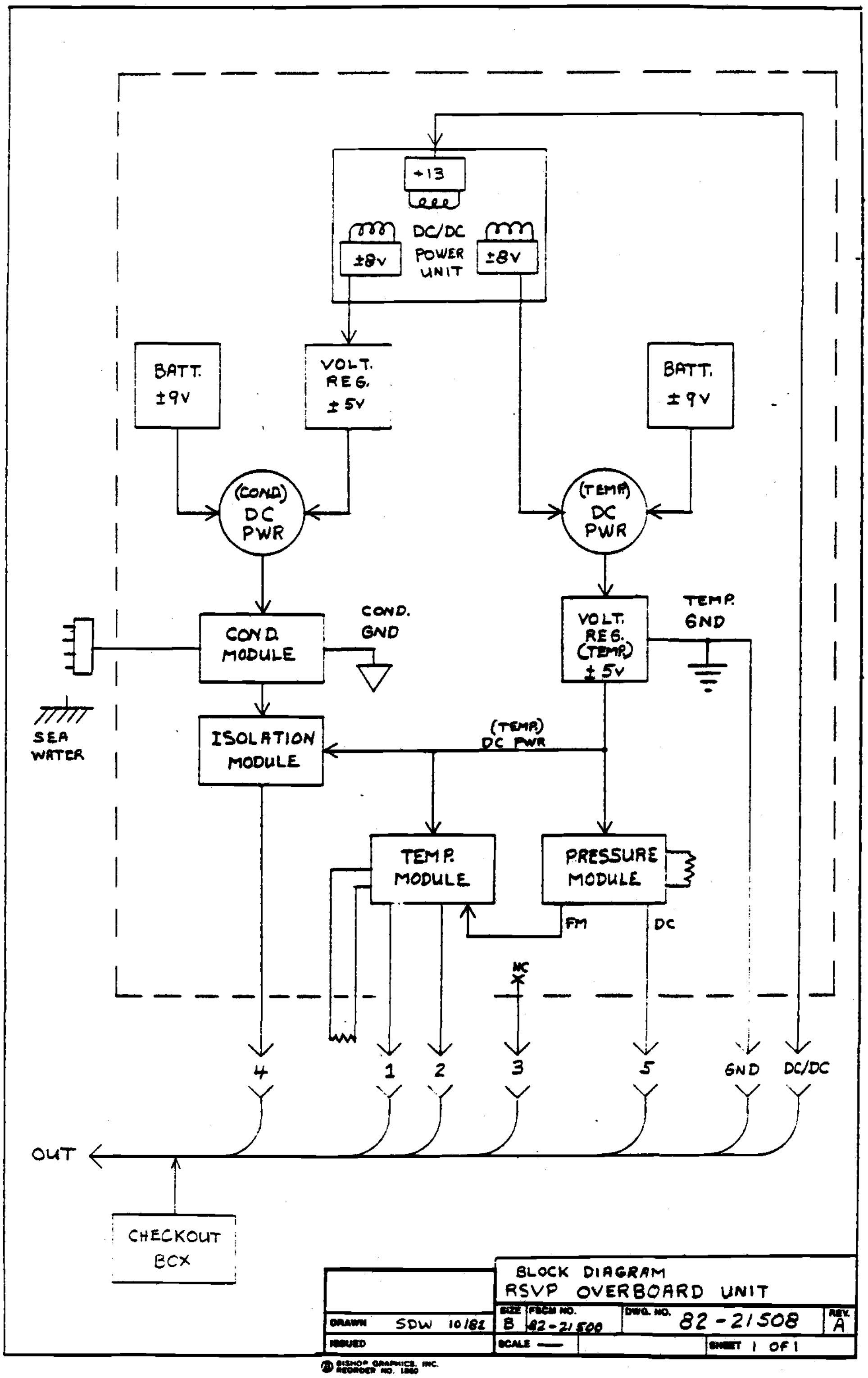


Figure IV-a-4. Block diagram of the RSVP overboard unit (dwg no. 82-21508).

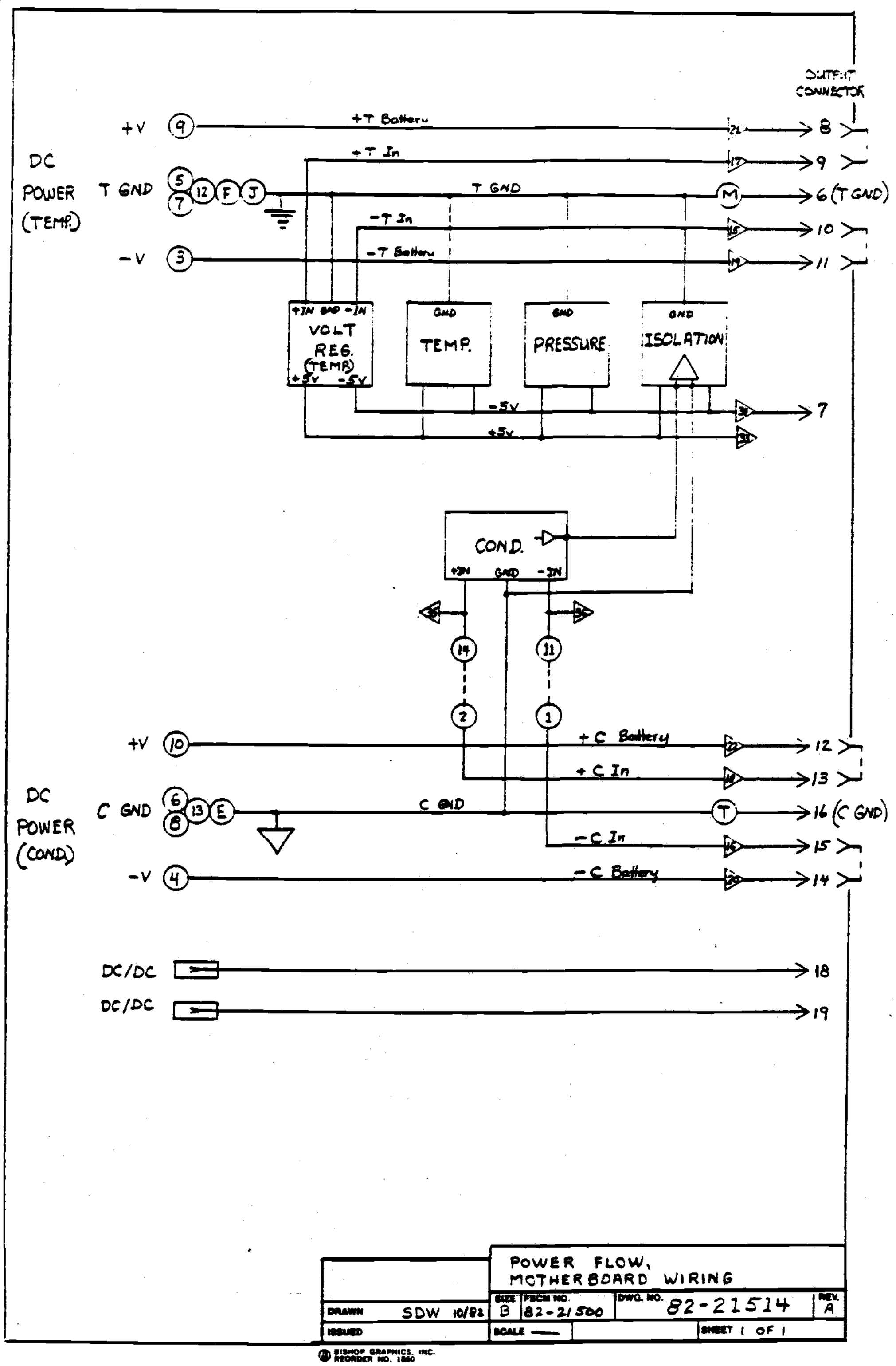


Figure IV-a-5. Motherboard power flow diagram (dwg no. 82-21514).

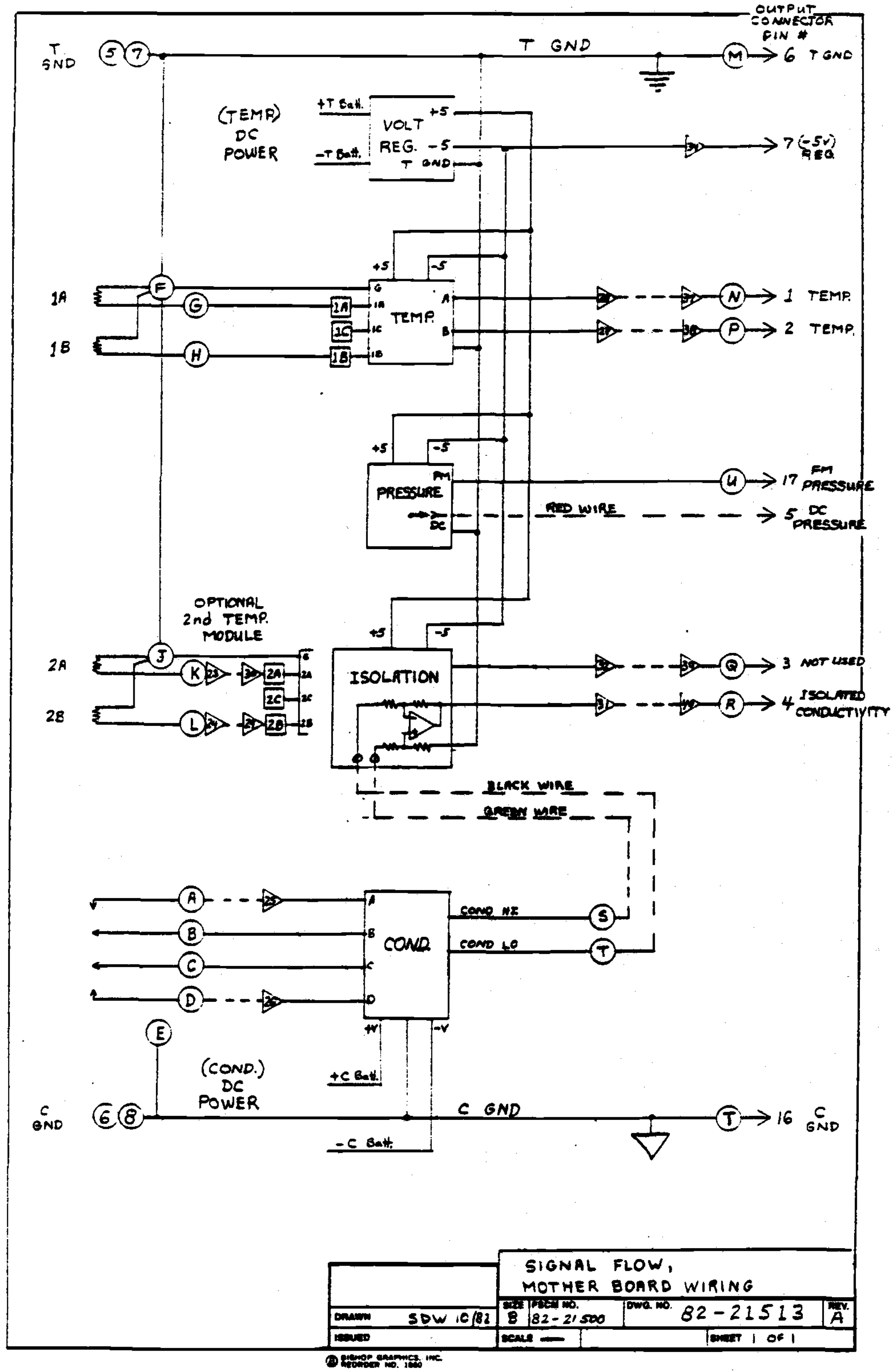


Figure IV-a-6. Motherboard signal flow diagram (dwg no. 82-21513).

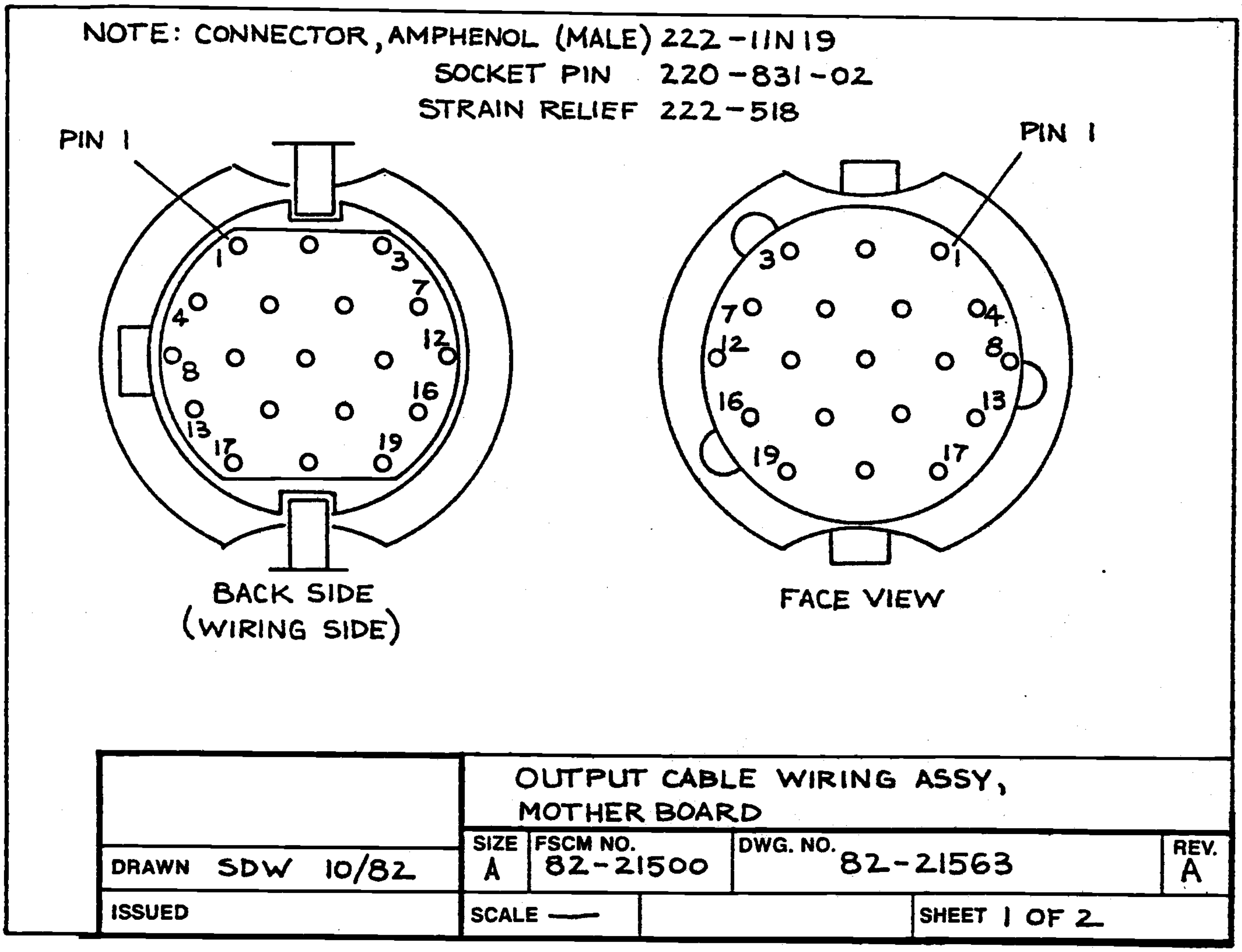


Figure IV-a-7. Output cable wiring assembly, motherboard (dwg no. 82-21563).

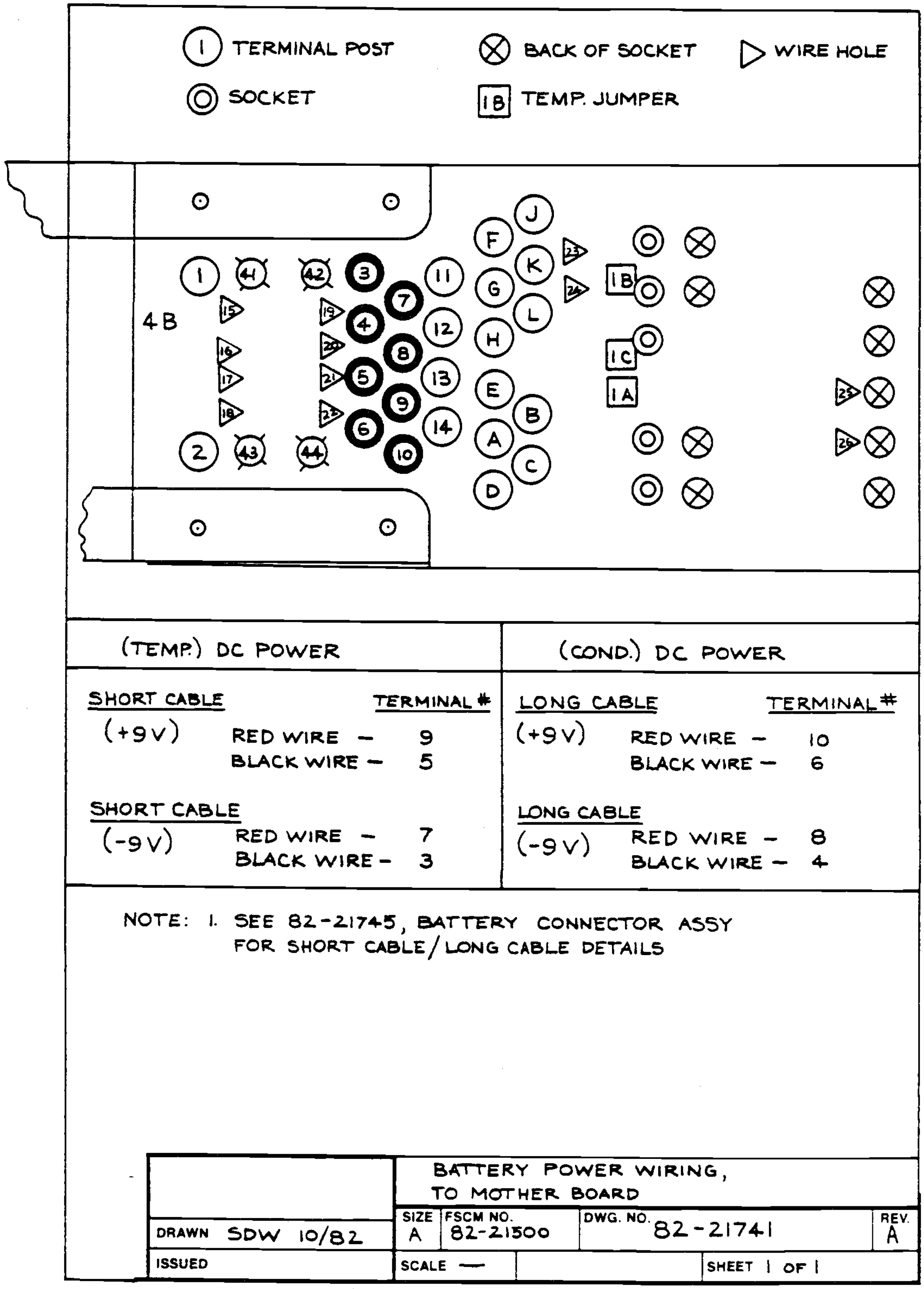
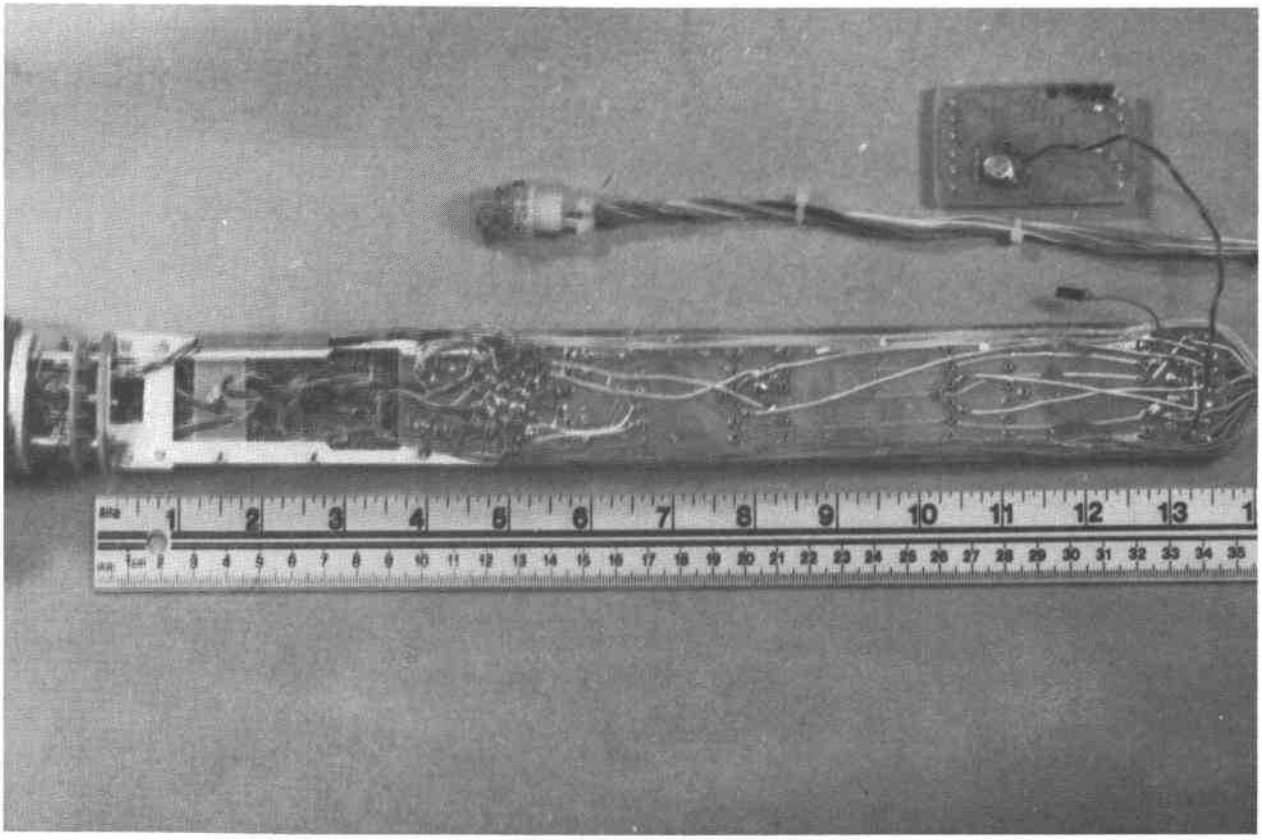


Figure IV-a-8. Battery power wiring to motherboard (dwg no. 82-21741.



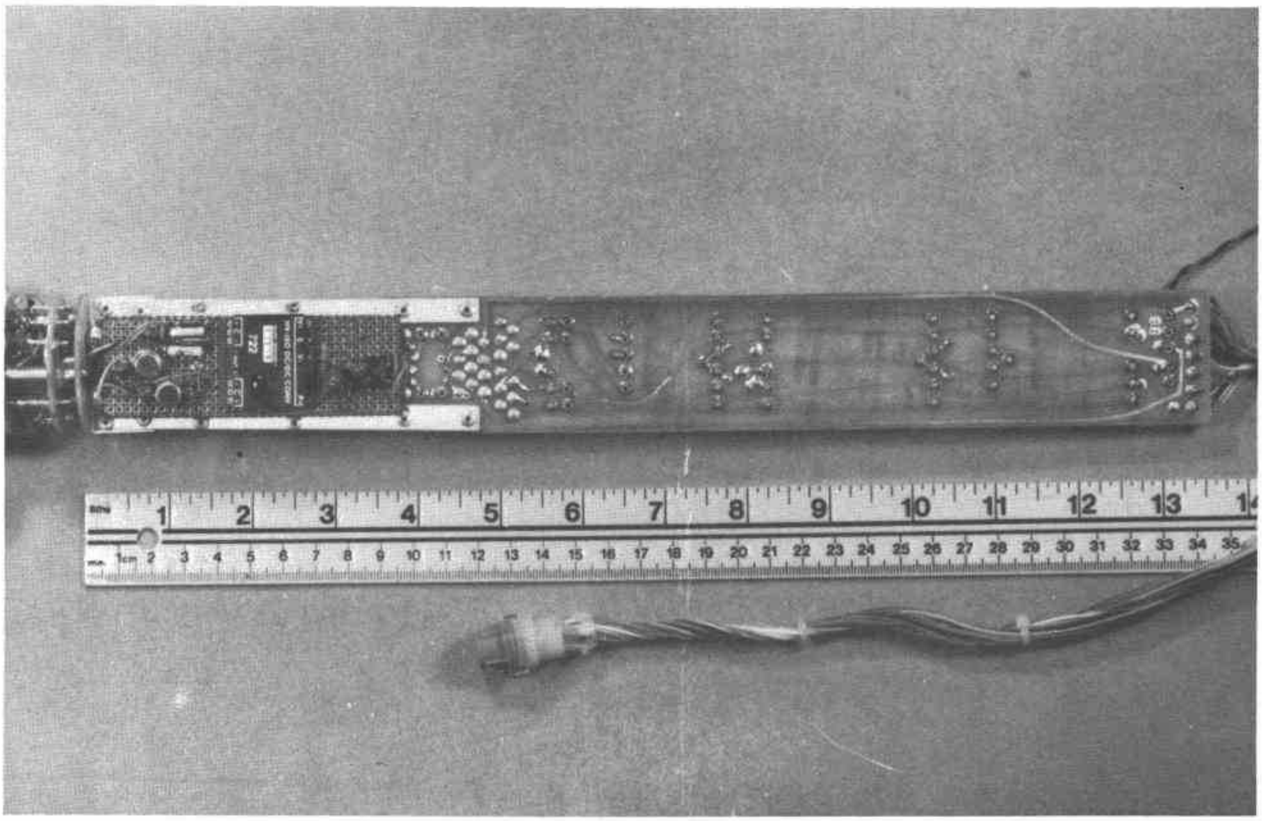


Figure IV-a-9. Photographs of DC/DC converter mounted on motherboard.

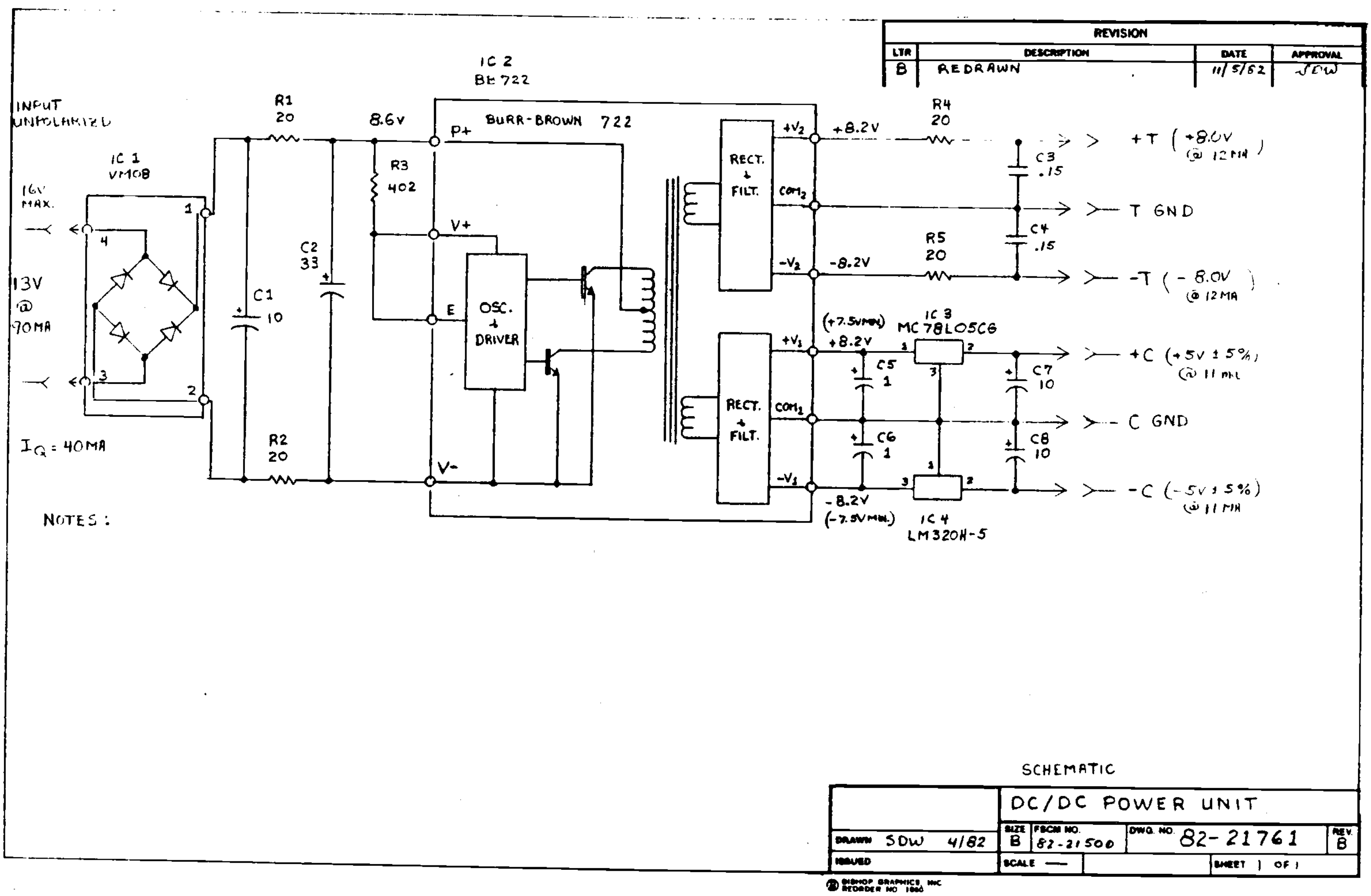


Figure IV-a-10. DC/DC power unit schematic (dwg no. 82-21761).

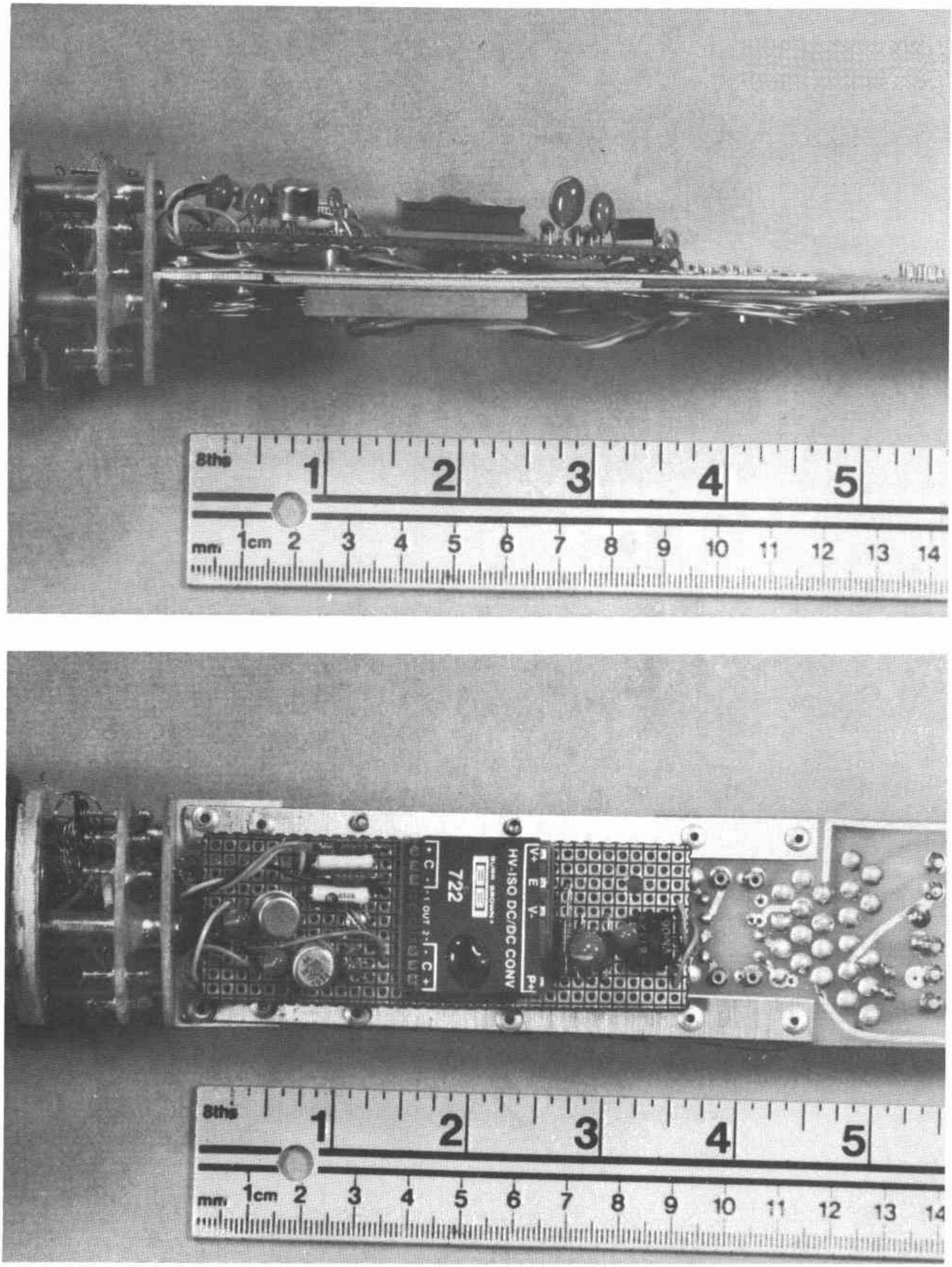


Figure IV-a-11. Close-up of DC/DC converter module.

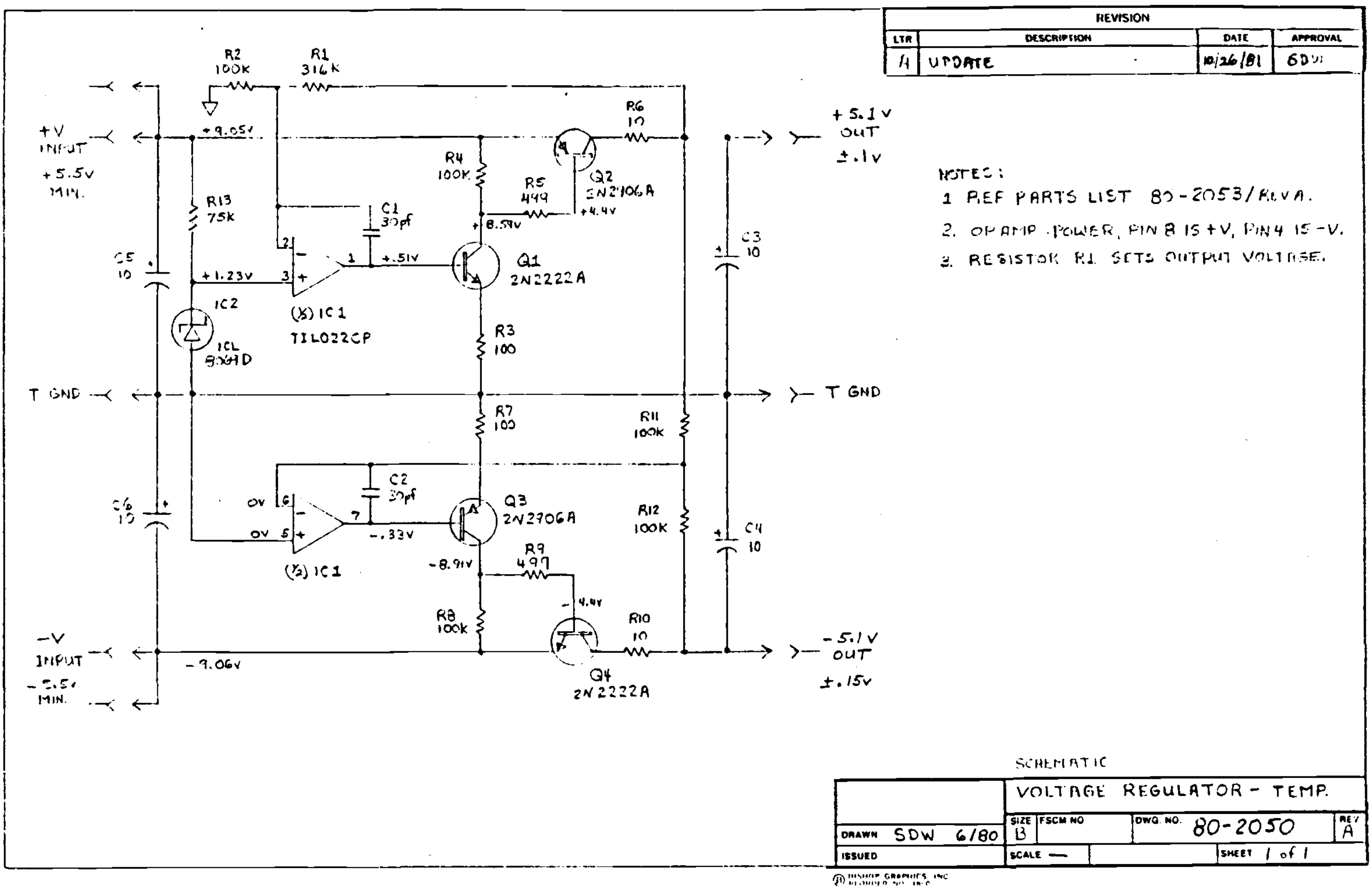


Figure IV-a-12. Voltage regulator schematic (dwg no. 80-2050).

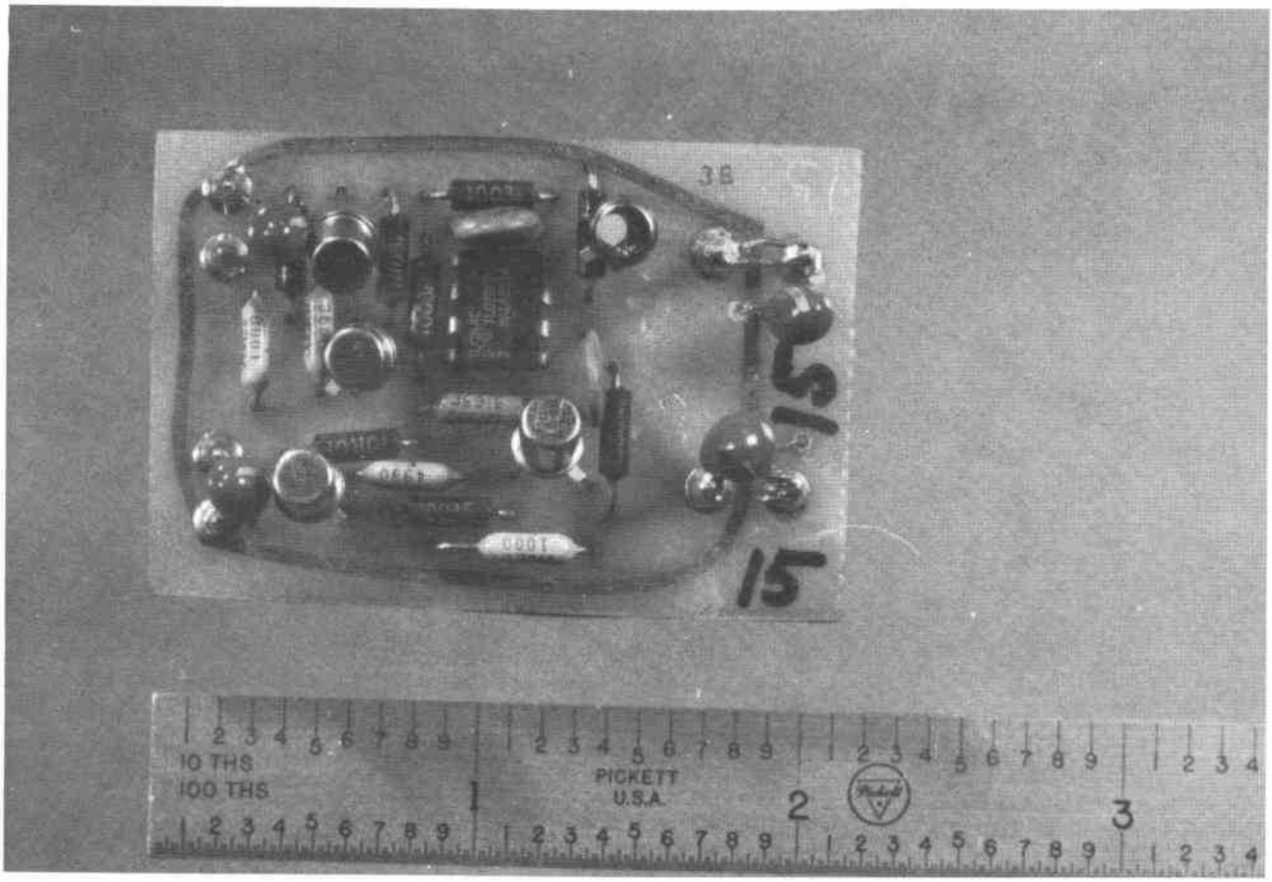


Figure IV-a-13. Photograph of voltage regulator.

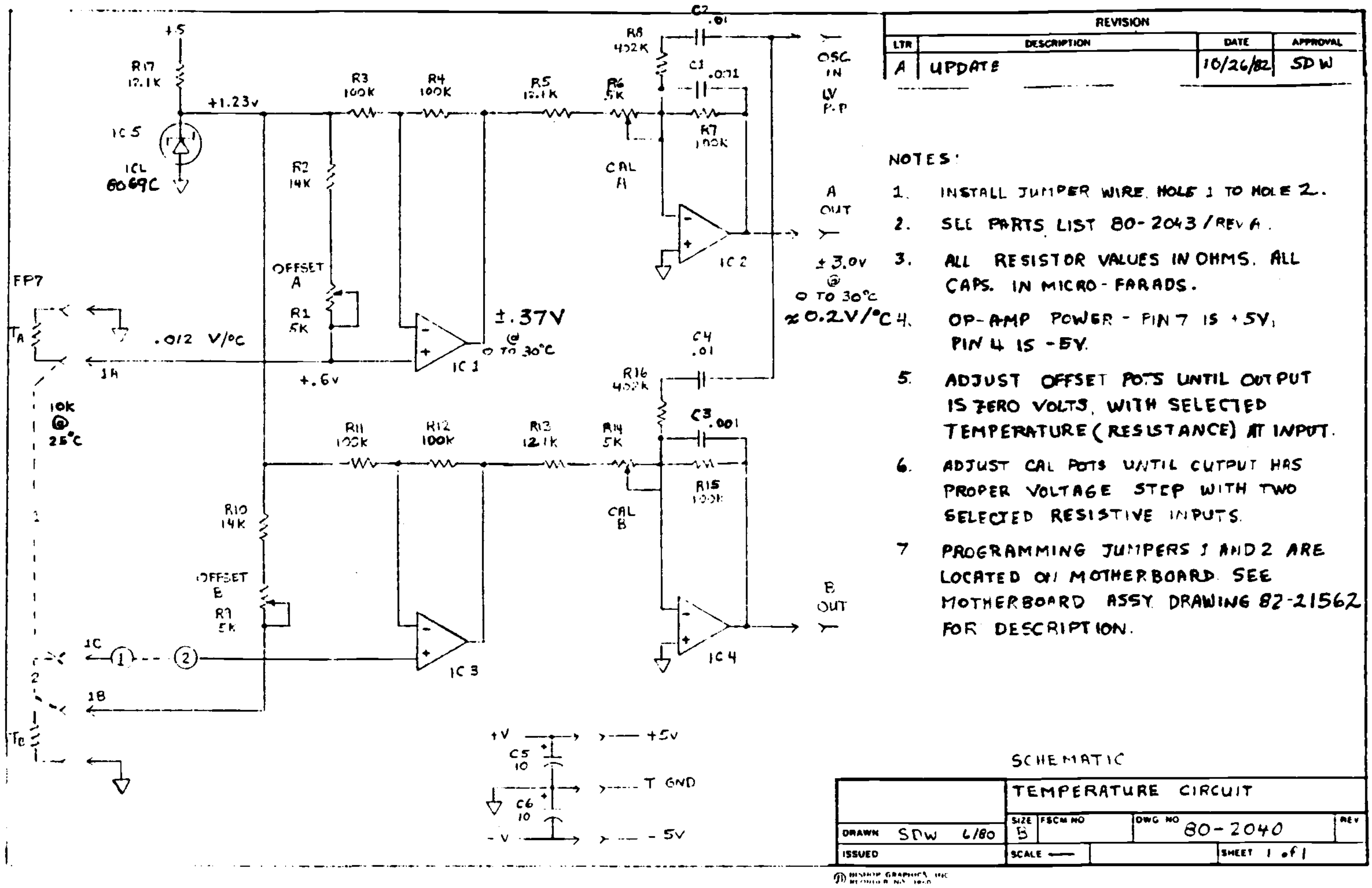


Figure IV-a-14. Temperature circuit schematic (dwg no. 80-2040).

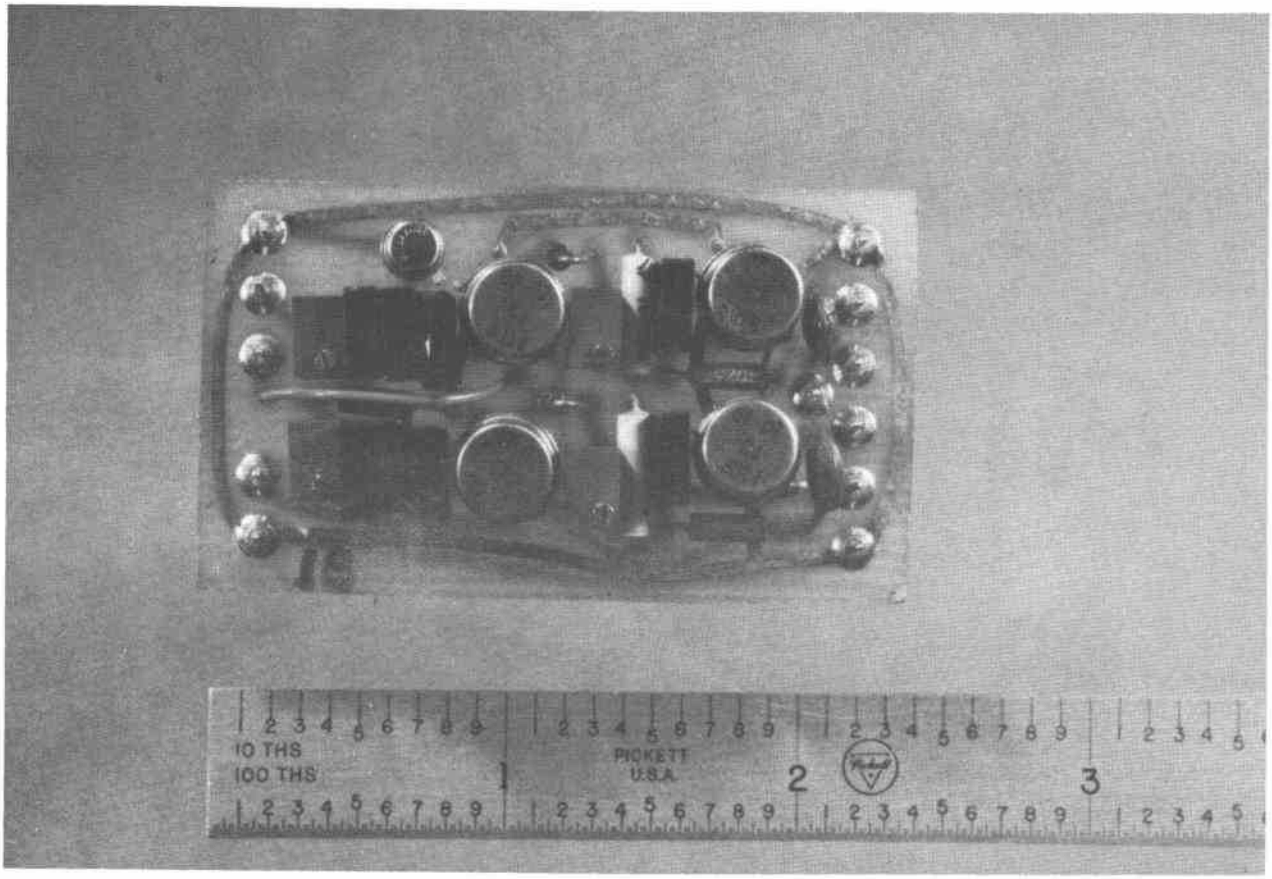
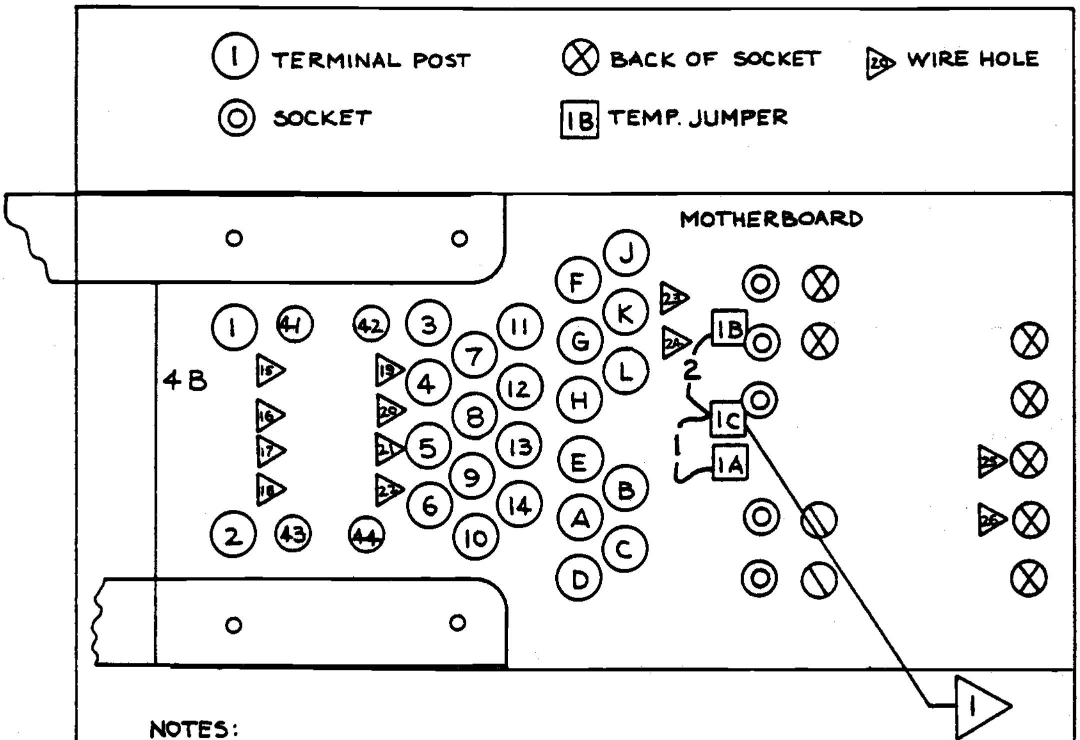


Figure IV-a-15. Photograph of temperature module.



NOTES:

1. SELECT JUMPER 1 OR JUMPER 2 FOR OPERATION MODE DESIRED.

   JUMPER 1 — (WIRE, C→A) REDUNDANT MODULE OUTPUTS, SINGLE THERMISTOR USED IN POSITION A, SEE SENSOR WIRING 82 —

   JUMPER 2 — (WIRE, C→B) SEPARATE OUTPUTS, TWO THERMISTORS REQUIRED

2. THERE ARE TWO TEMPERATURE MODULE SOCKET AREAS ON THE MOTHERBOARD. WHEN USING BOTH TEMP. MODULES, A SECOND JUMPER MUST BE SELECTED FOR THE SECOND AREA.

Figure IV-a-16. Jumper selection of one or two thermistor mode (dwg no. 82-21562).

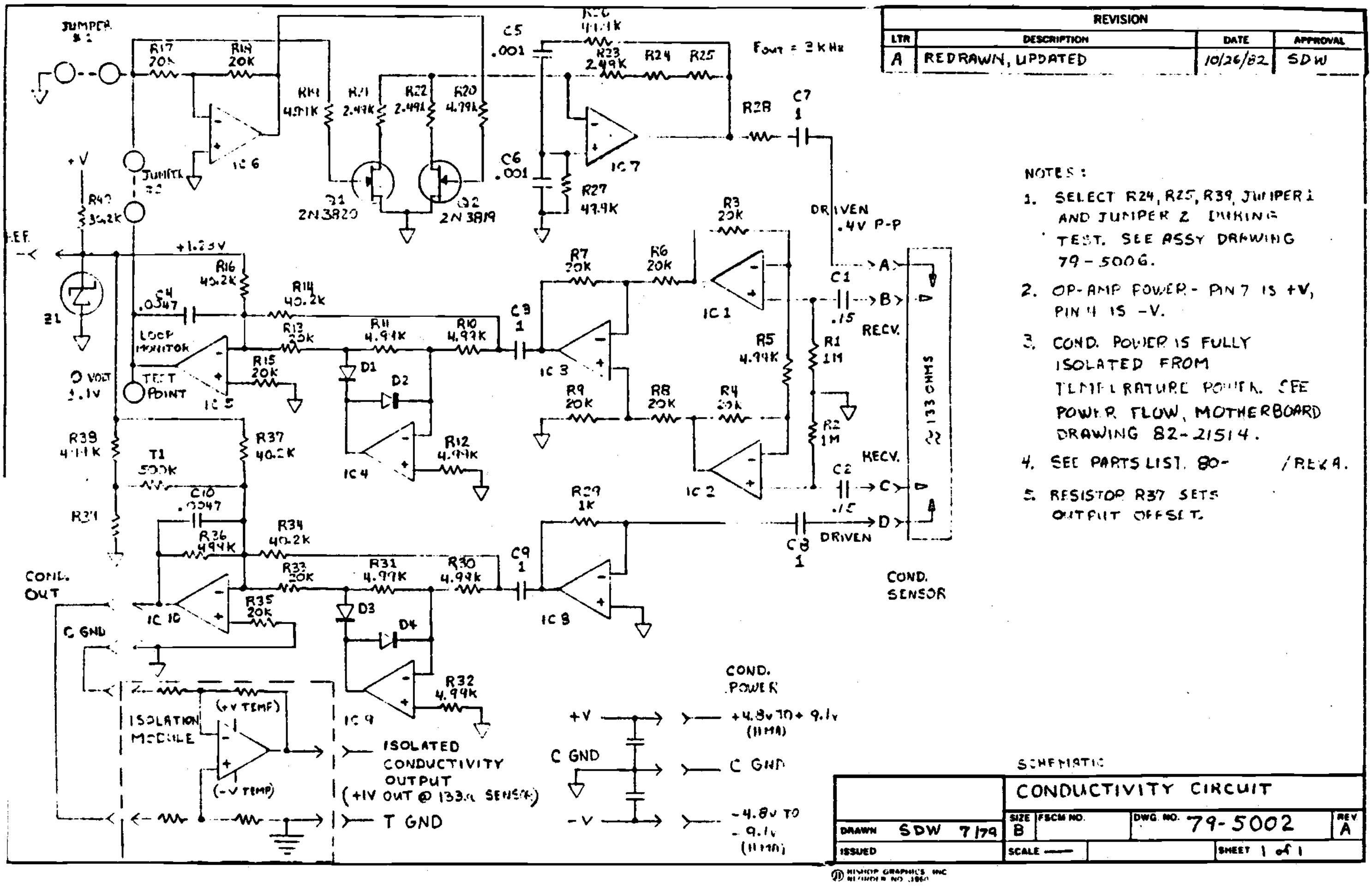


Figure IV-a-17. Conductivity circuit schematic (dwg no. 79-5002).

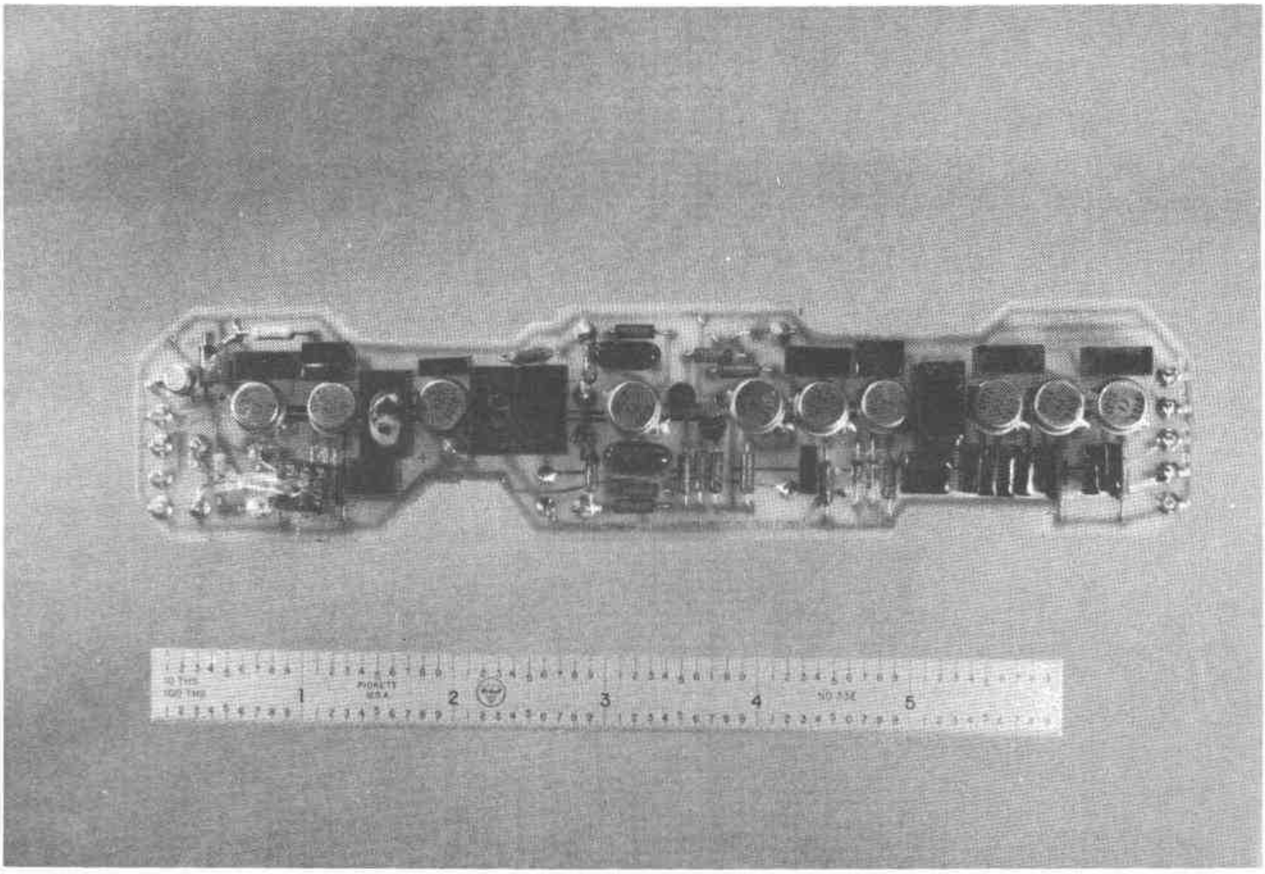


Figure IV-a-18. Photograph of conductivity module.

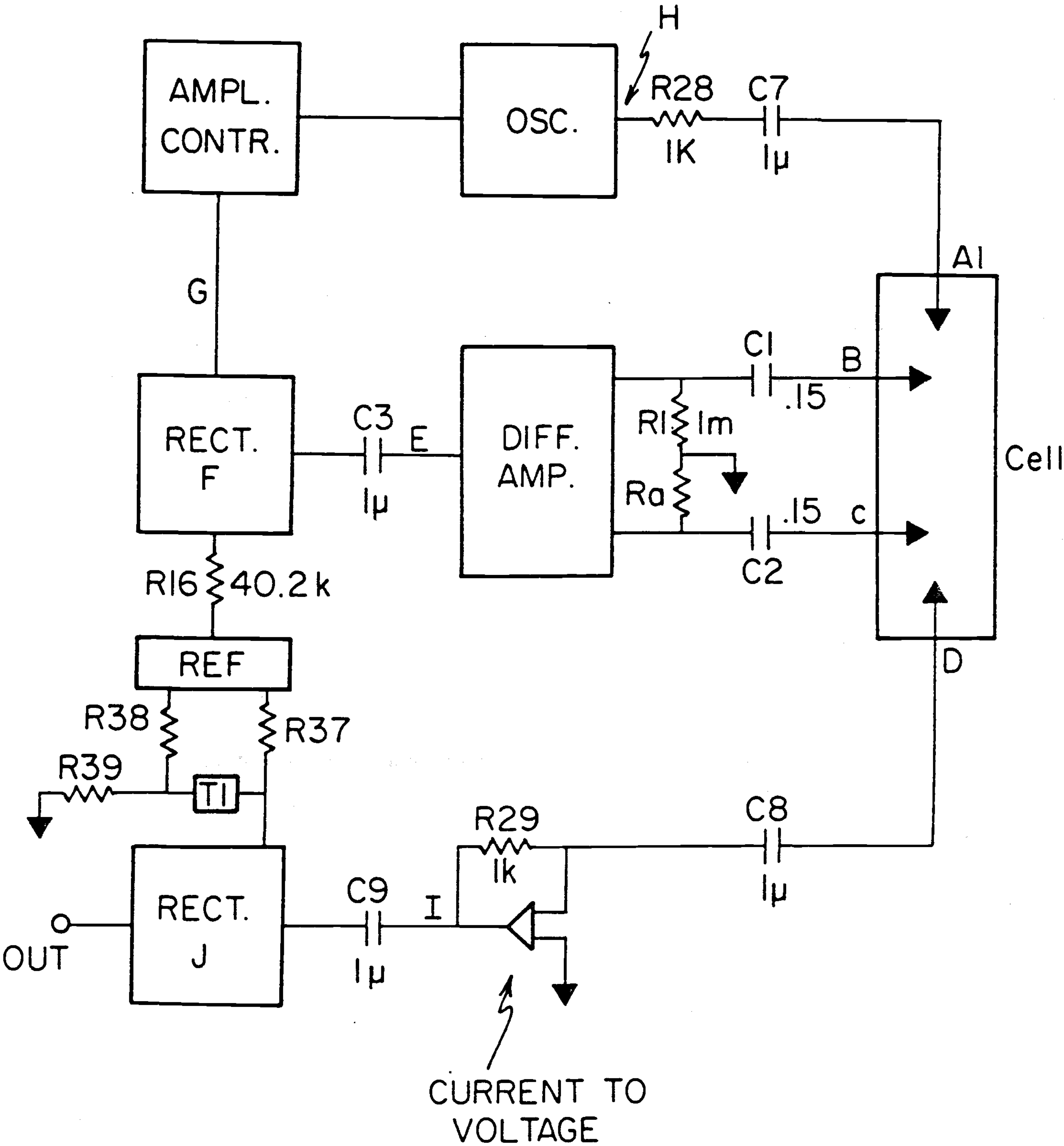


Figure IV-a-19. Block diagram of the conductivity circuit.

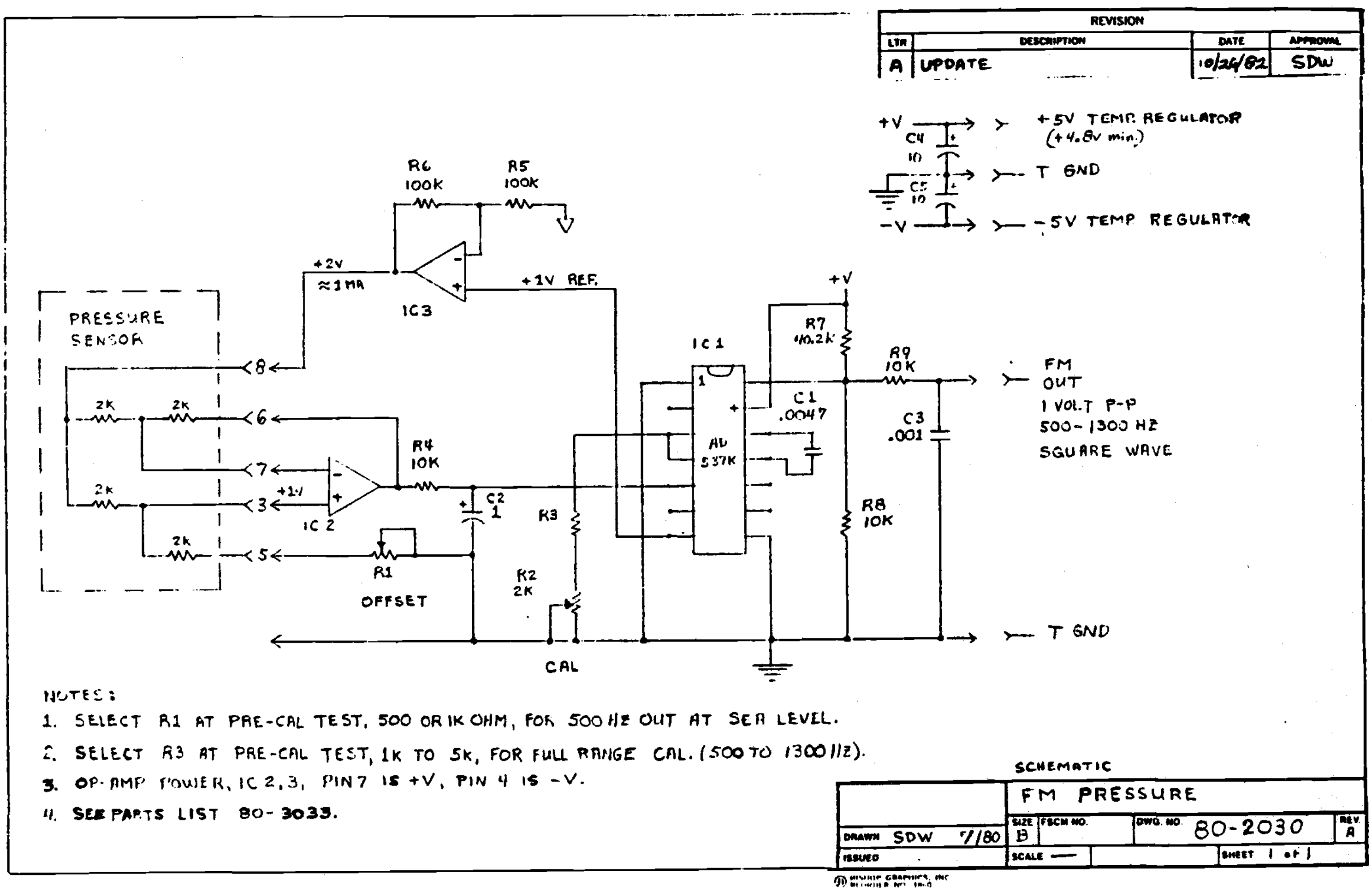


Figure IV-a-20. Frequency modulated pressure circuit schematic (dwg no. 80-2030).

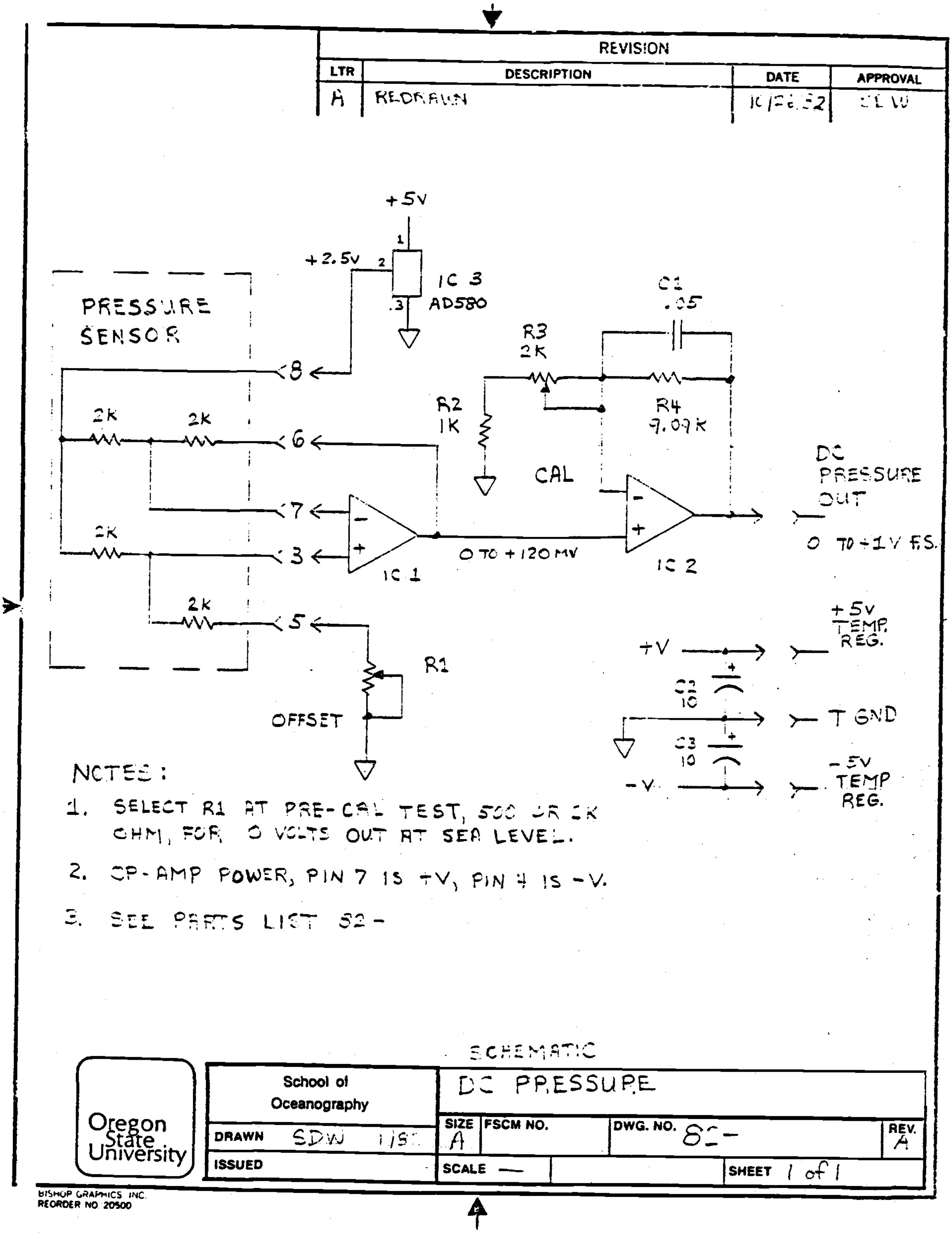


Figure IV-a-21. Direct current pressure circuit schematic (dwg no. 82-).

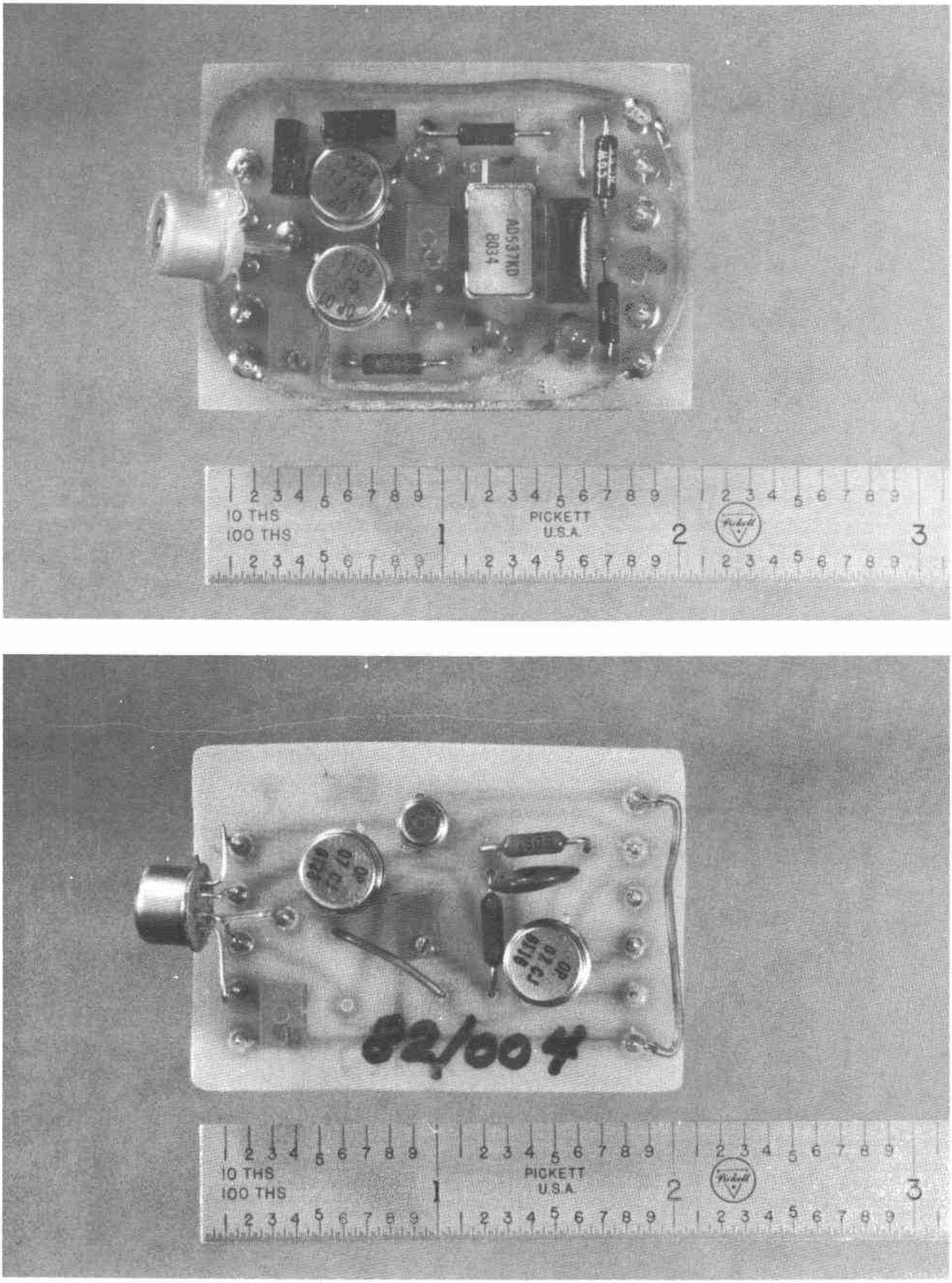


Figure IV-a-22. Photographs of a) FM pressure module and
b) DC pressure module.

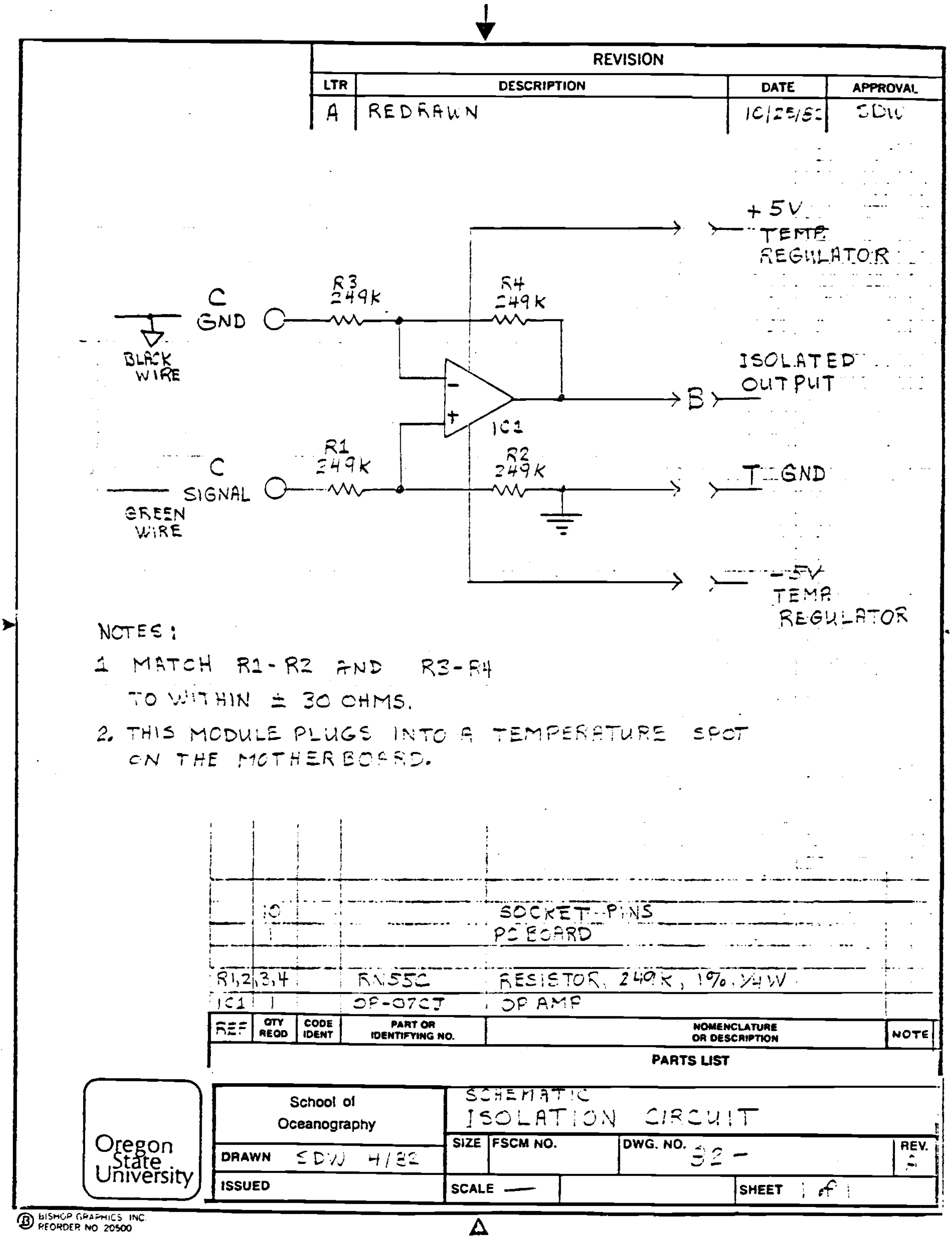


Figure IV-a-23. Signal isolation circuit schematic (dwg no. 82-   ).

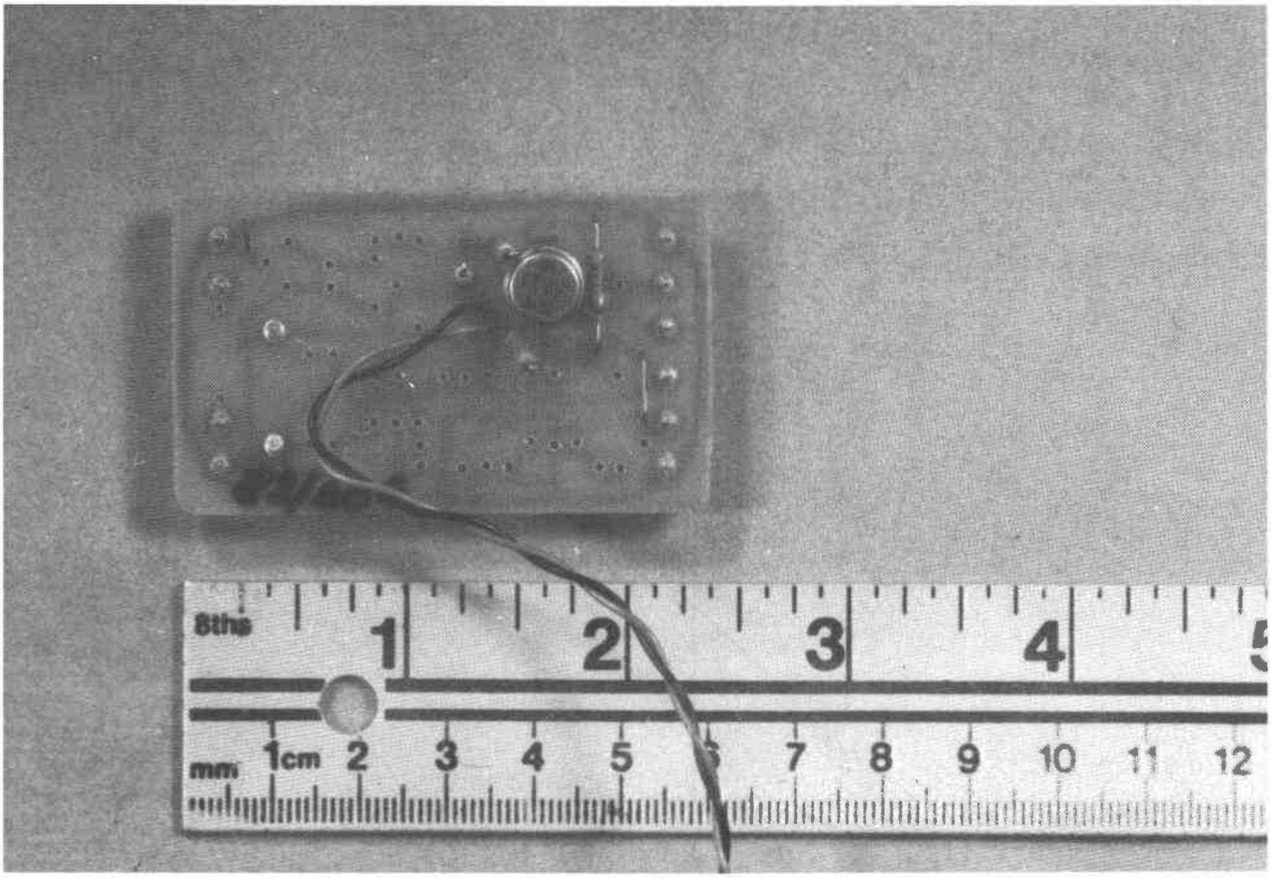


Figure IV-a-24. Photograph of signal isolation module.

b) Sensors

Except for the pressure transducer, which is mounted on the pressure module circuit board, all RSVP transducers are mounted in the nose cone at the front of the instrument body.

THERMISTORS:
Thermistors used on FRONTS 82 were FASTIP THERMOPROBE, Model no. FP07DA103N-A made by Thermometrics of Edison, NJ (Figure IV-b-1). These thermistors are made so that the temperature sensitive bead lies in a 0.007" diameter protrusion which sticks out perhaps 0.020" from the end of an at most 0.085" diameter glass cylinder (Table IV-b-1). The variation of the resistance of this thermistor with temperature is calibrated at OSU using a minimum of 10 temperature calibration points nominally distributed over the calibration range at 2 degree intervals. Resistance vs temperature characteristics over a narrow range are given by an exponential relationship between resistance and the reciprocal of temperature (Table IV-b-2).

The thermistor must be mounted in such a way as to prevent salt water from reaching the leads and entering the probe. Assembly of the thermistor unit must include installation of an o-ring seal and insulating sleeves (Figure IV-b-2).

CONDUCTIVITY CELLS:
Two conductivity transducers were used on FRONTS 82. The first is the Neil Brown Instrument System conductivity cell (Figure IV-b-3). The response and flow characteristics of this cell have been examined in detail (Gregg et al, 1982). In our application this cell must have wires soldered to the cell connector area and the solder joints encapsulated in epoxy (Figure IV-b-4). The connections must be made in such a way as to identify the pairs of electrodes, one inside and one outside for each pair, so that the proper connections to the electronics can be made (Figure IV-b-5). The sensor is purchased from NBIS to meet these requirements. The sensor is mounted to the probe with an o-ring seal.

The second transducer is the microconductivity cell manufactured by Michael Head Systems (Figure IV-b-6). This extremely small cell has separation of approximately 0.005" between electrodes and a total width of only 0.03". The transducer as purchased is attached to a stainless steel tube and is mounted on the nose cone with an o-ring seal (Figure IV-b-7).

PRESSURE:

Kulite Model PTQH-360-150SG (250 PSI) pressure transducers (Figure IV-b-8, Table IV-b-3) were used on the FRONTS 82 cruise. These were mounted directly on the pressure module circuit board (see Figure IV-a-22). These sensors have an output of approximately 100 mvolts per full scale rated pressure and are used in both the frequency modulated and direct current pressure modules. Since these are mounted within the probe no special mounting is necessary. Care must be taken however to remove the parylene-c insulation from the pins before the unit is plugged in or soldered.

Table IV-b-1. Thermistor specifications

1.	FASTIP THERMOPROBE, model no. FP07DA103N-A Thermometrics, Edison, NJ.	
2.	Resistance:	10K ohm +- 25%,
	nominal	29K at 0 °C 8K at 30 °C.
3.	Dissipation constant:	0.25 mW/ °C, in still water.
4.	Maximum power:	0.006 watt.
5.	Time constant:	5-10 mS, plunge test in water to 63.2% change per MIL-T-23648.
6.	Probe body material:	Glass, bora-silicate, Corning 012.
7.	Probe dimensions:	0.055-0.060" nominal body diameter 0.085" maximum diameter at tip 0.5" length.
8.	Leads:	0.012" diameter x7/8" minimum length, tinned dumet.
9.	Bead material:	Type "A", per material system code MIL-T-23648.
10.	Bead dimension:	0.007".
11.	Sensitivity:	see Table IV-b-2.
12.	Pressure test specifications:	Thermistors must pass salt water meg-ohm tests: Minimum resistance 100 meg-ohms, after 24 hour pressure test at 500 PSI in 3% salt water solution. This test is conducted by Thermometrics.
13.	OSU calibration:	Minimum of 10 temperature points over the selected temperature range. Ohmmeter power loading approximately 0.000015 W at 15 °C.
14.	Thermometrics calibration:	Single point calibration at a selected temperature. Cost is based on lot setup charge and unit cost per each calibration temperature point. Calibration accuracy is approximately 10 millidegrees.

Specification reference: Harold Broitman, Thermometrics, and Catalog No. 181-A.

Table IV-b-2. Resistance vs temperature, narrow range calibration

$$R(T) = R(T_0) \exp[B \times [1/(273.15 + T) - 1/(273.15 + T_0)]$$

$R(T)$ = resistance at temperature T,
T_0 = the calibration temperature,
= 25 °C for Thermometrics calibration
= 15 °C for middle of in house calibration.
B is approximately equal to 3420 (the mean over the 1982 units), typically, 3540+- 15%.

Example: Calculate R(T) for a typical thermistor at 0, 15 and 30 °C.

R(0) = 28.57 K ohm
R(15) = 14.89 K ohm
R(30) = 8.28 K ohm

Table IV-b-3. Pressure sensor specifications

1. Kulite, Model no. PTQH-360-100SG (100 PSI)
   PTQH-360-250SG (250 PSI)
   PTQH-360-500SG (500 PSI)
   PTQH-360-1000SG (1000 PSI)
   The PTQH-360-250SG was used on FRONTS 82.
2. Special conditions:
   a) Basic unit, without nulling and compensation network.
   b) Screen over the vent.
   c) Coated with parylene-c insulation.
   d) Sealed gauge pressure unit.
3. Input-output resistance - approximately 2000 ohms.
4. Full scale output - approximately 100 millivolts per full scale rated pressure.
5. Zero balance +- 50 mV at 5V excitation.
6. Combined error (linearity & hysteresis) - not given.
7. Zero shift vs temperature - not given.
8. Sensitivity shift vs temperature - not given.
9. Maximum pressure - two times rated pressure.
10. Basic unit - 5 wire open bridge version.
11. Suggested operating temperature - 0 to 25 °C.

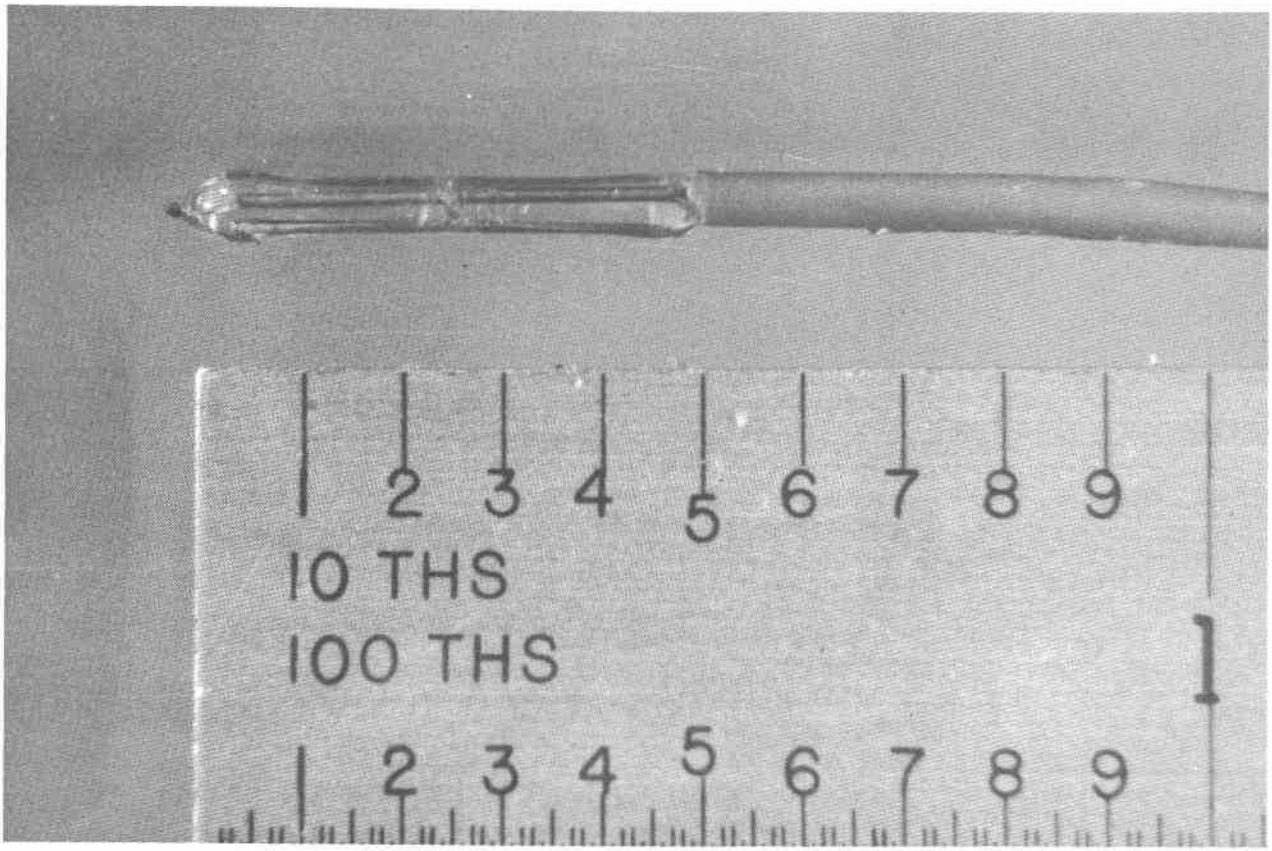
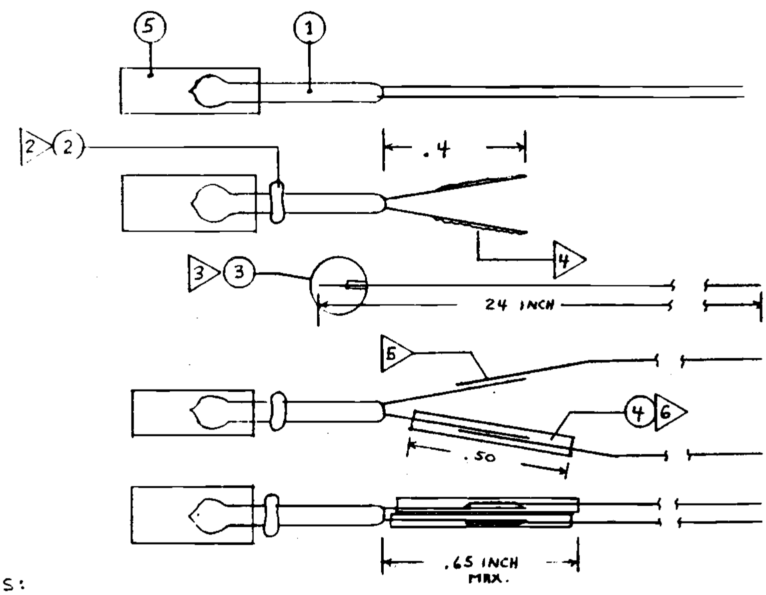


Figure IV-b-1. Photograph of unmounted thermistor.

REVISION			
LTR	DESCRIPTION	DATE	APPROVAL
A		10/82	[illegible]



NOTES:

1. CUT LEADS TO .4 INCHS. LEAVE PROTECTOR TUBE (ITEM 5) IN POSITION OVER BEAD DURING ASSY AND STORAGE.
2. INSTALL O-RING, ITEM 2.
3. CUT MAGNET WIRE 24 INCHES, BURN INSULATION OFF END WITH MATCH (3 SECONDS), SCRAPE WITH EXACTO KNIFE TO BRIGHT COPPER, TIN END UP TO INSULATION, CUT TINNED PORTION TO .2 INCH LENGTH.
4. TIN LEADS OF THERMISTOR APPROX. .25 INCH.
5. SOLDER WIRE TO THERMISTOR LEAD. MAKE VERY FLAT OVERLAPPING JOINT WITH SOLDER BUMPS PROTRUDING LESS THAN .010 INCH MAXIMUM.
6. SLIDE INSULATING SLEEVES UP WIRES AND OVER SOLDER JOINTS, (TWO PLACES).
7. GREASE (ITEM 6) O-RING HEAVILY BEFORE INSTALLING FINISHED THERMISTOR ASSEMBLY IN CALIBRATION FIRXTURE OR NOSECONE.
8. REF THERMISTOR SPECIFICATION, 82-21723.
9. FOR ITEM 4, STRIP A .5 INCH LENGTH OF INSULATION FROM A #24 AWG INSULATED HOOKUP WIRE.
10. PRODUCT OF:
    A. THERMOMETRICS, INC.
       EDISON, N.J.
    B. PARKER
    C. ALPHA

	QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	NOTE
		7			
		6			
		5	# 14	PROTECTOR TUBE, TFT-200	10C
		4	# 24	INSULATING SLEEVE, PVC	
		3	# 28 AWG	WIRE, MAGNET	
		2	# 002	O-RING, NITRILE	10B
		1	FP07DA103N-A	THERMISTOR SENSOR	10A

PARTS LIST

	THERMISTOR ASSY		
DRAWN SDW 10/82	SIZE B	FSCM NO. 82-21500	DWG. NO. 82-21721 — REV. A
ISSUED	SCALE 4/1		SHEET 1 of 1

Figure IV-b-2. Thermistor assembly drawing (dwg no. 82-21721).

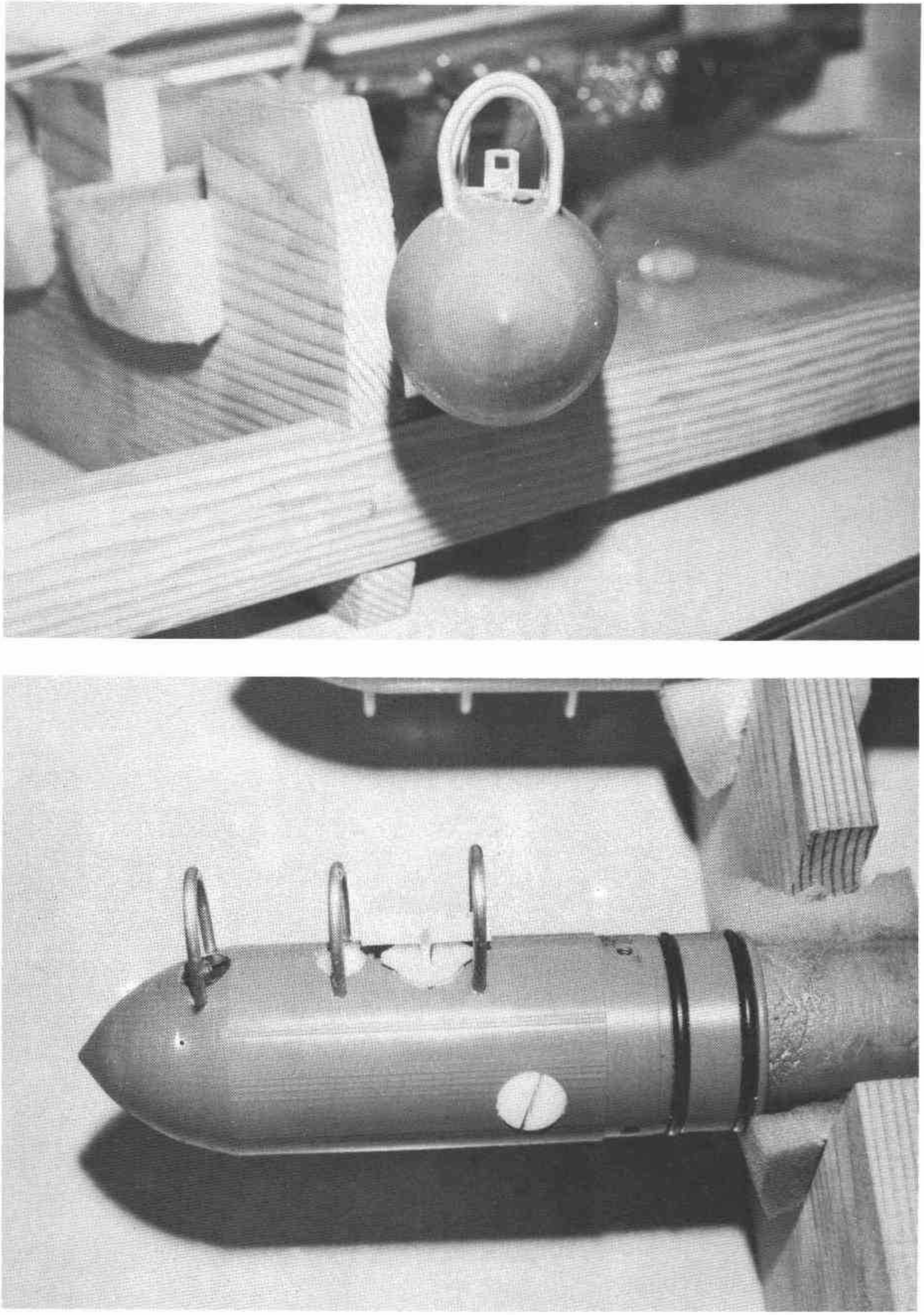


Figure IV-b-3. Photograph of Neil Brown conductivity sensor mounted in RSVP nose cone.

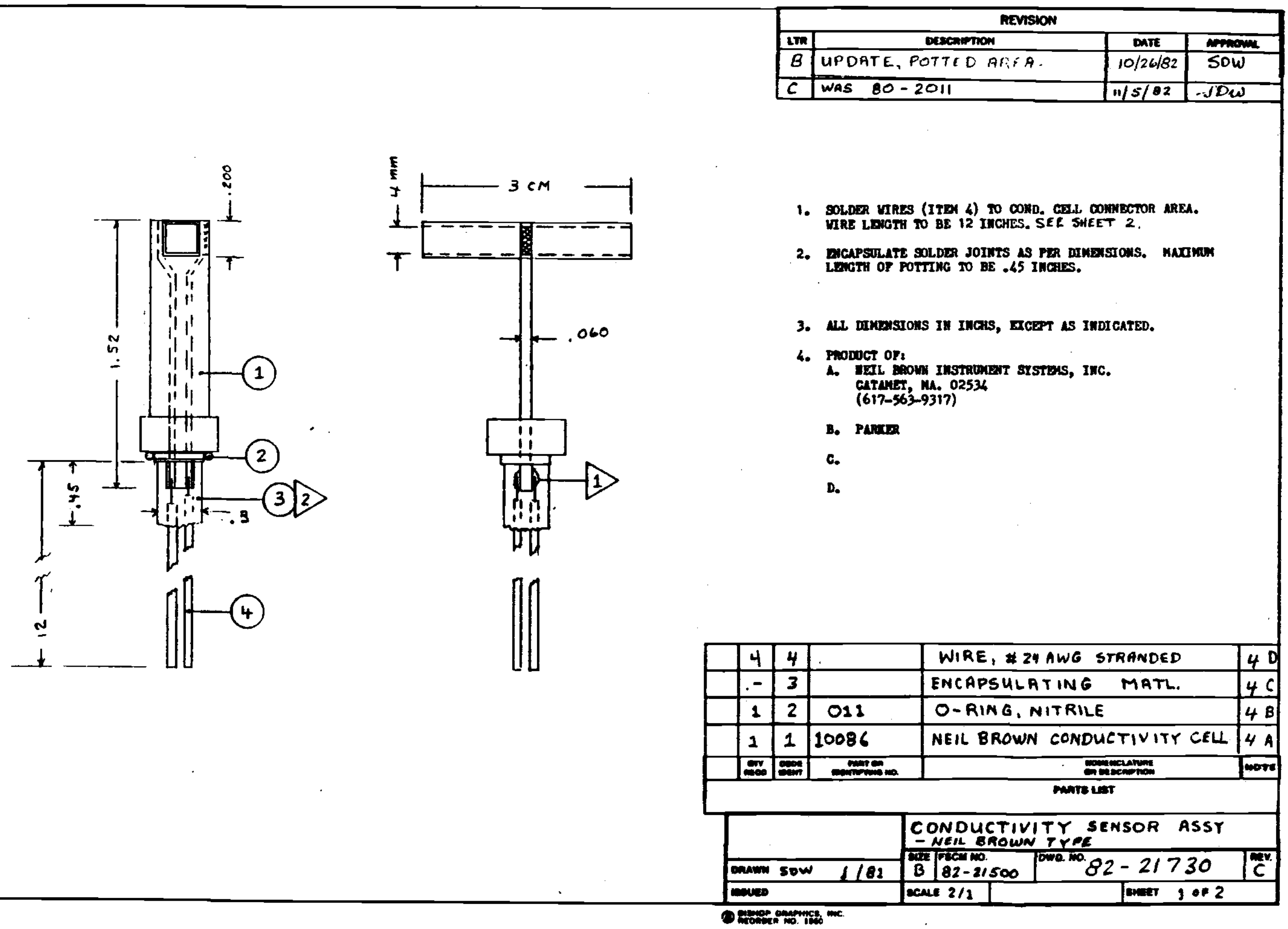


Figure IV-b-4. Neil Brown conductivity sensor assembly drawing (dwg no. 82-21730).

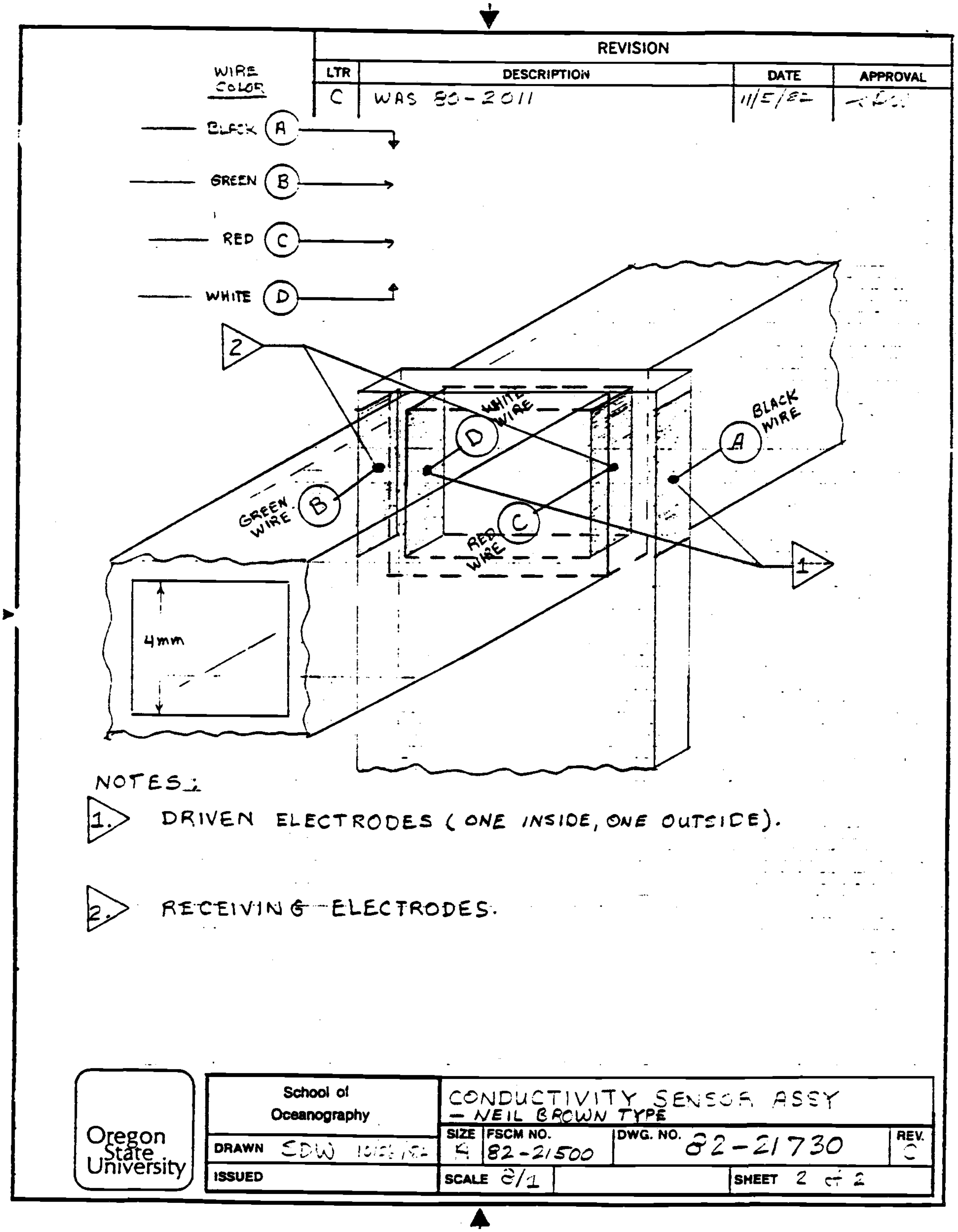


Figure IV-b-5. Neil Brown conductivity sensor electrode placement (dwg no. 82-21730).

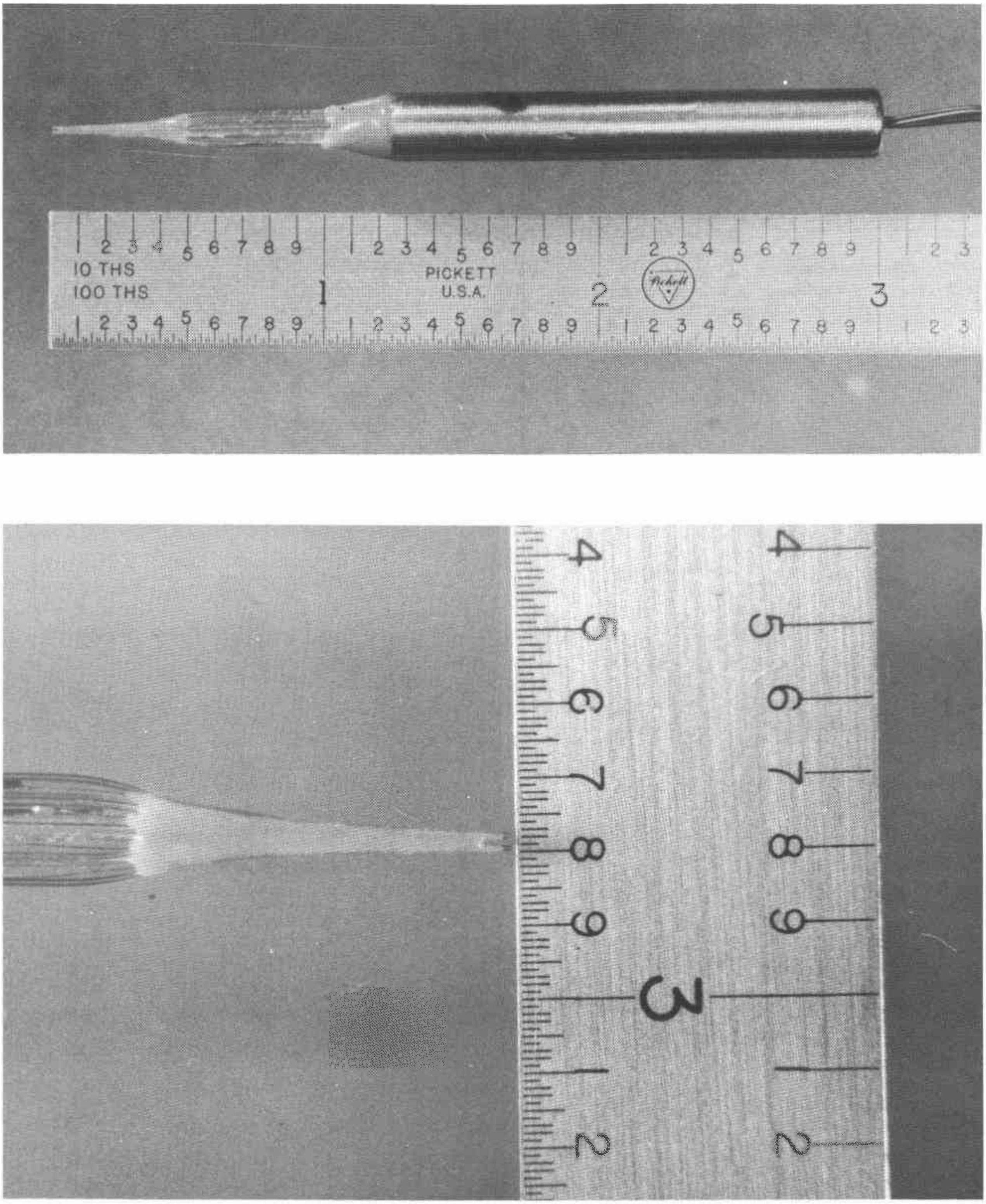


Figure IV-b-6. Photograph of Michael Head microconductivity sensor.

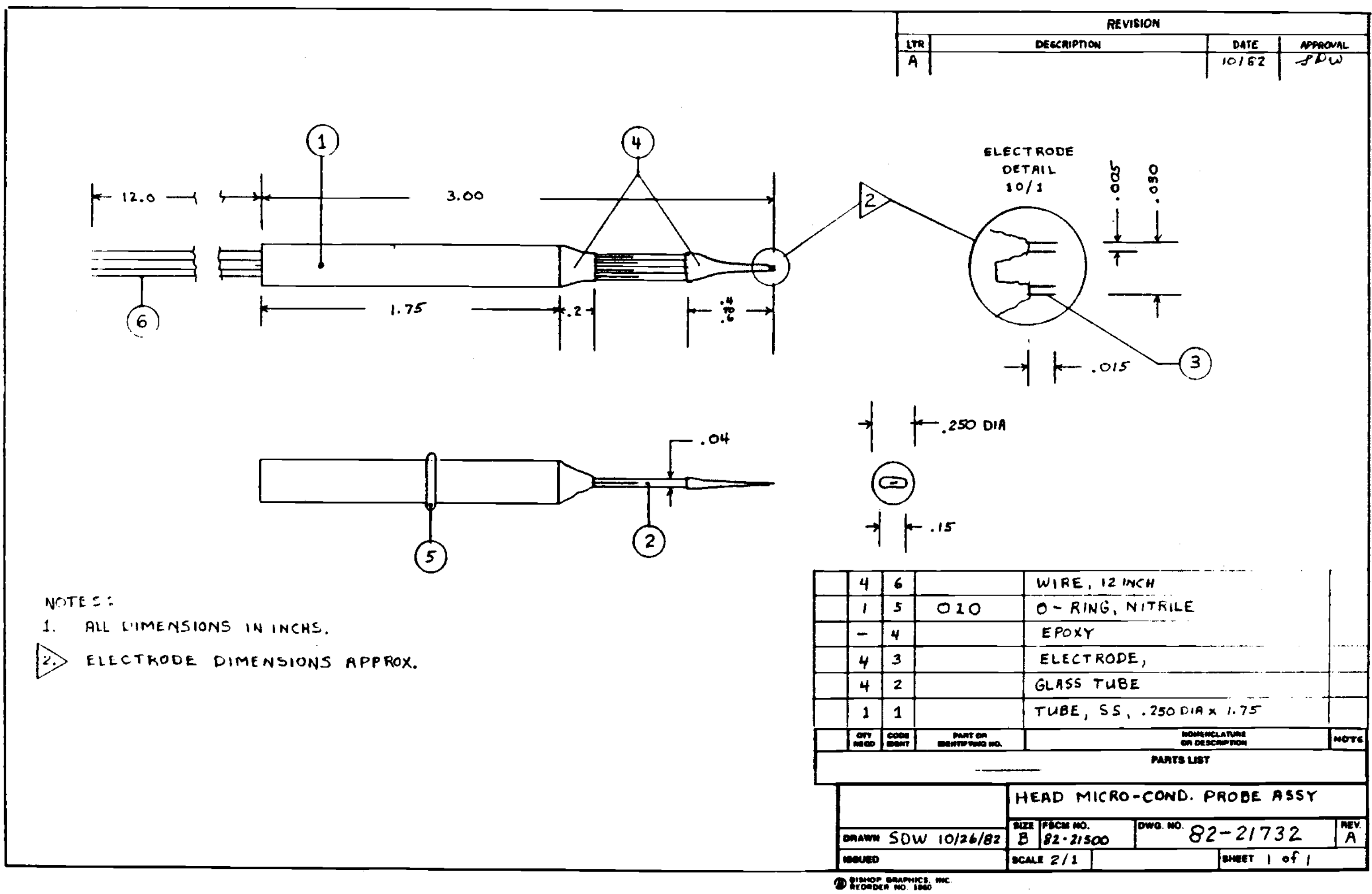
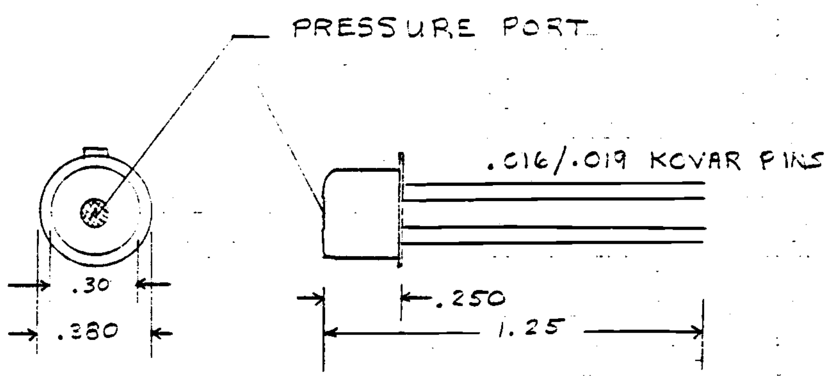


Figure IV-b-7. Microconductivity sensor assembly drawing (dwg no. 82-21732).

REVISION			
LTR	DESCRIPTION	DATE	APPROVAL
A		10/82	[illegible]



NOTES:

1. PINS MUST BE SCRAPED CLEAN OF PARYLENE-C INSULATION BEFORE UNIT CAN BE PLUGGED IN OR SOLDERED.

2. ALL DIMENSIONS IN INCHES.

Oregon State University	School of Oceanography	PRESSURE SENSOR SPECIFICATION			
	DRAWN SDW 10/82	SIZE A	FSCM NO. 82-21500	DWG. NO. 82—21728	REV. A
	ISSUED	SCALE 2/1		SHEET 2 of 2	

Figure IV-b-8. Pressure sensor specifications (dwg no. 82-21728).

c) Probe mechanical design

The mechanical part of the probe comprises the instrument body, the nose cone in which the sensors are mounted, the oil bladder, stabilizing fins and the instrument termination (Figure IV-c-1, Table IV-c-1). A lead cylinder secured between the nose cone and the motherboard provides the weight necessary to insure that the instrument descends vertically at the desired speed. These must be designed so that the sensors are protected from breakage under normal conditions while at the same time the flow passing the sensors must be as unobstructed as possible. The sensors must be mounted in such a way that damaged sensors can be replaced, but sea water cannot enter the case. The probe is not pressure sealed, thus the oil bladder is required as a reservoir to insure that the instrument body remains full of oil under pressure. A means of connecting the probe to the data link/retrieval line must be provided that allows the data link to be changed if necessary, that protects the connectors from salt water, and is strong enough to pull the instrument through the water and back onto the deck.

NOSE CONE:
The nose cone (Figure IV-c-2) is machined from a 2" PVC rod. Threaded holes are positioned to hold the various sensors that can be inserted into the nose cone. Sensor guards of 0.125" stainless steel rod prevent the sensors from being inadvertently touched and broken. The instrument end is machined to fit inside the stainless steel body and indentations for o-ring seals are made in this area (Figures IV-c-3,IV-c-4). The retainers (Figures IV-c-5 - IV-c-7) to be used with each of the sensor types (thermistors, NBIS conductivity, microconductivity) are made from Delrin rod. One of the two fill holes for oil is also located in the nose cone. The basic nose cone is modified to accept the microconductivity transducer (Figure IV-c-8) or to attach to the thermistor/conductivity chain (Figure IV-c-9).

BODY:
The probe body is constructed of 2.0" O.D., 0.49 W 304 stainless steel tube (Figures IV-c-10, IV-c-11).

INSTRUMENT TERMINATION:
The upper end of the probe (Figures IV-c-12, IV-c-13) must provide both mechanical and electrical connection to the data link/retrieval line. An oil bladder is required to insure that the electronics compartment remains completely oil-filled under pressure. The bladder, a 4.5" tube of nalgene 180 (1.5" I.D. 0.125" wall thickness), is supported by the body plug and the bladder support (Figures IV-c-14 - IV-c-17). The second oil-fill hole is located in the bladder

support. The body-connector housing (Figure IV-c-18) passes through the bladder and contains #24 insulated wires joining two amphenol connectors. These connectors, located within the body plug and the body-connector housing, mate with connectors in the probe and the line termination respectively. A termination collar (Figure IV-c-19) turns to allow the line termination to be screwed into the probe.

FINS:
The RSVP requires fins to stabilize its movement through the water. These comprise an acrylic tube 3.3" long, 2.0" I.D., 0.125" wall thickness, with three fins, 0.125" thick, 3" long, 3" wide at the base tapering to 2.25" at the tip. The fins are glued to the tube and reinforced at both sides of the joint with acrylic 0.125" thick and 0.3" wide. The tube slides freely on the instrument body so that they are at the top when the instrument is falling and at the rear on retrieval.

Table IV-c-1. RSVP parts list

510	Line termination	
	511	Strain relief
	512	Line connector housing
	513	Cable snubber
		Connector - Amphenol 222-11N19 plug
		Strain relief - Amphenol 222-518
		Safety line - 15' nylon boot lacing
520	Instrument termination	
	521	Body connector housing
		Connector - Amphenol 222-12N19 receptacle
		Cable - 19 strands #24 insulated wire 9" long
	522	Termination collar
	523	Bladder support
	524	Fill plug
	526	Instrument connector housing
		526-1 sleeve
		526-2 housing
		Strain relief - Amphenol 222-518
		Connector - Amphenol 222-12N19
	527	Body plug
540	Body	
530	Nose cone	
	530/1	Thermistor Modification
	530/2	Conductivity Modification
	530/3	Microconductivity Modification
	530/4	Chain Modification
	532	Thermistor retainer (may be modified to microconductivity retainer by increasing hole size to 17/64".
	533	Weight
	535	Conductivity retainer
		535-1 tightener
		535-2 spacer

Seals

Parker 2 series o-rings nitrile

002	111	212
010	114	215
011	115	223

Fasteners - stainless steel

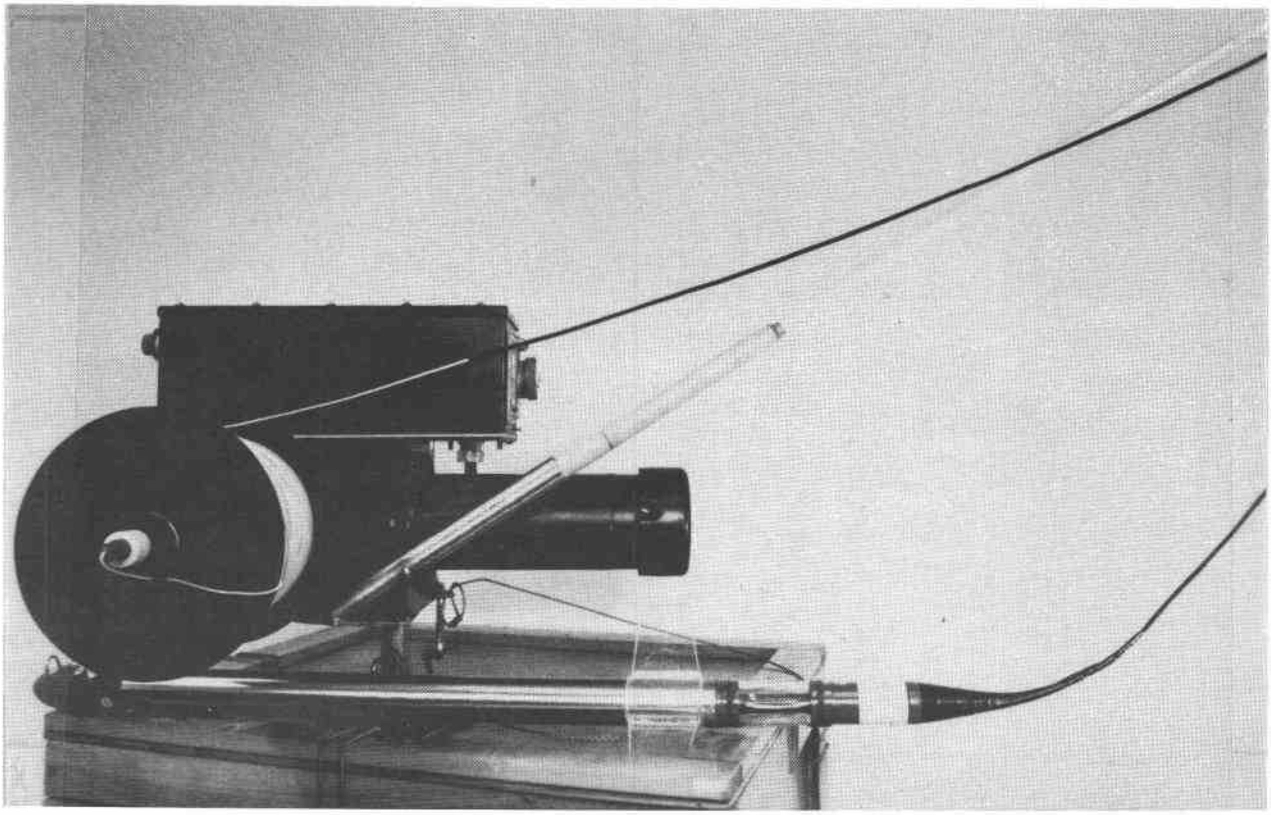
6 - 32 x 1/4" socket head

6 - 32 x 1 1/2" round head

10 - 32 x 3 1/2" flat head

Misc. Hardware -stainless steel

1/8" x 3/4" groove pin



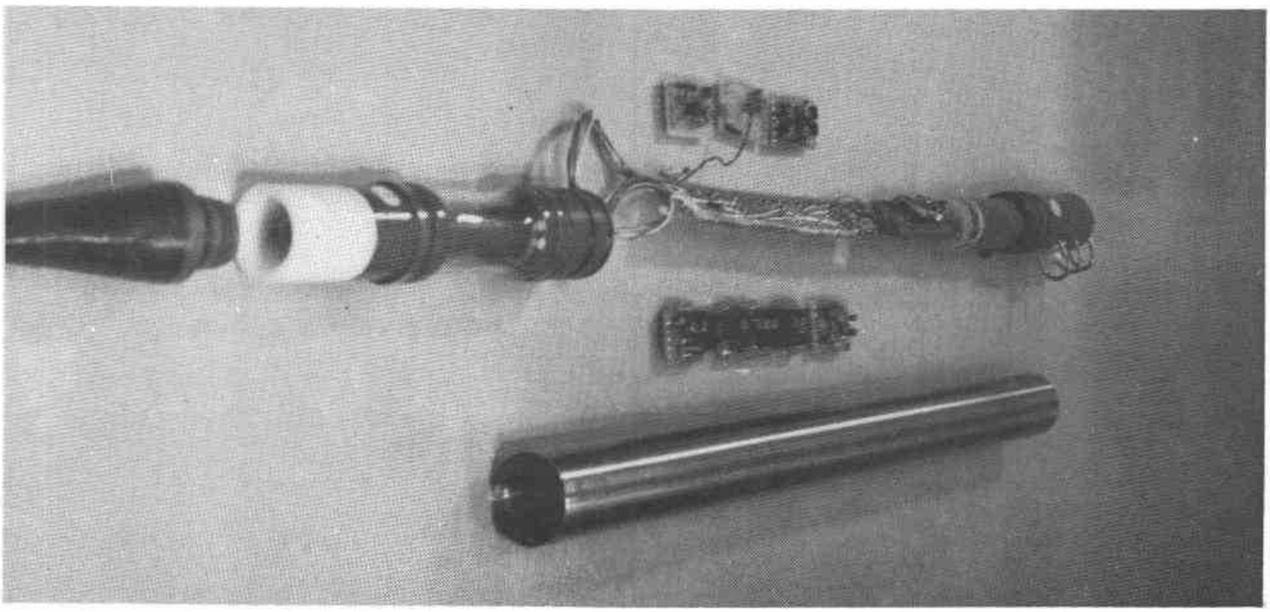


Figure IV-c-1. Photographs of RSVP unit and winch.

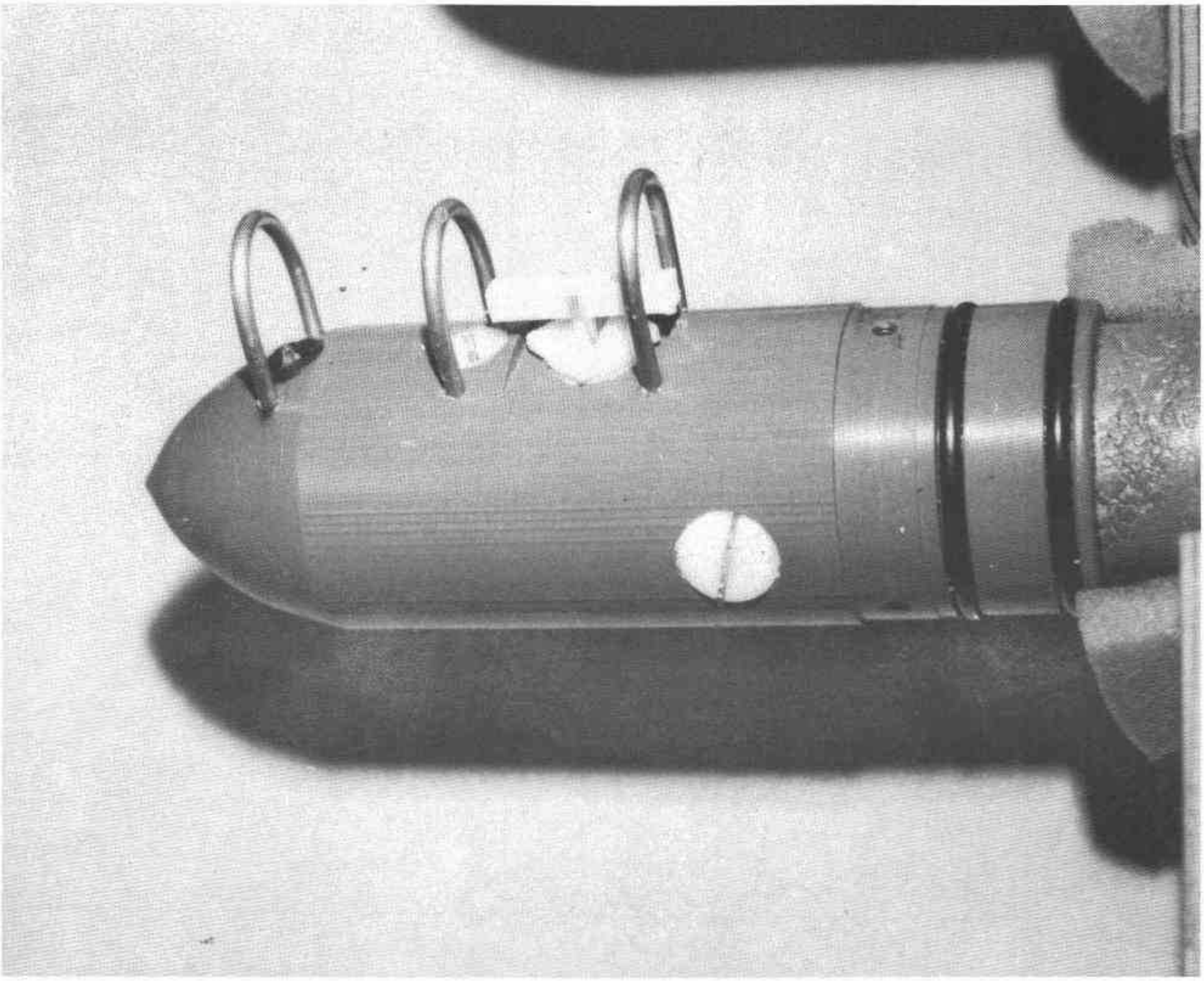


Figure IV-c-2. Photograph of nose cone with sensors.

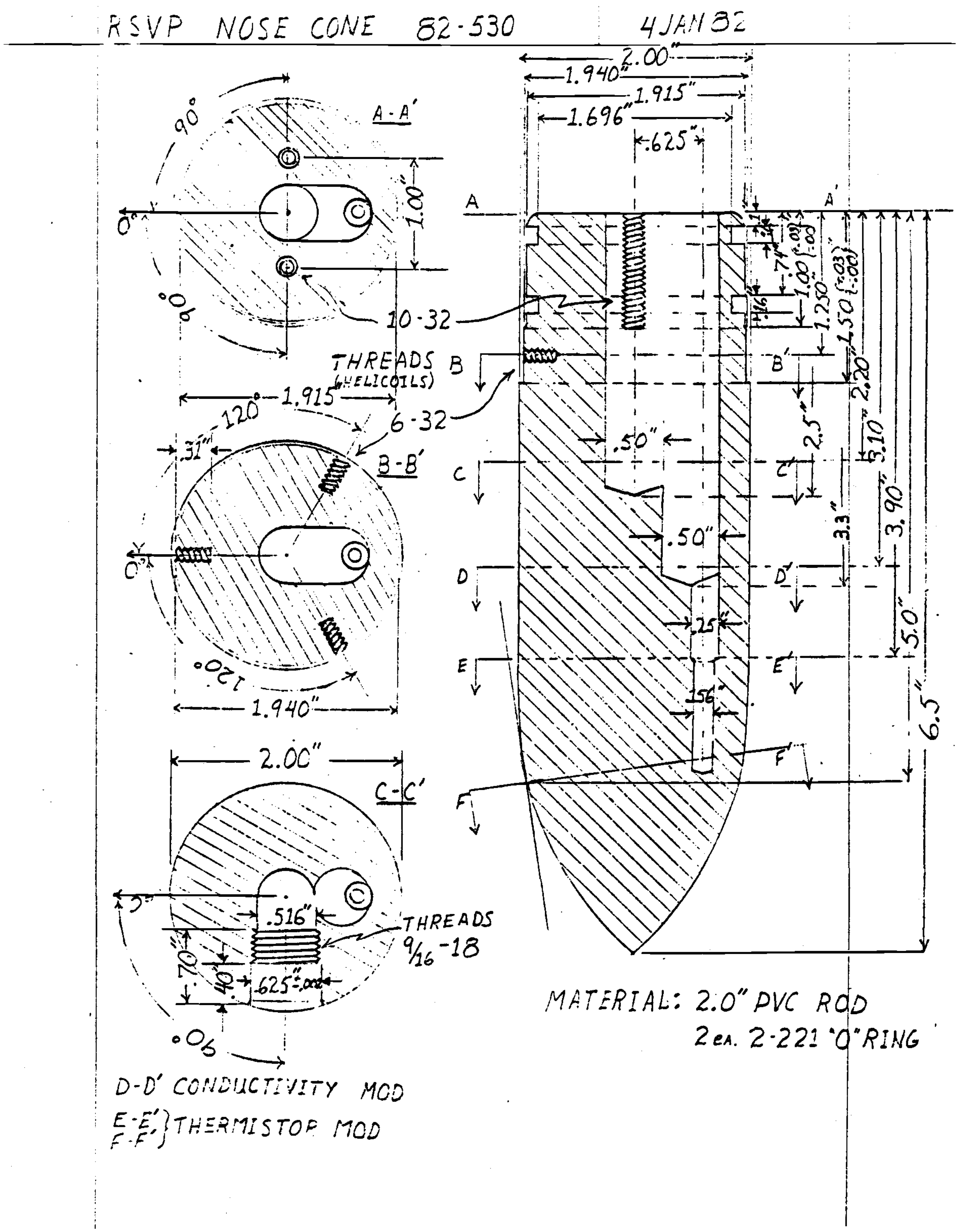


Figure IV-c-3. RSVP nose cone, machinist's drawings (dwg no. 82-530).

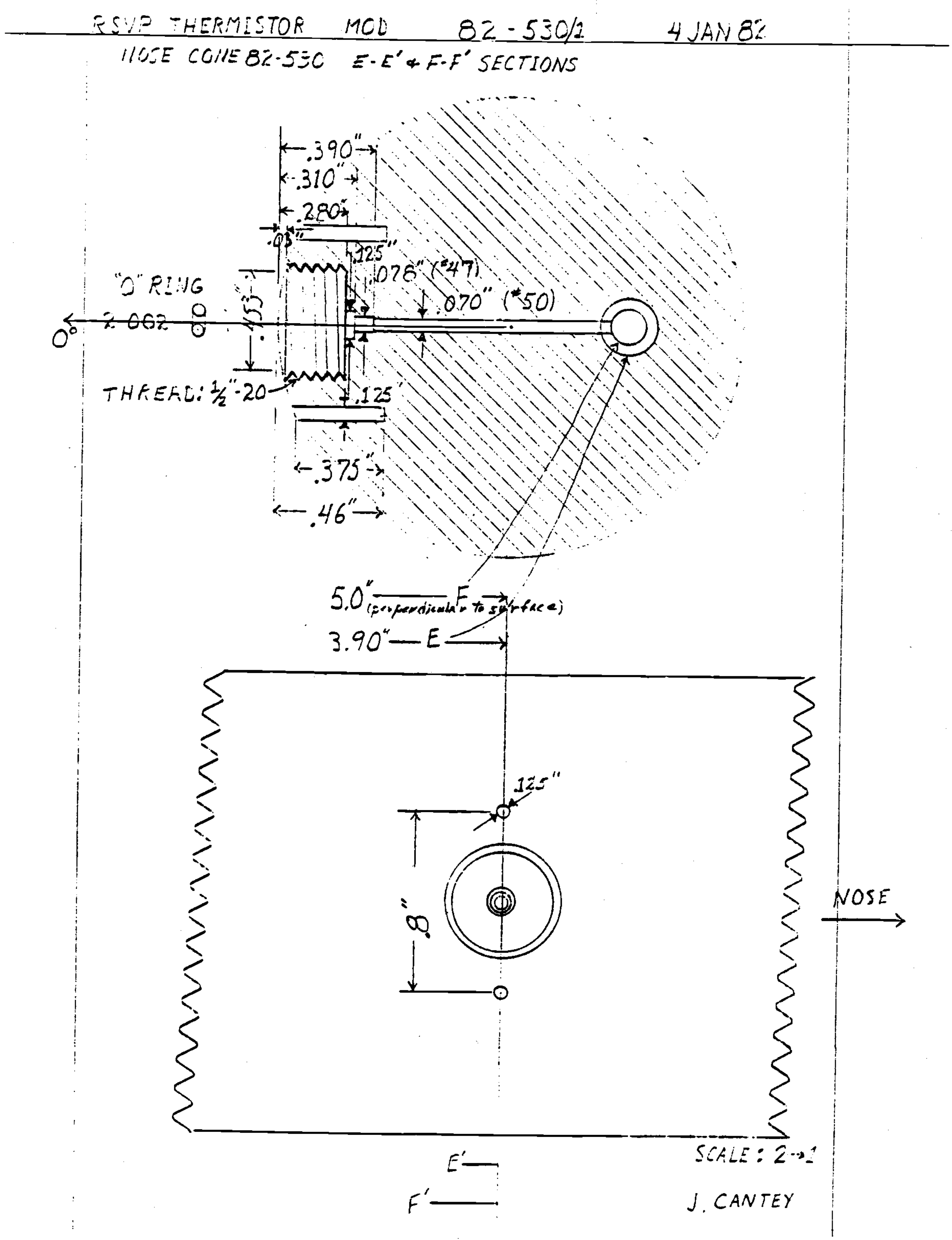
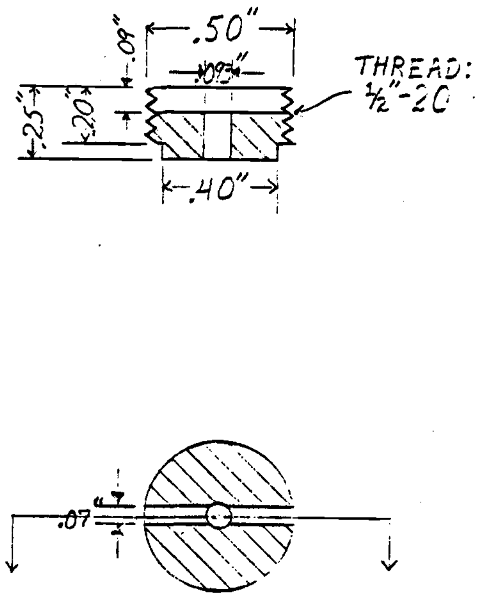


Figure IV-c-4. RSVP nose cone showing hole for thermistor (dwg no. 82-530/1).

RSVP THERMISTOR RETAINER 82-532 4 JAN 82



MATERIAL: ½" DELRIN ROD

SCALE: 2→1

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Figure IV-c-5. Thermistor retainer (dwg no. 82-532).

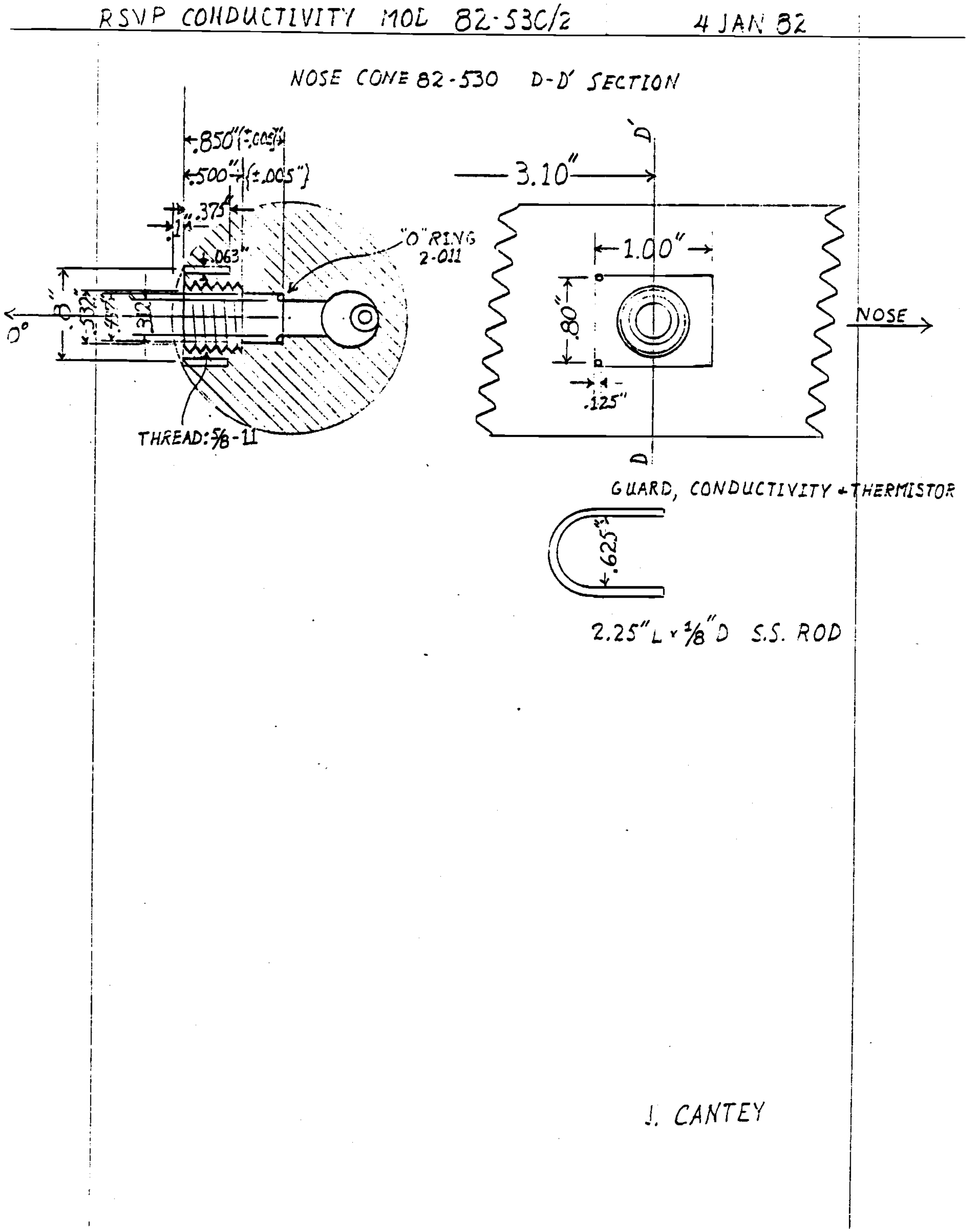

Figure IV-c-6. Mount for Neil Brown conductivity (dwg no. 82-530/2).

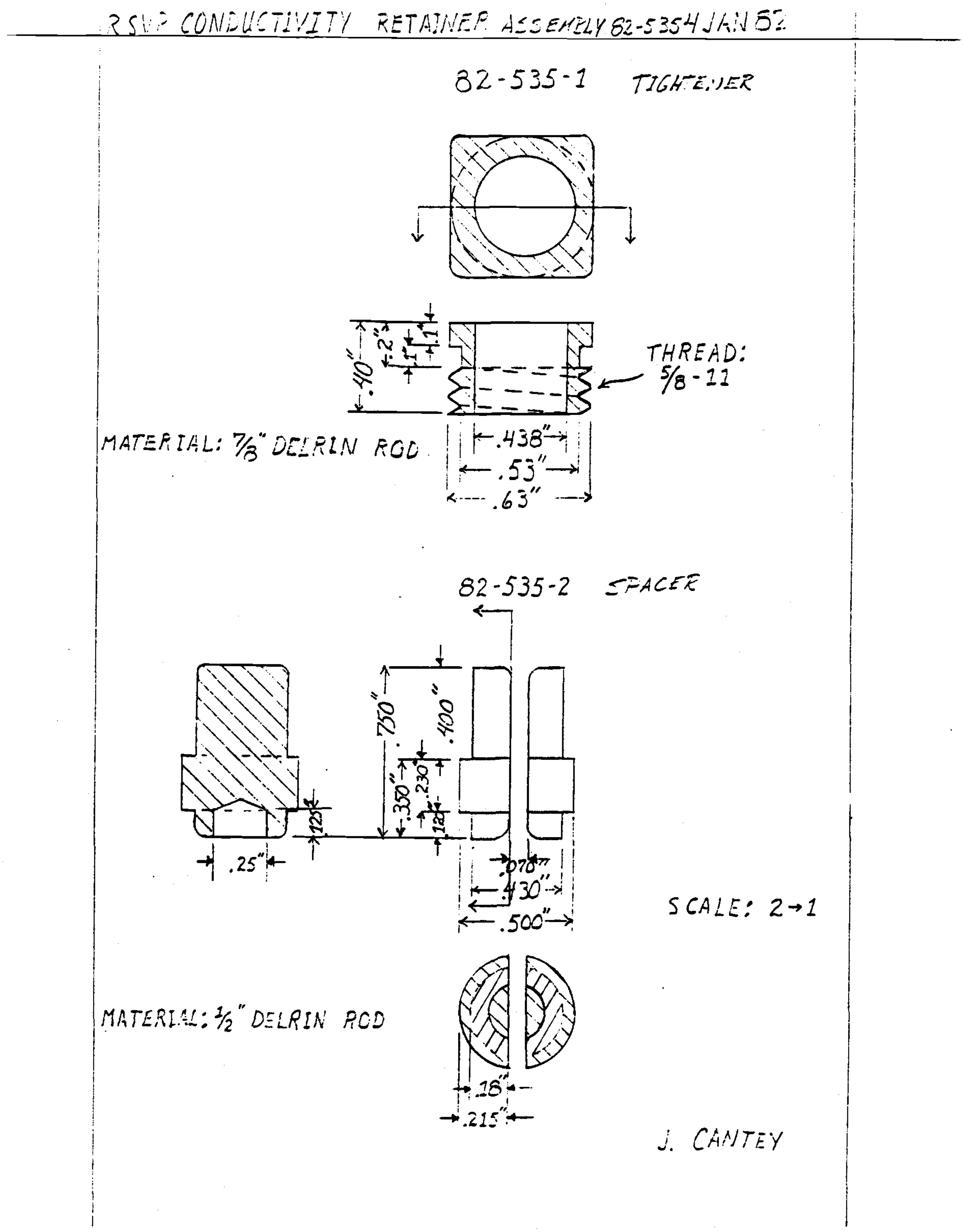

Figure IV-c-7. Neil Brown conductivity retainer (dwg no. 82-535).

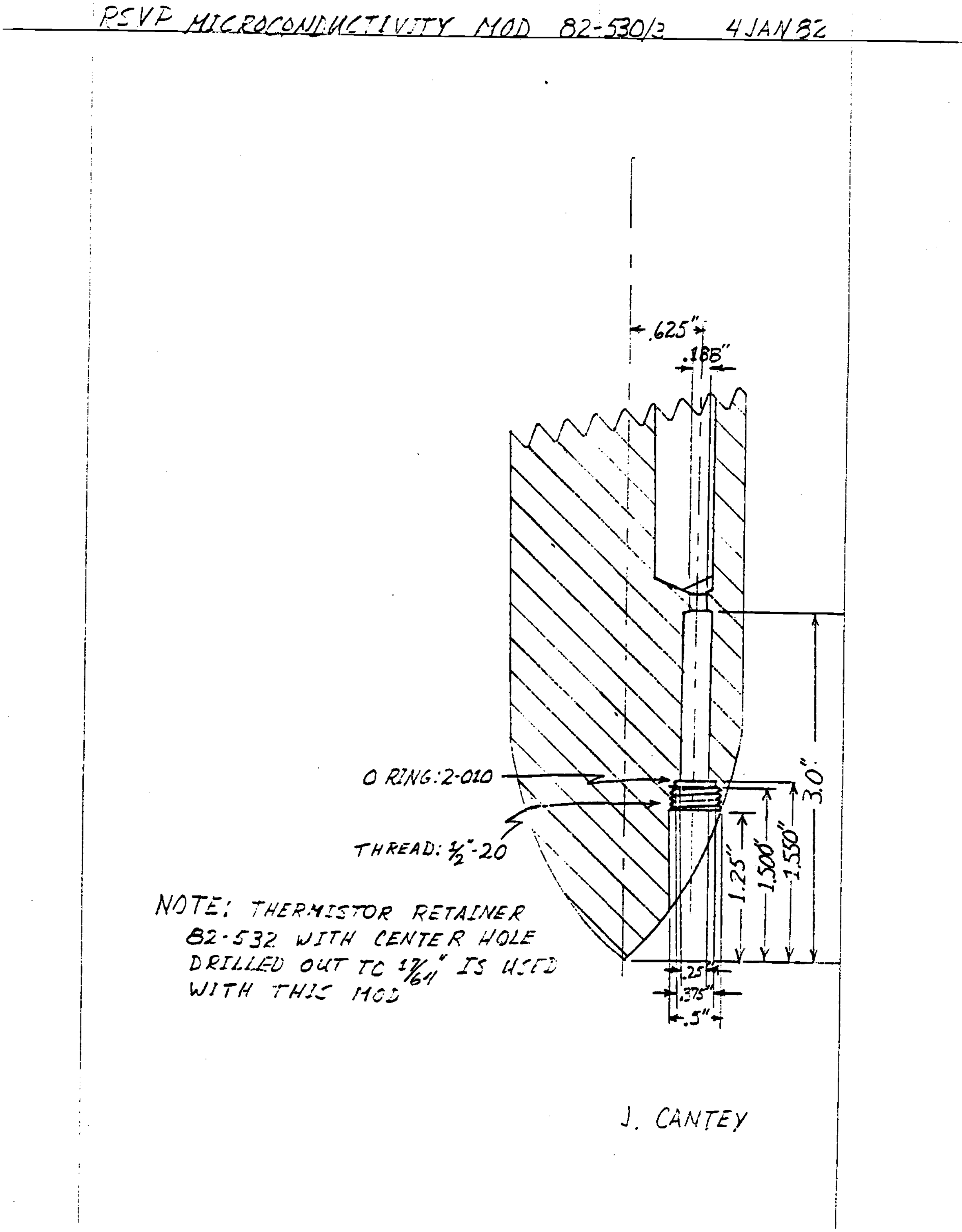

Figure IV-c-8. Mount for Head microconductivity (dwg no. 82-530/3).

RSVP CHAIN MOD 82-530/4 4 JAN 82

NOTE: THE CABLE SLEEVE THAT COMPLETES THIS ASSEMBLY WAS 1/2" ID, 5/8" OD WITH FLANGES 2.05" APART. MATERIAL: DELRIN

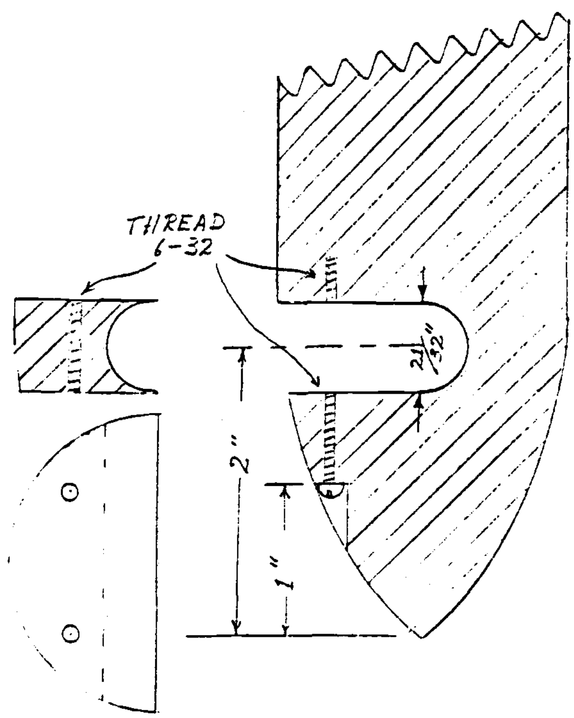

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Figure IV-c-9. Nose cone modification for use with thermistor chain (dwg no. 82-530/4).

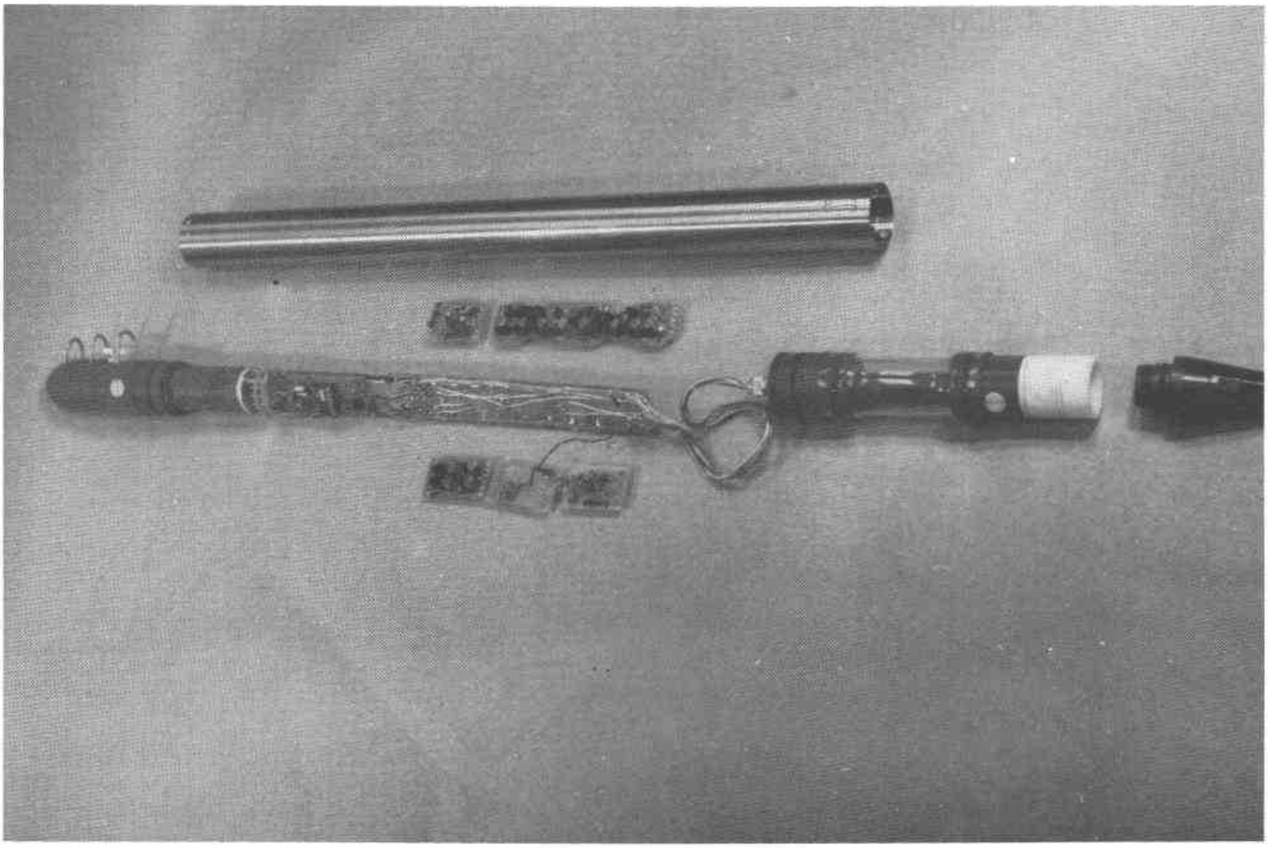


Figure IV-c-10. Photograph of RSVP with nose cone, body and instrument termination.

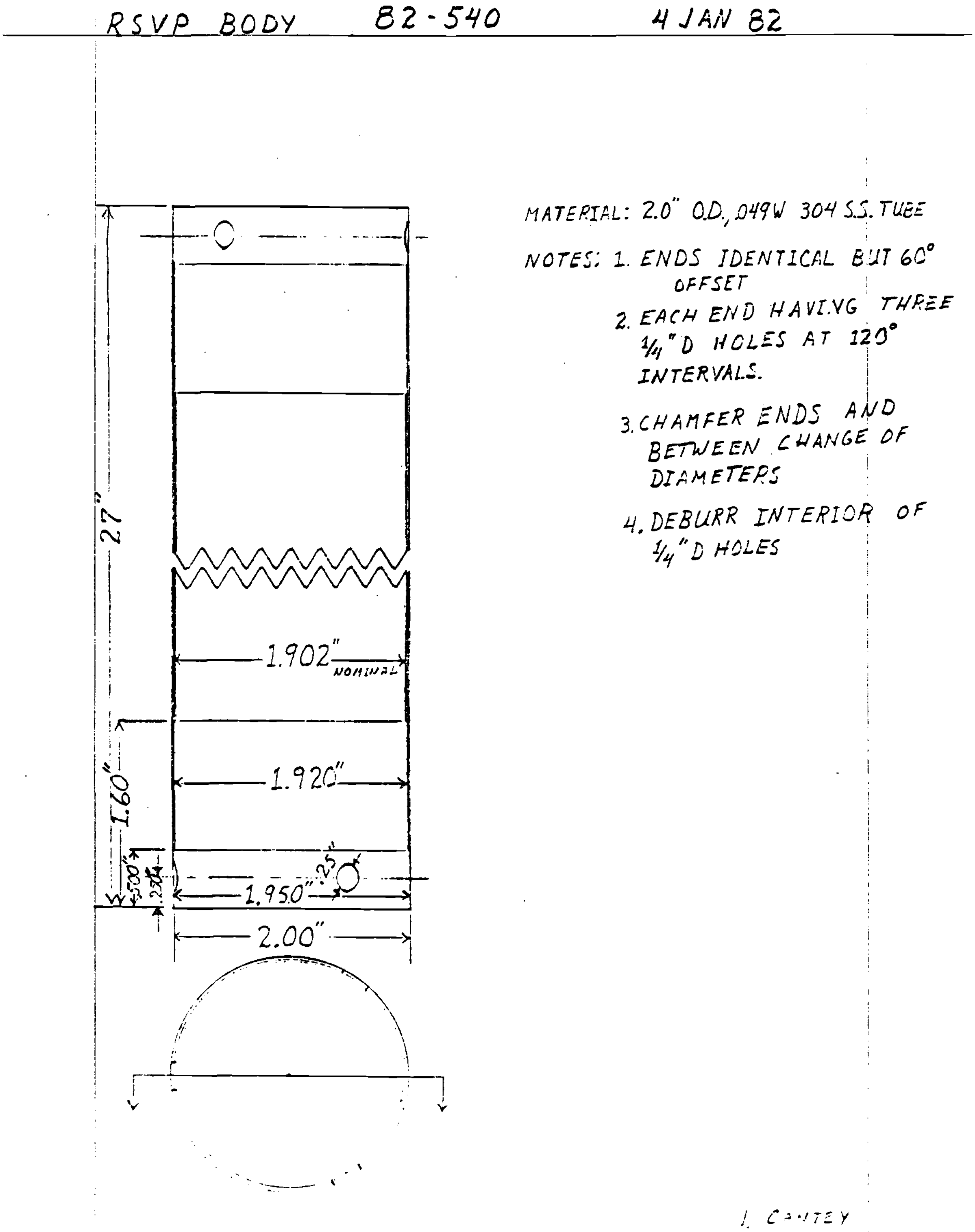


Figure IV-c-11. RSVP body specifications (dwg no. 82-540).

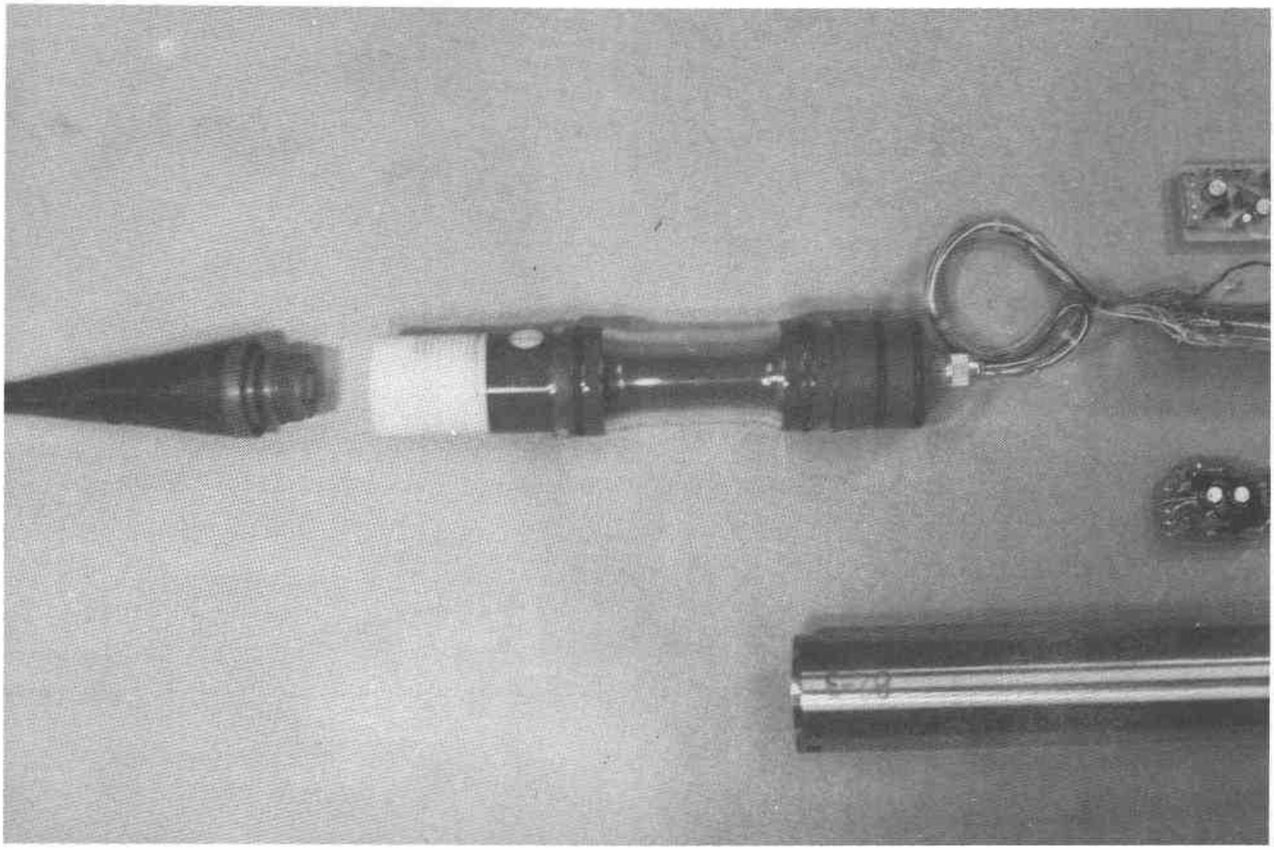


Figure IV-c-12. Photograph of instrument termination.

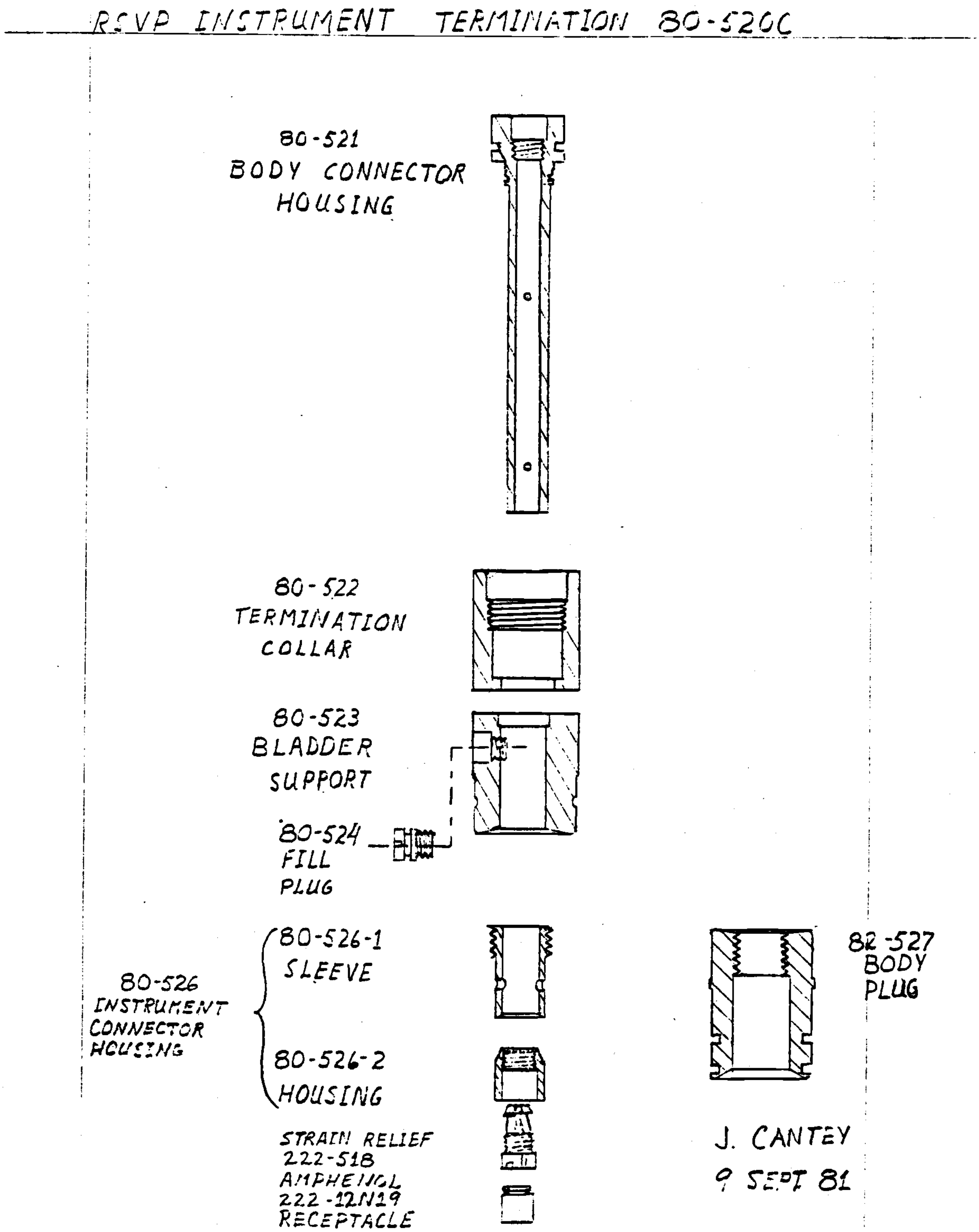


Figure IV-c-13. Components of the instrument termination (dwg no. 80-520C).

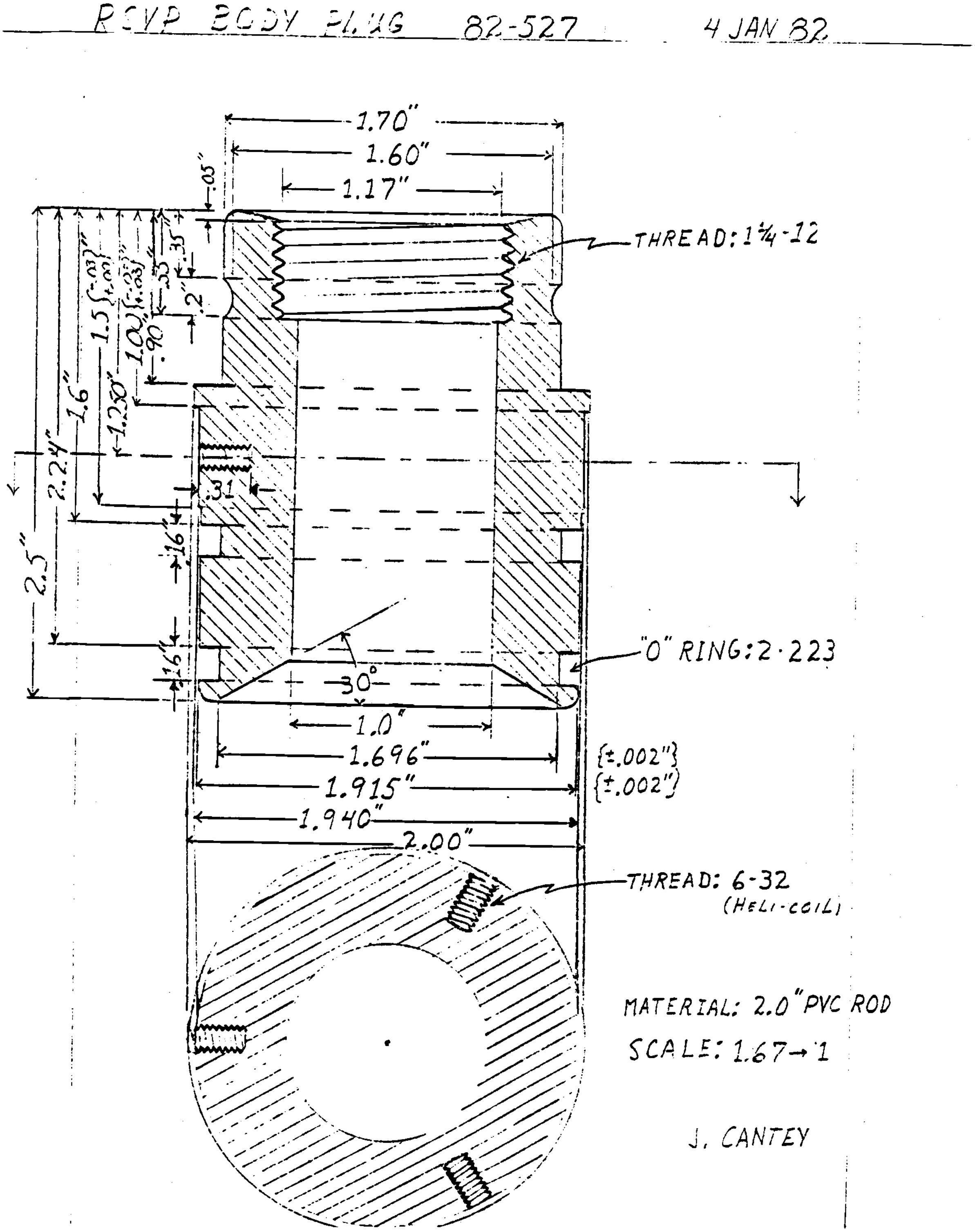


Figure IV-c-14. Body plug (dwg no. 82-527).

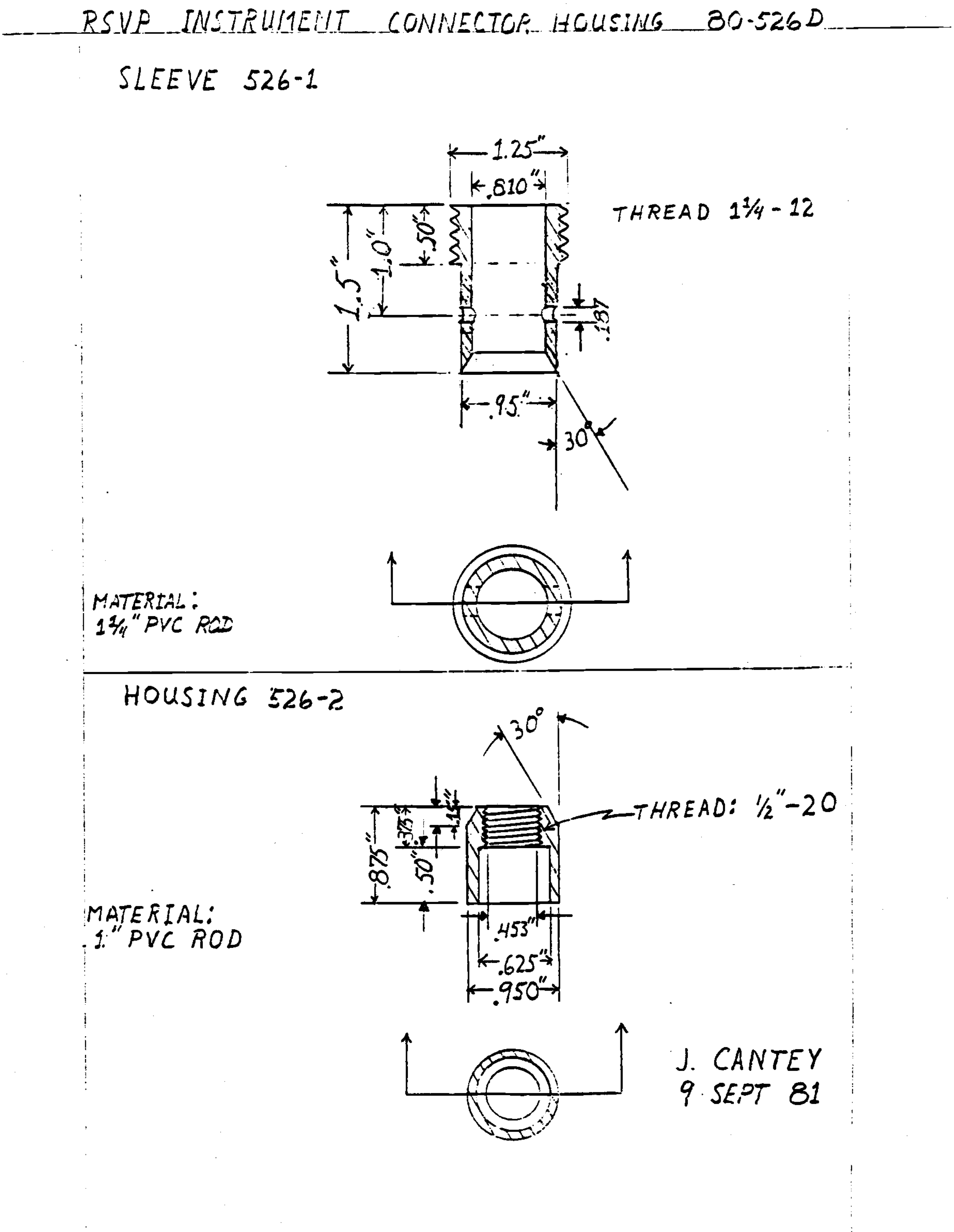
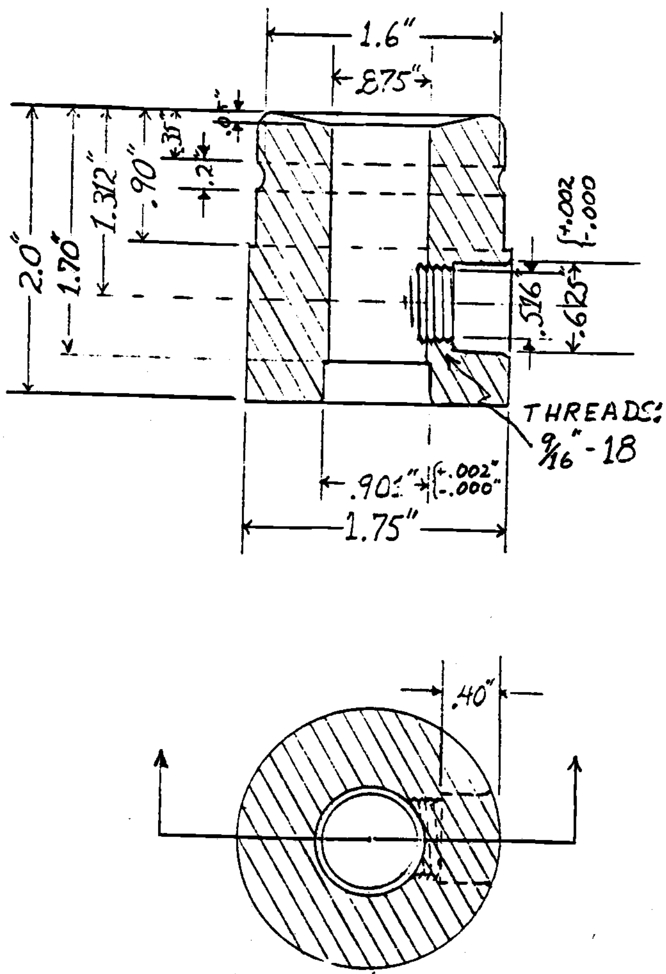


Figure IV-c-15. Instrument connector housing (dwg no. 80-526D).

RSVP BLADDER SUPPORT 80-523C



NOTE: ASSEMBLE TERMINATION COLLAR (80-522) TO BODY CONNECTOR HOUSING (80-520) AND GLUE WITH PVC CEMENT TO BLADDER SUPPORT PRIOR TO DRILLING AND TAPPING FILL HOLE. TAP THRU BODY CONNECTOR HOUSING WALL.

MATERIAL:
1.75" PVC ROD

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Figure IV-c-16. Bladder support (dwg no. 80-523C).

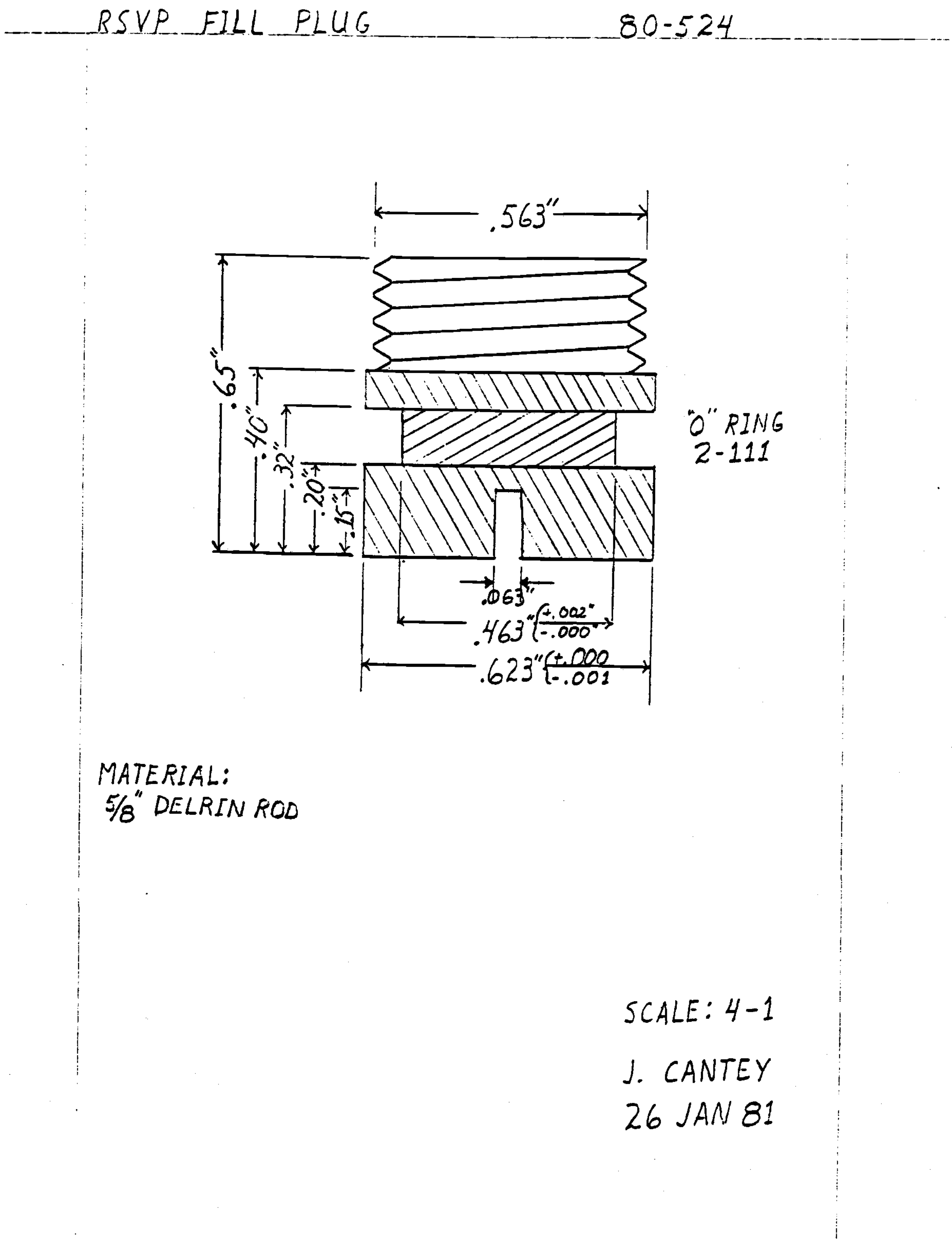


Figure IV-c-17. Oil fill plug (dwg no. 80-525).

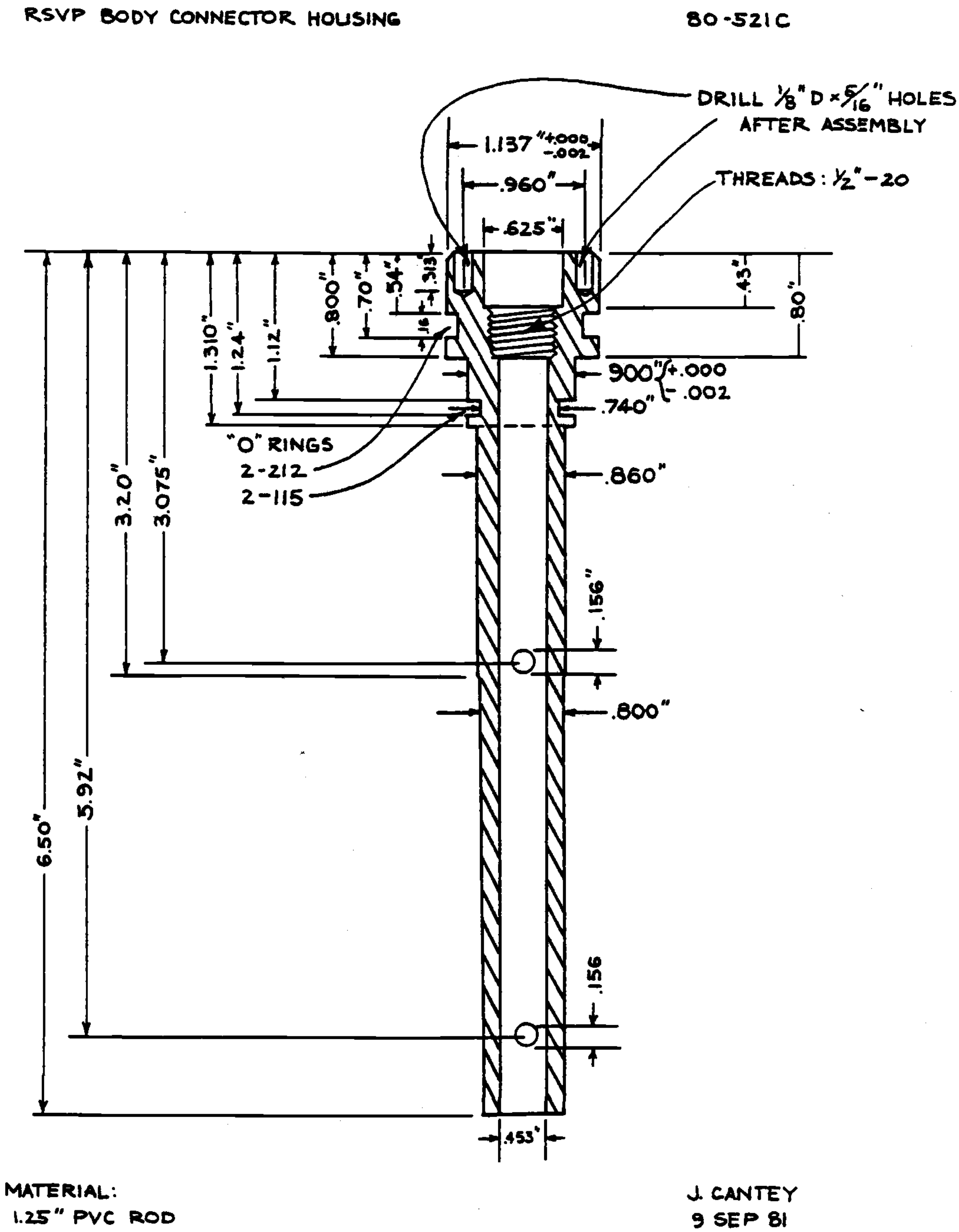


Figure IV-c-18. Body connector housing (dwg no. 80-521C).

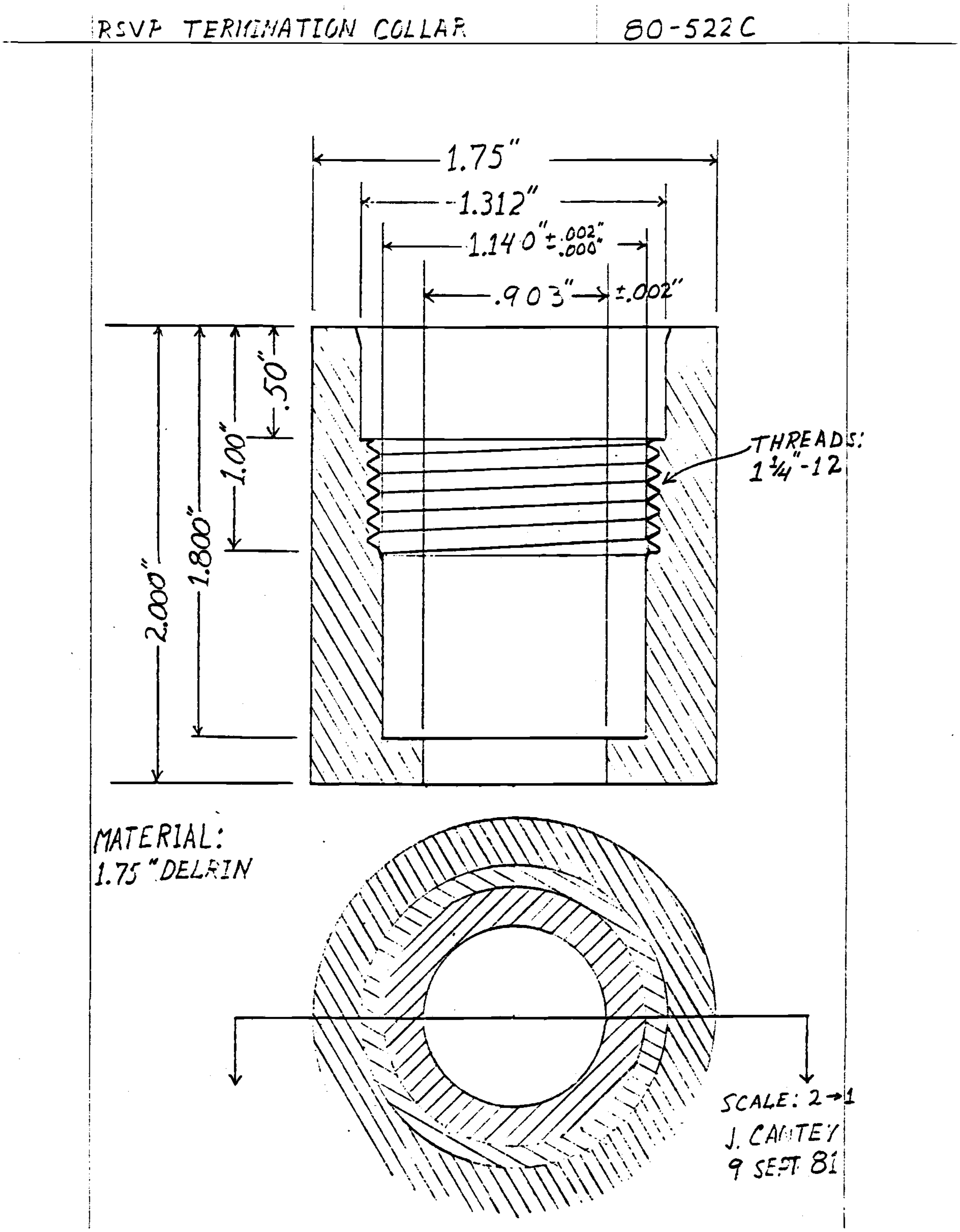


Figure IV-c-19. Termination collar (dwg no. 80-522C).

d) Cable and terminations

The cable (Figure IV-d-1) used with the RSVP is manufactured by Cooner Wire Company, Chatsworth, CA. This cable is required to be waterproof to 500 PSI in sea water with a breaking strength of greater than 400 pounds. The conductors are #32 AWG solid wire with triple poly-nylon insulation. The overall diameter is 0.095". For FRONTS 82 1400 feet of continuous cable was required to reach the desired depth. Two versions of the line were used, one with 10 and one with 16 conductors.

The ends of this cable must be terminated with electrical connectors and strain relief mechanisms that can stand up to shipboard deployment.

INSTRUMENT END TERMINATION:

a) Clean threads of line-connector housing (Figures IV-d-2, IV-d-3) with Freon TF.
b) Place o-ring into line-connector housing.
c) Thread cable thru:
   1) safety line (not shown)
   2) strain relief (Figure IV-d-4)
   3) line-connector housing
   4) cable snubber (Figure IV-d-5)
   5) Amphenol strain relief
d) Solder jumpers and wires to female pins and insert into Amphenol plug, jumpers first.
e) Check for shorts between wires.
f) Coat pins and wires with "5-minute" epoxy.
g) Check for shorts between wires.
h) Tie knot in cable above Epoxy.
i) Position Amphenol strain relief onto plug. Fill cracks between strain relief and plug with clay.
j) Apply MEK (methyl ethyl ketone) to threads of Amphenol strain relief.
k) Fill Amphenol strain relief with polyurethane (Products Research and Chemical Corporation PR-1592 Amber) and slide cable snubber into place in end of strain relief. Lightly coat strain relief threads with polyurethane and screw plug assembly into line connector housing. Carefully apply MEK to inside threads of line-connector housing. DO NOT allow MEK to come into contact with the cable jacket. MEK will severely weaken it. Fill cavity with polyurethane. Screw strain relief into line-connector housing. Allow polyurethane to cure 3 days at room temperature before use.
l) Check for shorts between wires and continuity through cable.
m) Thread safety line through line-connector

housing and tie off.
n) Place o-ring onto line-connector housing.

WINCH END TERMINATION:

a) Remove tabs from Amphenol strain relief.
b) Thread cable through: 1) line-connector housing (Figure IV-d-6)
   2) Amphenol strain relief (Figure IV-d-7).
c) Tie knot in Kevlar.
d) Solder wires to female pins and insert into Amphenol plug.
e) Check for shorts between wires.
f) Position Amphenol strain relief onto plug. Fill cracks between strain relief and plug with clay.
g) Screw plug assembly into line-connector housing.
h) Check for shorts between wires.
i) Center cable in line-connector housing and fill with "5-minute" epoxy.
j) Check for shorts between wires and continuity through the cable.
k) Place o-ring onto line-connector housing.

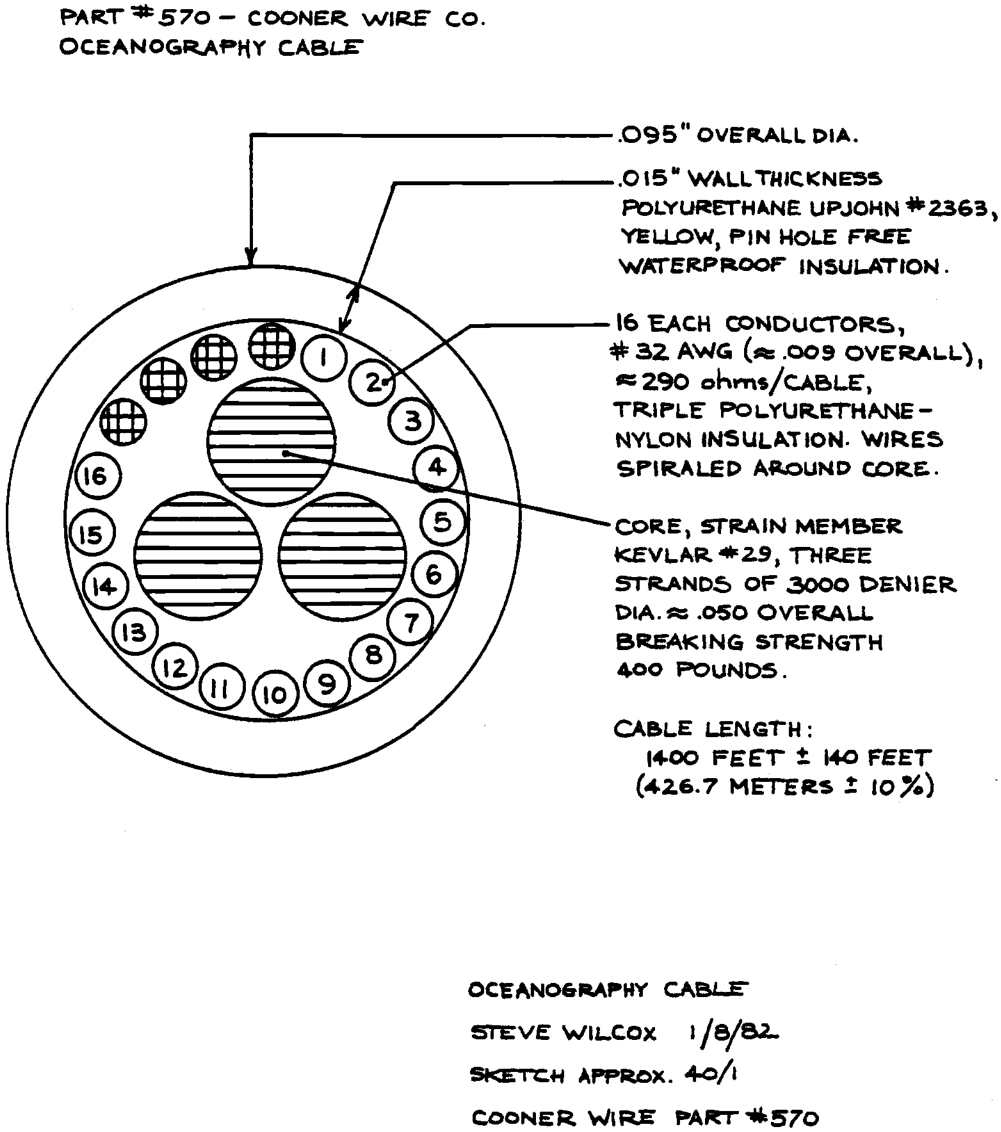


Figure IV-d-1. Cooner wire sketch, part #570.

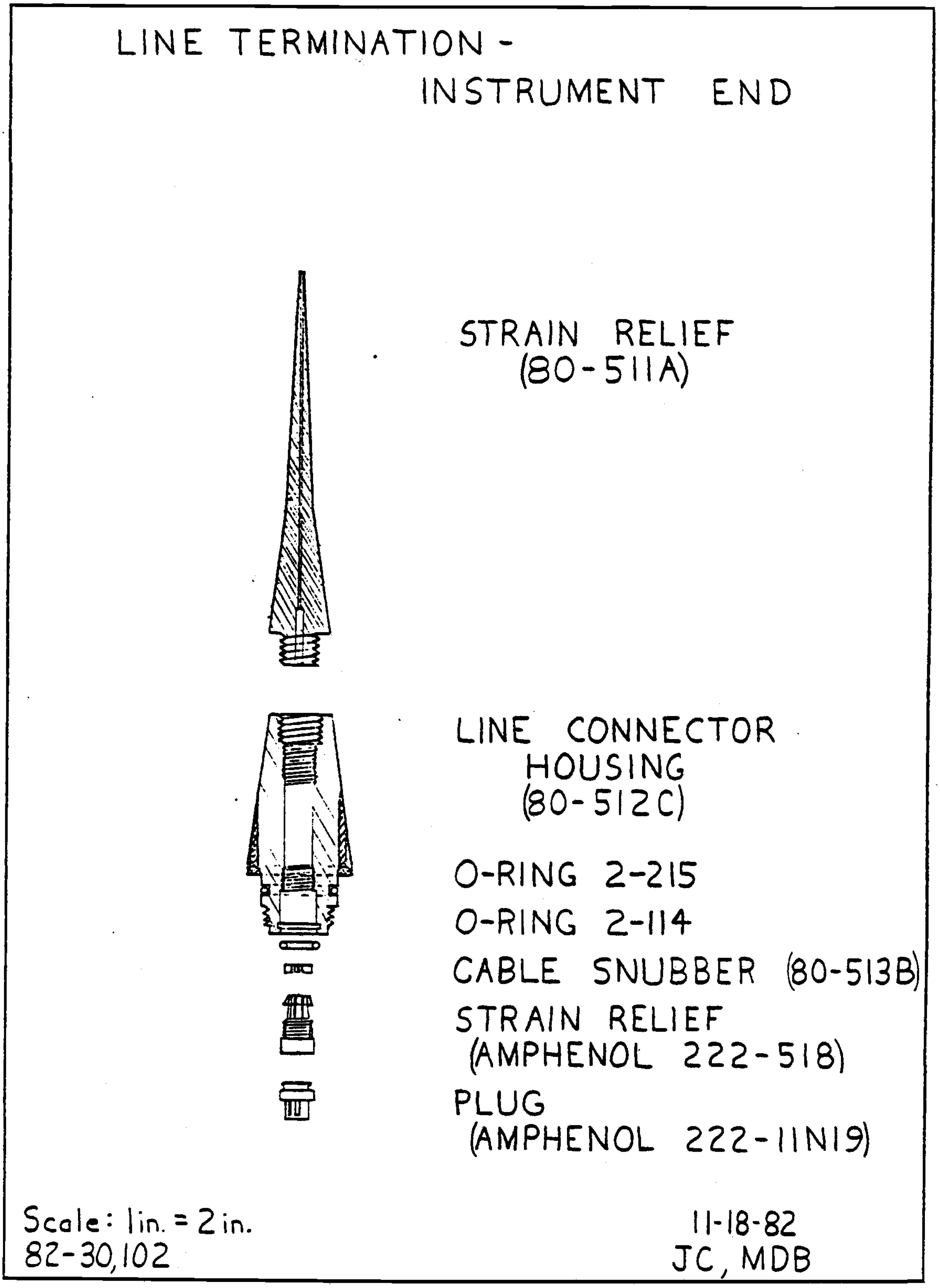


Figure IV-d-2. Line termination - instrument end (dwg no. 82-30,102).

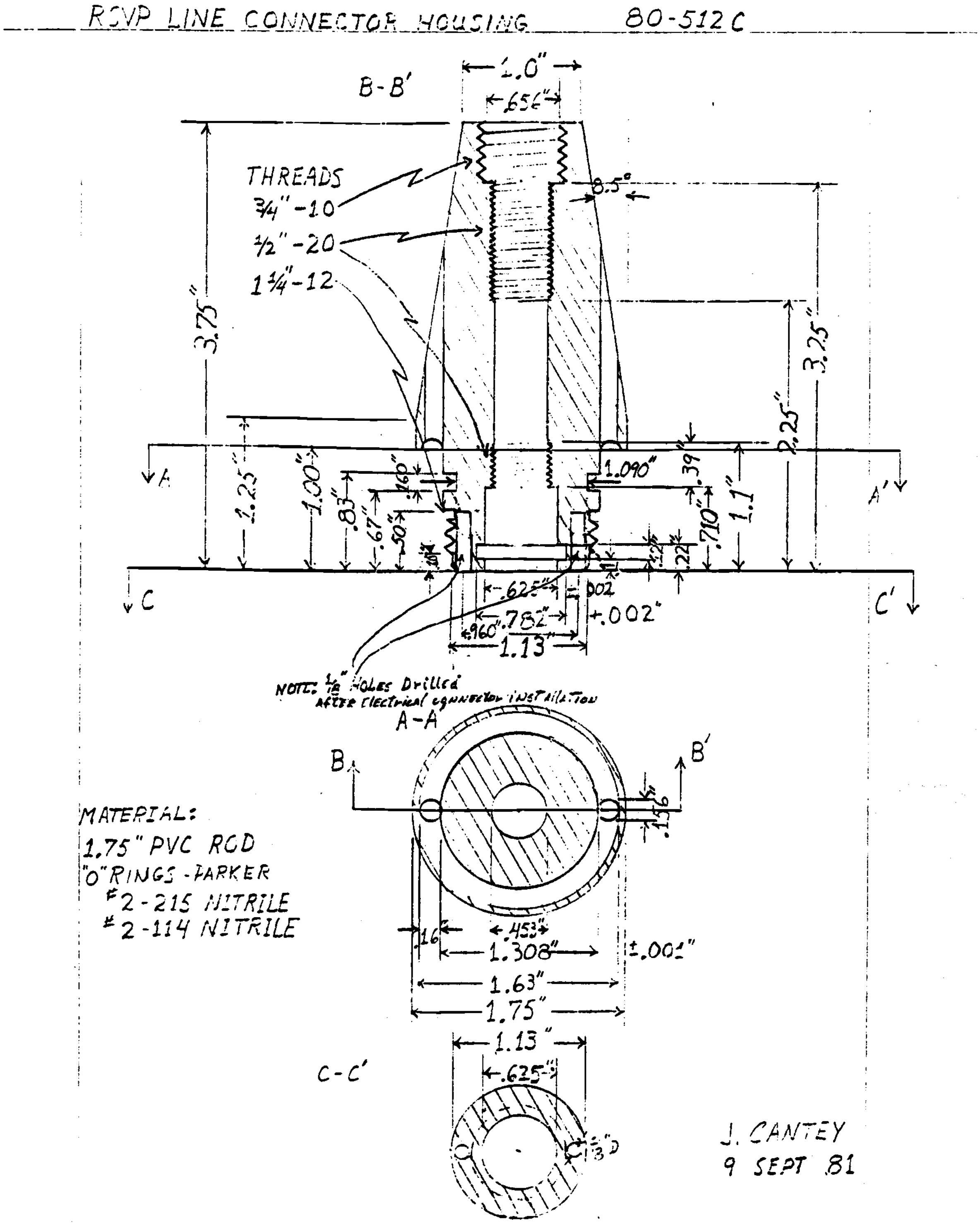


Figure IV-d-3. Line connector housing - instrument end (dwg no. 80-512C).

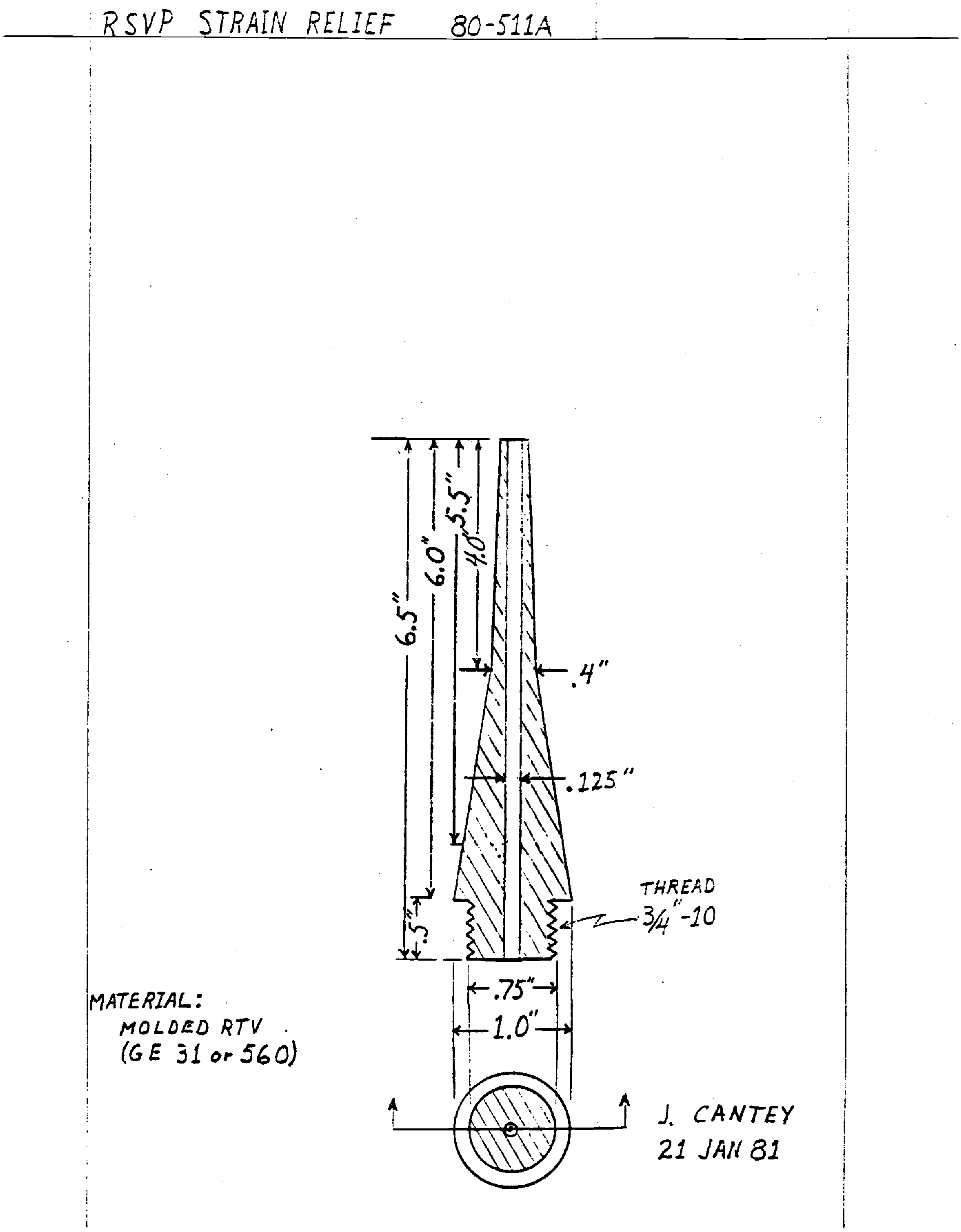


Figure IV-d-4. Strain relief - instrument end (dwg no. 80-511A).

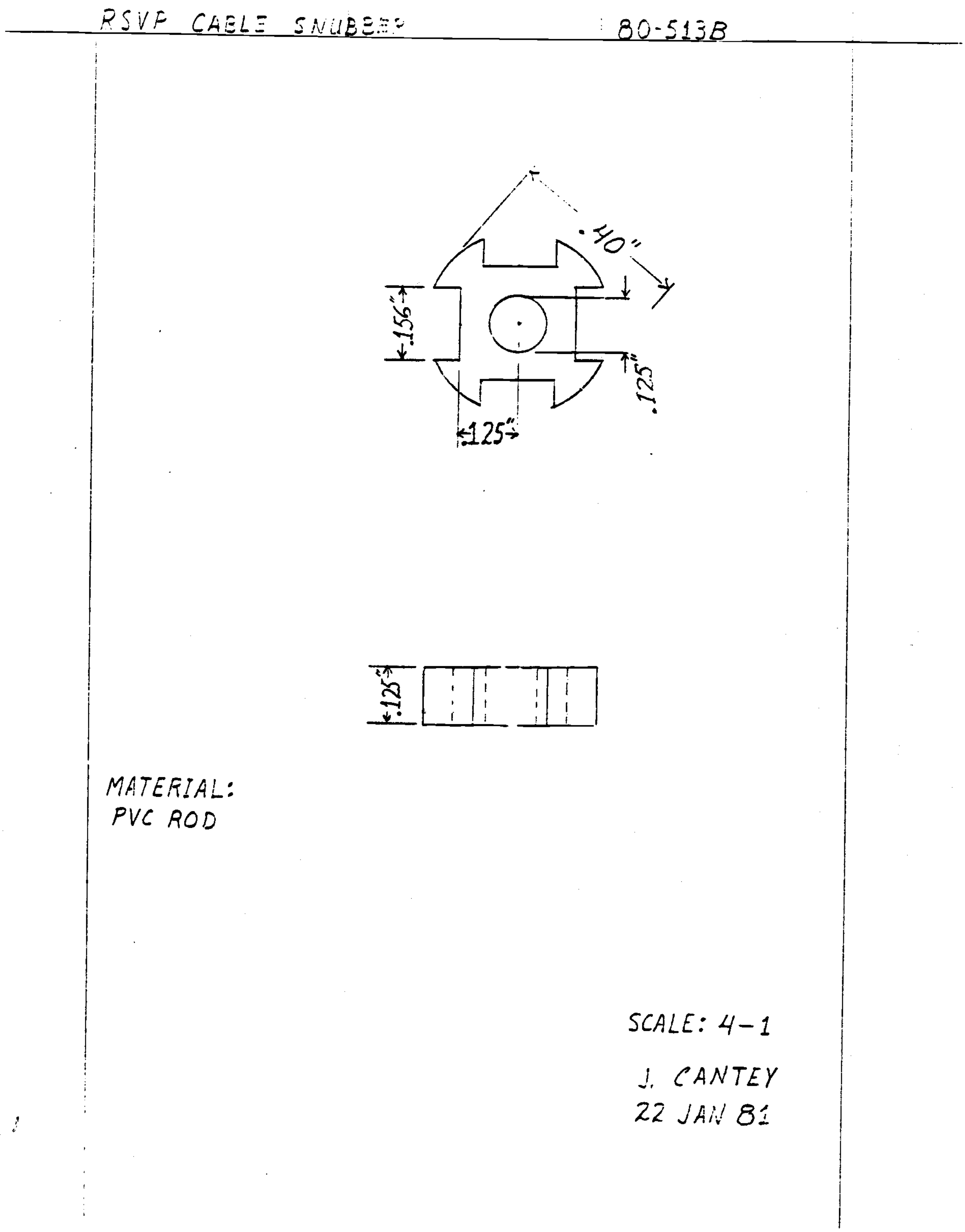


Figure IV-d-5. Cable snubber (dwg no. 80-513B).

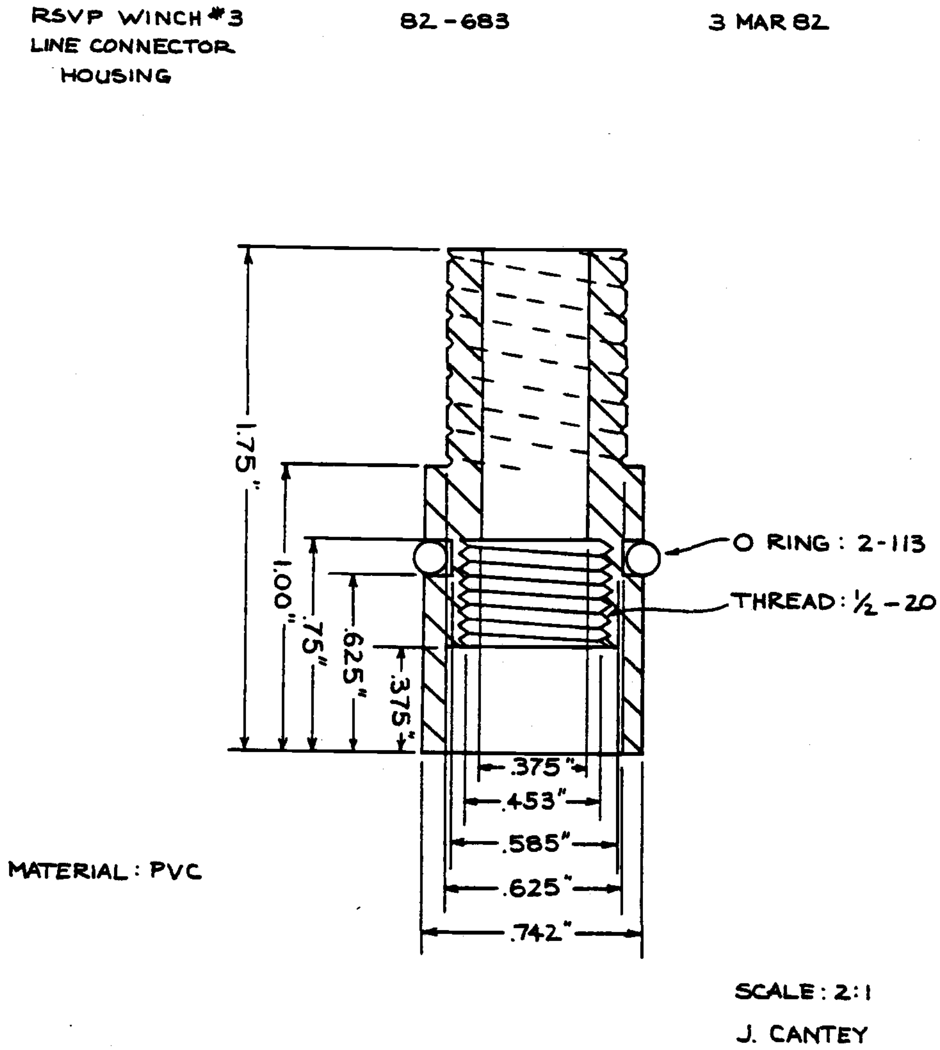


Figure IV-d-6. Line connector housing - winch end
(dwg no. 82-683).

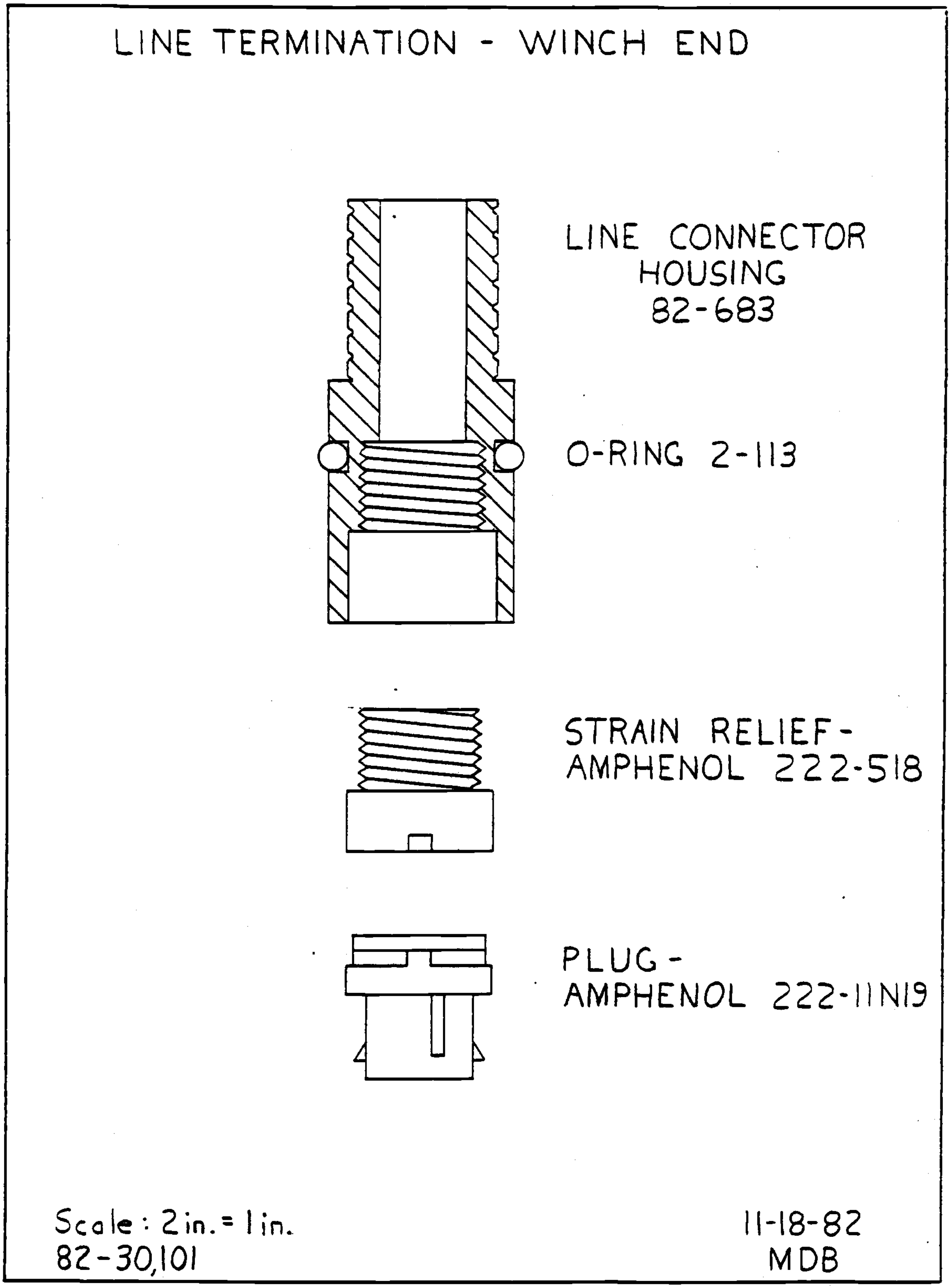


Figure IV-d-7. Line termination - winch end (dwg no. 82-30,101).

e) Winch

The RSVP winch system (Figure IV-e-1, Table IV-e-1) is an electrical winch driven by a 3/4 hp 110V variable speed dc motor. Speed reduction is 5/1, allowing a maximum retrieval rate of approximately 2.5 m/s at 45 pound cable tension with a spool radius of 3 inches. While the winch may be powered either in or out, in practice the cable free wheels out and is powered only on the retrieval cycle. With this version of the RSVP probe, drops to 220 m were achieved at 5 knots ship speed with a consistent turn-around time of 6 minutes.

The winch system consists of an aluminum box mounted on a swiveling base with a fishing rod and pulley as a line guide. The drive train incorporates a moveable gear to act as a decoupler, and the cable spool is mounted on a cantilevered shaft to allow rapid cable change with minimum data gathering interruption. Data is transmitted through slip rings mounted in the hollow drive shaft.

The mount system consists of the rail mount (Figure IV-e-2), pole holder (Figure IV-e-3), pole, and snatch block. Because the winch does not have a level-wind, it is necessary to provide a means of keeping the line from piling up. This is accomplished by using a flexible pole and allowing the operator to swivel the winch about a vertical axis. The pole is a solid fiberglass fishing "boat rod" about 6 ft long, designed for use with greater than 50# test line. All hardware was removed and the butt machined to 1" diameter. The block mount (Figure IV-e-4) is a stainless tube with a bent piece of 1/8" rod welded on to form a D. The block mount is epoxied to the end of the pole. The snatch block used is a Blockits #343K. The supplied roller is replaced with one (Figure IV-e-5) machined from Delrin which fits closer to the cheek plates so that line cannot catch between the cheeks and roller.

The winch drive train (Figures IV-e-6, IV-e-7) is designed to free-wheel out as easily as possible. A modified bicycle brake allows the operator to stop the cable at the end of a drop. The clutch is then engaged to reel the probe in. Details of the construction of the drive train are shown in Figures IV-e-8 - IV-e-11.

The winch is driven by an electric motor, Dayton #2M169 (Figure IV-e-12). The controller, Dayton #2M171, is located in a waterproof aluminum box (Figures IV-e-13 - IV-e-16). This box is mounted on the top of the winch frame which houses the drive train unit. The electrical system and operator are protected by a ground-fault circuit-interrupter. The winch is powered by ship's power through a waterproof connector.

Data is transmitted from the cable through the slip ring assembly (Figures IV-e-17, IV-e-18, details shown in Figures IV-e-19 - IV-e-26). This assembly is located within the hollow shaft on which the cable spool is mounted (Figures IV-e-27 - IV-e-29) and extends out the other side of the winch frame. A deck cable (Figure IV-e-30) connects to the stationary end of the slip rings and transmits the signals to the laboratory.

The winch frame (Figures IV-e-31, IV-e-32, details Figures IV-e-33 - IV-e-42) is constructed of aluminum plate due to the critical alignment required between the long shaft and the short shaft (Figures IV-e-9, IV-e-10). The three side plates were stacked and the edges milled and holes bored simultaneously. Silicone sealant was used between the plates and to seal all screw holes.

A crank (Figure IV-e-43) that can be used to retrieve the probe in the event of winch failure is available. This was not required on the FRONTS 82 cruise.

Table IV-e-1. Winch parts list

Mount System		
	613	Rail mount
	612	Pole - solid fiberglass tapered rod designed for greater than 50# test line
	614	Block mount
		Snatch block - Blockits #343K
	615	Snatch block roller
607	Frame	
	610	Motor mount
	611	Front
	620	Side #1
	621	Side #2
	622	Side #3
	623	Bearing mount
	630	Bottom
	631	Top
606	Drive train	
	Bearings	
		4 ea R6 closed
		2 ea R10 closed
		2 ea R20 closed
		2 ea R20 open
	Gears	
		Bevel 20 degree pressure angle, 12Pd Pinion 18T dpitch = 1.5", Bore 0.625" Gear 54T dpitch = 4.5", Bore 0.625" Keyway 3/16" 1 set screw
		Spur 14.5 degree pressure angle, 20 Pd, 3/8" face, 1/2" shoulder 1 ea 48T Dpitch=2.4", Bore 0.652", 2 set screw 1 ea 40T Dpitch=2.0", Bore 0.375", 2 set screw 2 ea 80T Dpitch=4.0", Bore 1.250", 2 set screw 1 ea 40T Dpitch=2.0", Bore).875", 1.0" face, no shoulder
		Bevel shaft 5/8" x 3.78", 3/16 keyway / 2 flats @ 90 degrees other end
		Idler shaft 3/8" x 2.5", 2 flats @ 90 degrees 0.525" from end

Table IV-e-1 (continued)

	624	Clutch mount
	642	Eccentric shaft
	643	Detent handle
	641	Short shaft
	640	Long shaft
		Splash shield
	625	Brake mount
	626	Brake lever
		Brake - Modified "atom" bicycle rear drum brake
		Line restraint plates
	670	Spool retainer
	671	Crank
		Spacers 5/8" I.D. x 7/8" O.D. x 0.050"
		x 1.000"
		3/8" I.D. x 5/8" O.D. x 0.050"
		x 1.000"
605		Data transmission assembly
	603	Deck cable wiring
	629	Plug
		o-ring Parker 2-221 nitrile
	627	Connector mount
		Connector - Amphenol 165-28
		Cable - see wiring diagram 83-603
		Connector - Amphenol 222-11N19
	628	Connector bracket
		Connector - Amphenol 222-12N19
	695	Stationary connector housing
	694	Slip ring shaft
		Bushing 0.500" I.D. x0.555" O.D. x 0.50L"
		6-32 clearance hole
		Flex coupling H.H. Smith #164
	691	Slip ring cap
		Slip ring - Airflyte Electronics CAY 110-20
	692	Slip ring body
	693	Slip ring rear body
		Connector - Amphenol 222 series
	680	Spool connector
		Connector - Amphenol 222 series

Table IV-e-1 (continued)

Electrical system

Connector as required for specific research ship
Cable - 14-350 Neoprene
Waterproof connector - Russell Stoll 20A 115V
#3729 plug
#3743 receptacle
Ground fault circuit interrupter - 110V
Controller - Dayton #2M171
Motor - Dayton #2M169

661 Waterproof shaft
Toggle switch boot - APM Hexseal #1030
660 Electrical box with covers

Aluminum standoff 4-40 female threaded 1/4"d x 1"
Waterproof electrical cord grips
Cable 14-250 Neoprene
Gaskets - molded from self leveling RTV 734 silicone

Seals

Parker polypak 12500250
APM hex seal 1030
Parker 2 series o-rings nitrile

006	113	221
010	115	
016	119	
019	128	
020		

Fasteners - stainless steel

0-80x1/4"	flat hd	4-40x3/8"	round hd
2-56x1/4"	flat hd	6-32x1/4"	round hd
10-32x1/2"	flat socket hd	6-32x1/2"	round hd
10-32x3/4"	flat socket hd	6-32x2"	round hd
10-32x1/2"	socket hd	10-32x1/2"	round hd
10-32x3/4"	socket hd	1/4"-20x4"	hex hd
5/16"-18x3/4"	socket hd	3/8"-16x3/4"	hex hd
6-32x3/16"	set	10-32x1/4"	set
1/4"-20x1/4"	set	5/16"-18x1/4"	set

Misc. hardware - stainless steel

3/16" roll pin 1/8"x3/4" groove pin
3/16" key
10-32 blind press nut 1132-NBS-EXRR-.056
6-32 blind press nut 932-NBS-EXRR-.040
(Precision metal products)

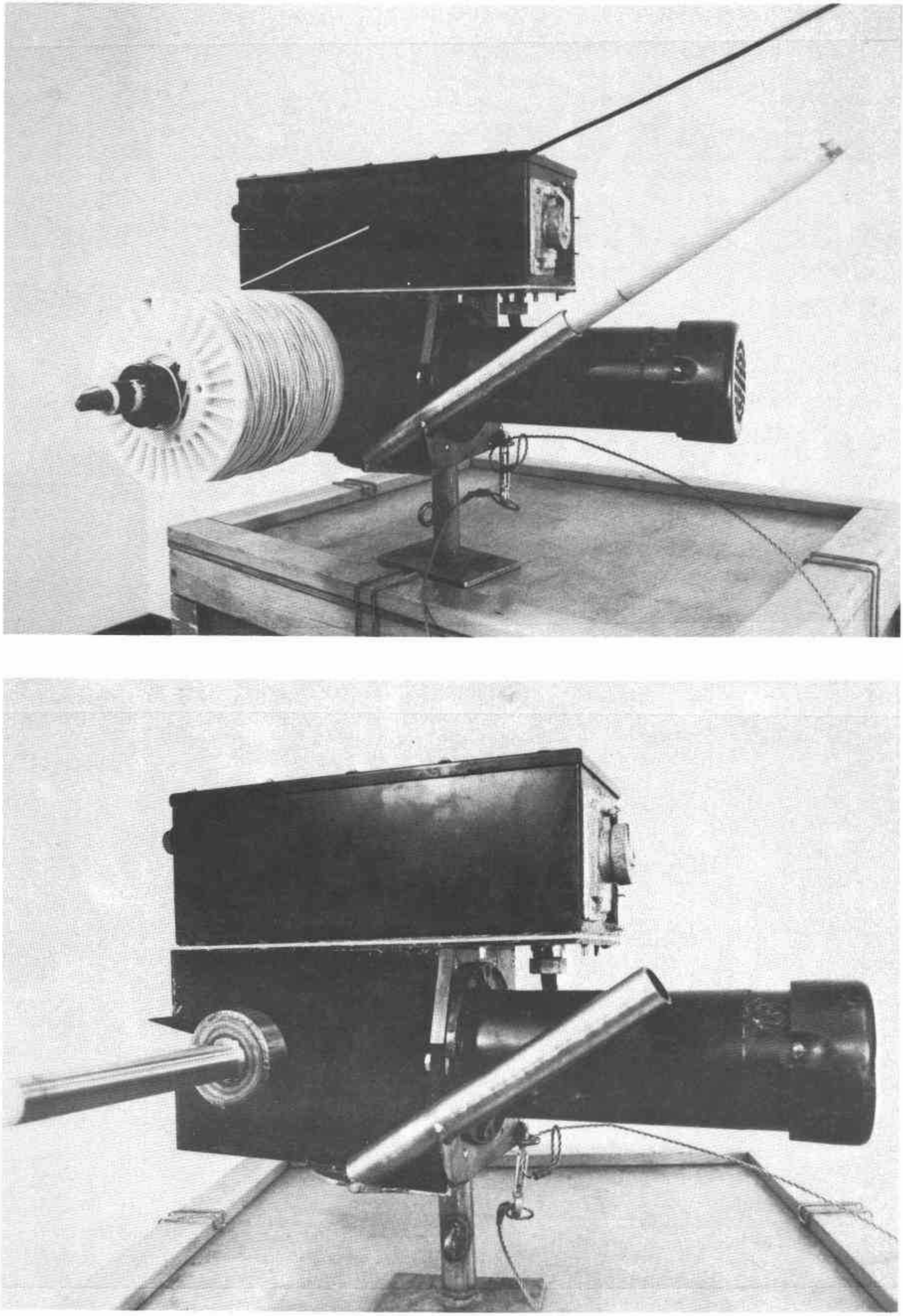


Figure IV-e-1. Photographs of mounted winch system.

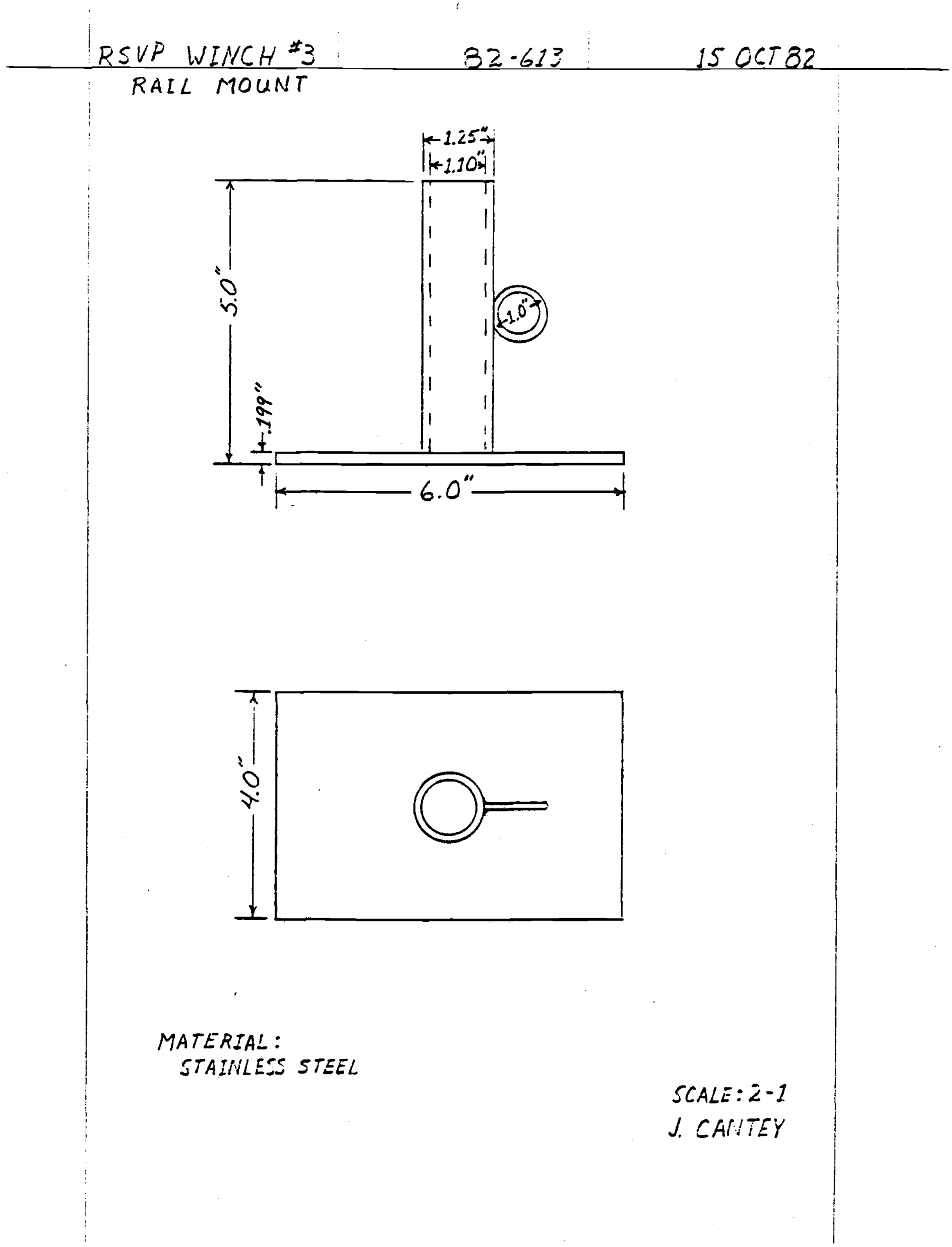


Figure IV-e-2 Rail mount (dwg no. 82-613).

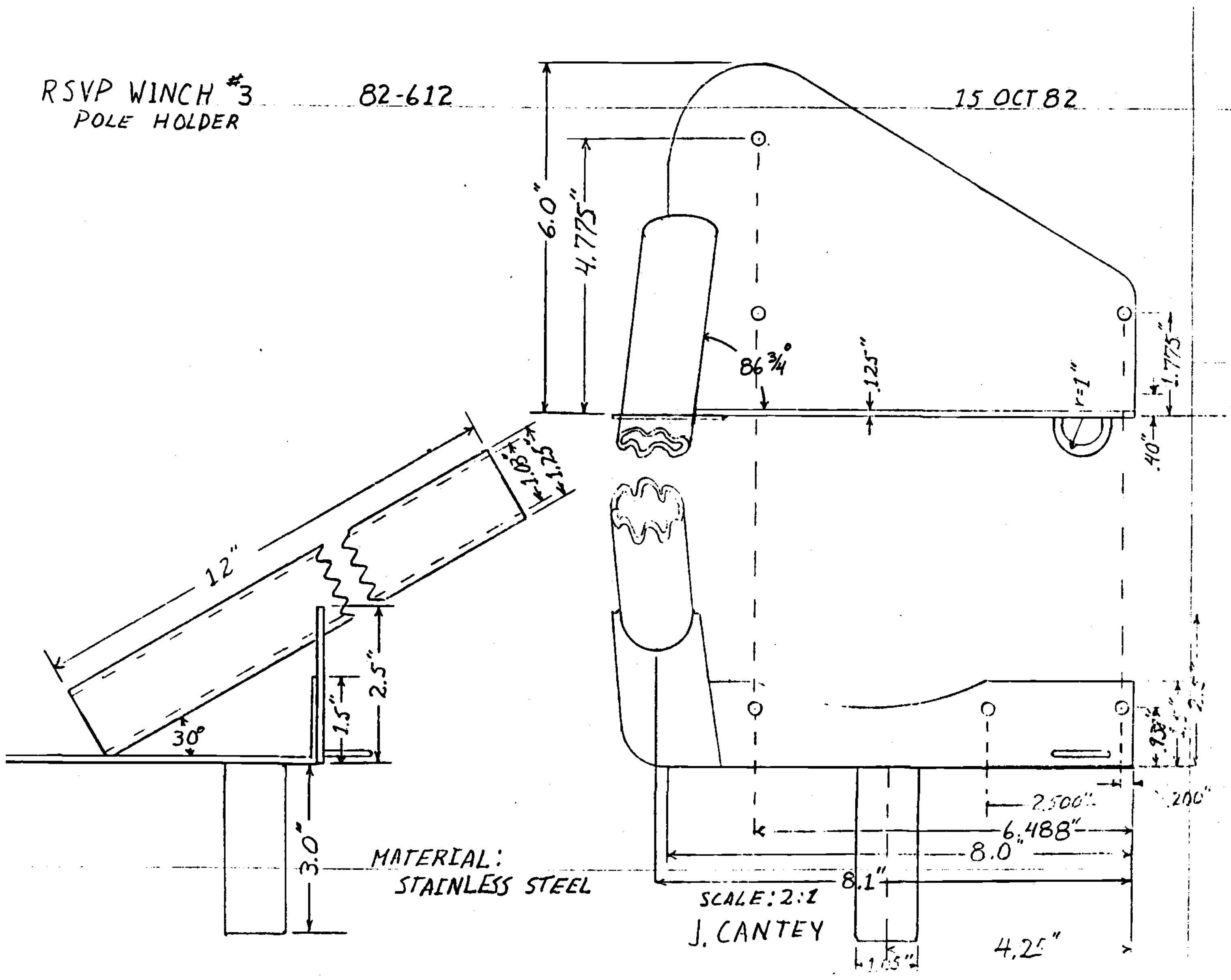
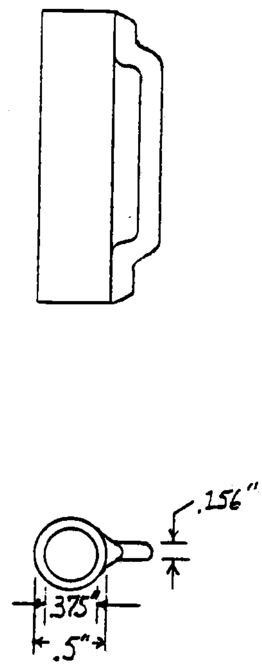


Figure IV-e-3. Pole holder (dwg no. 82-612).

RSVP WINCH #3 82-614 18 OCT 82

BLOCK MOUNT



MATERIAL: STAINLESS STEEL

J. CANTEY

Figure IV-e-4. Block mount (dwg no. 82-614).

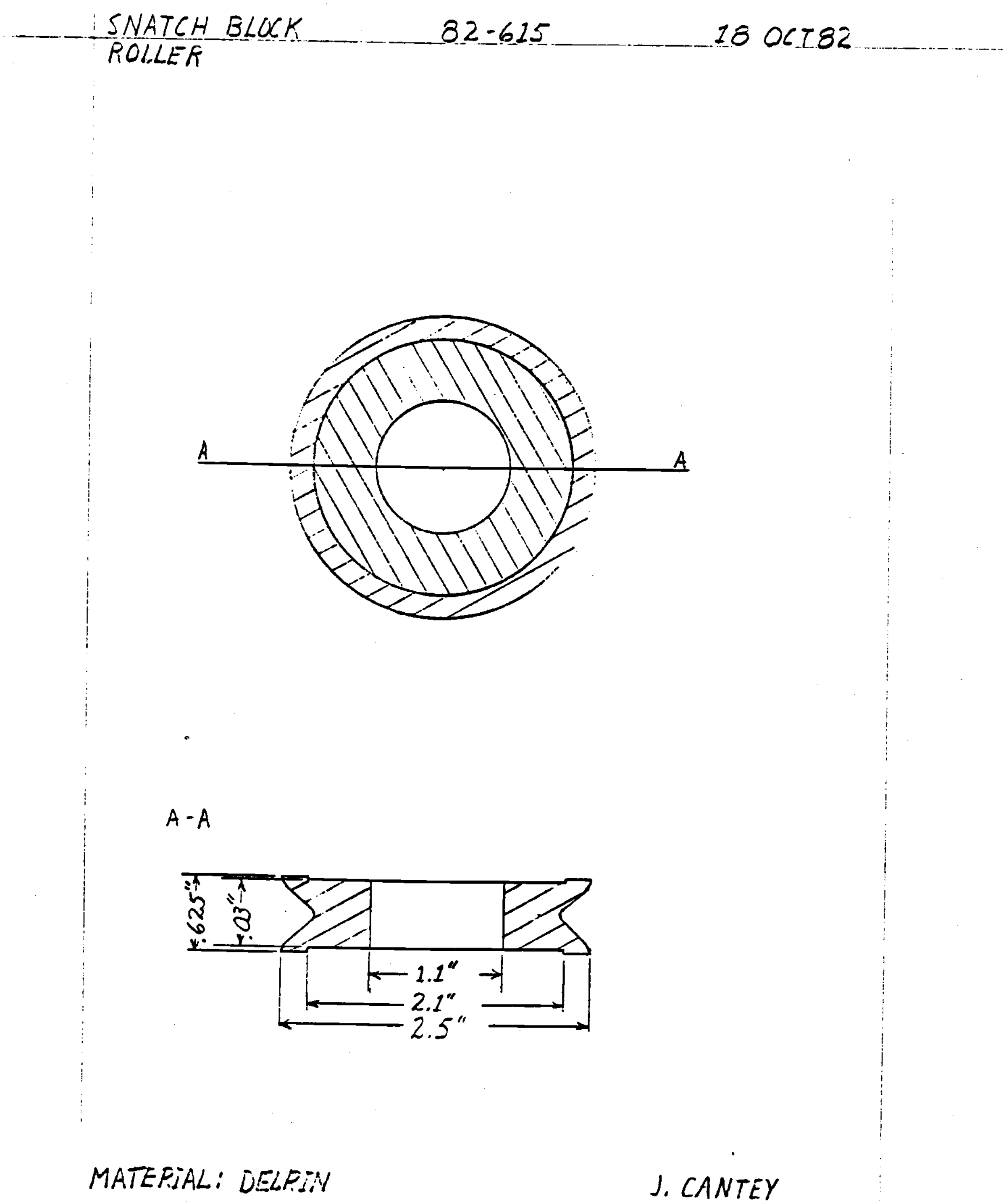


Figure IV-e-5. Snatch block roller (dwg no. 82-615).

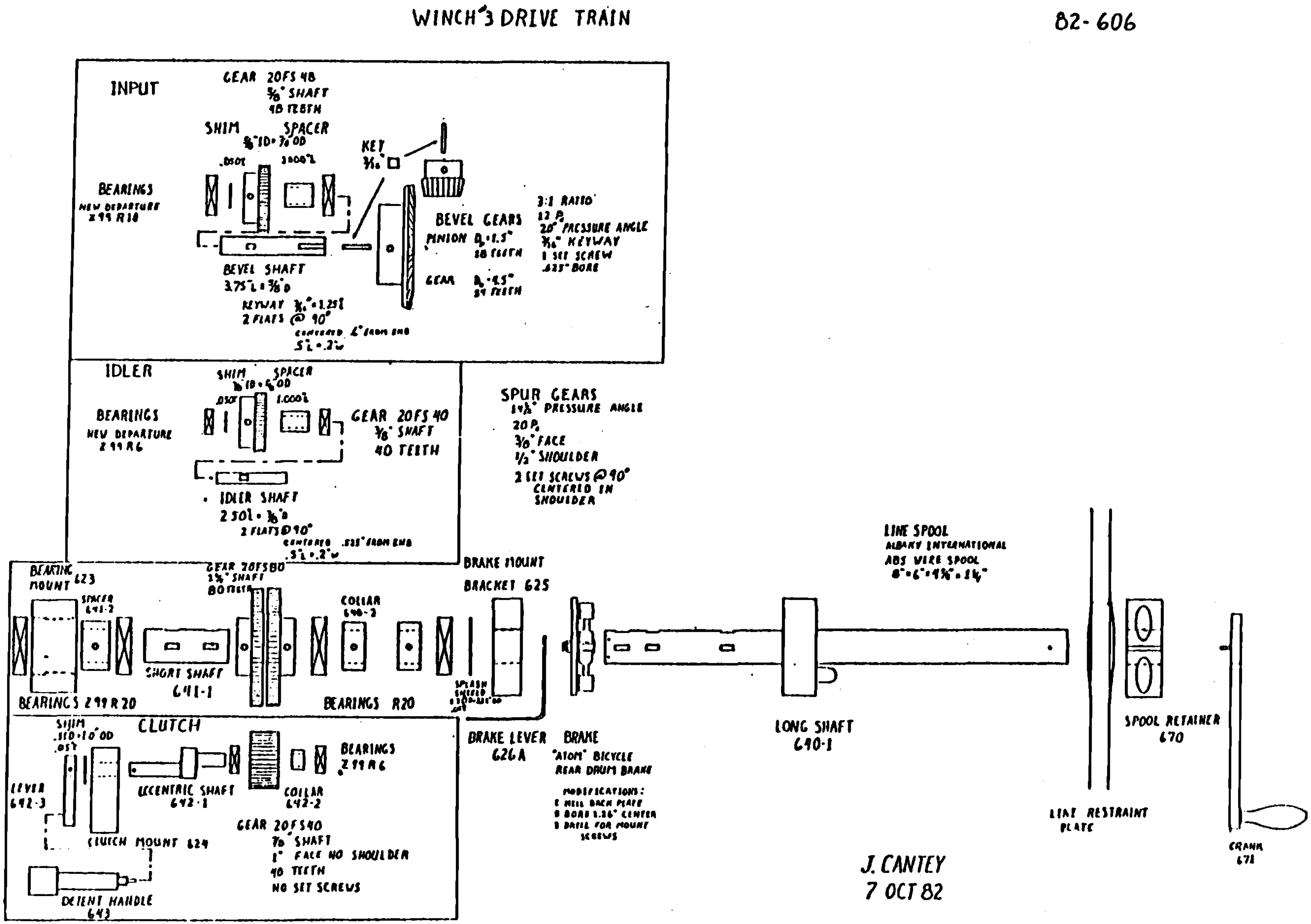


Figure IV-e-6. Winch drive train drawing (dwg no. 82-606).

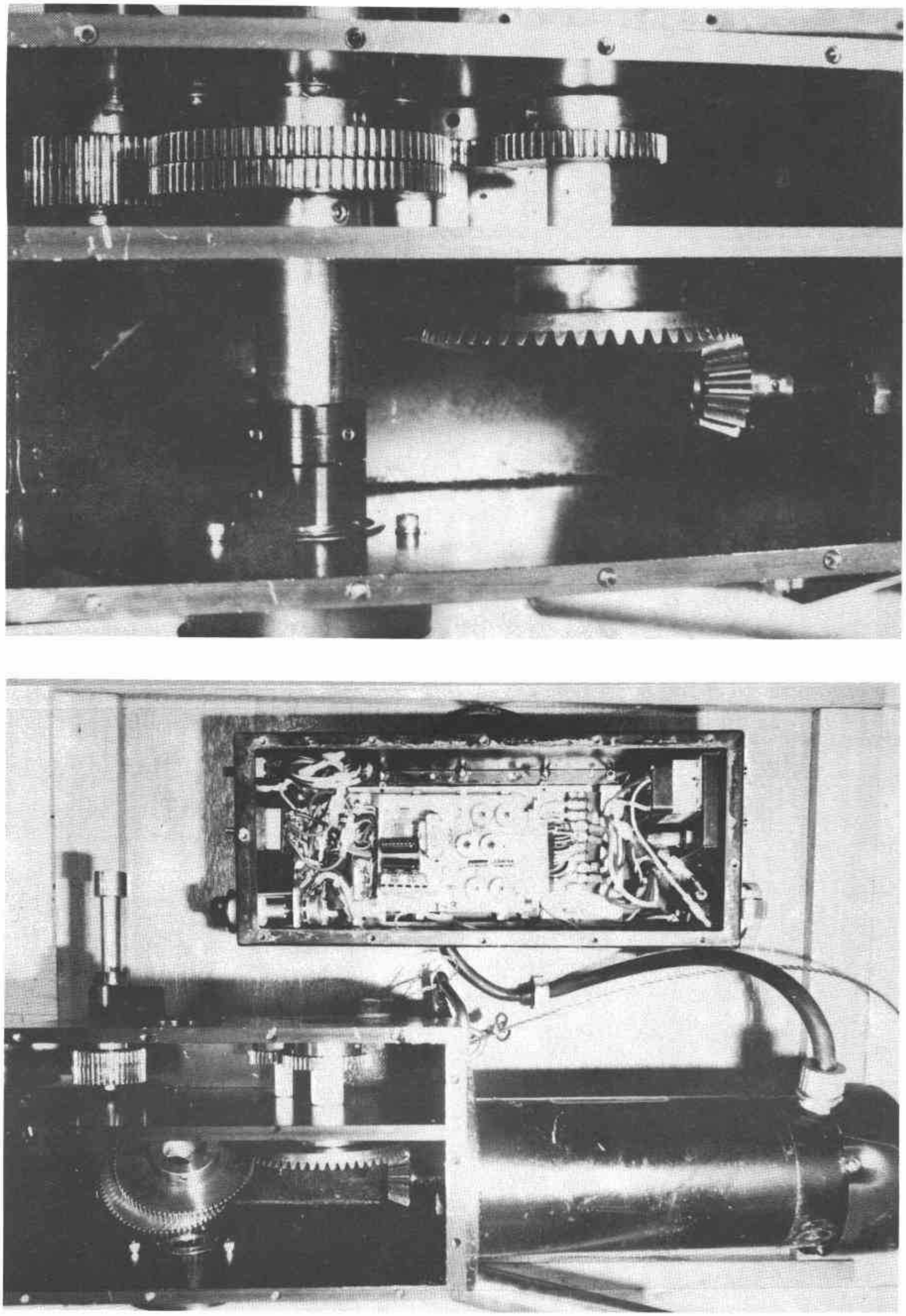


Figure IV-e-7. Photographs of winch drive train.

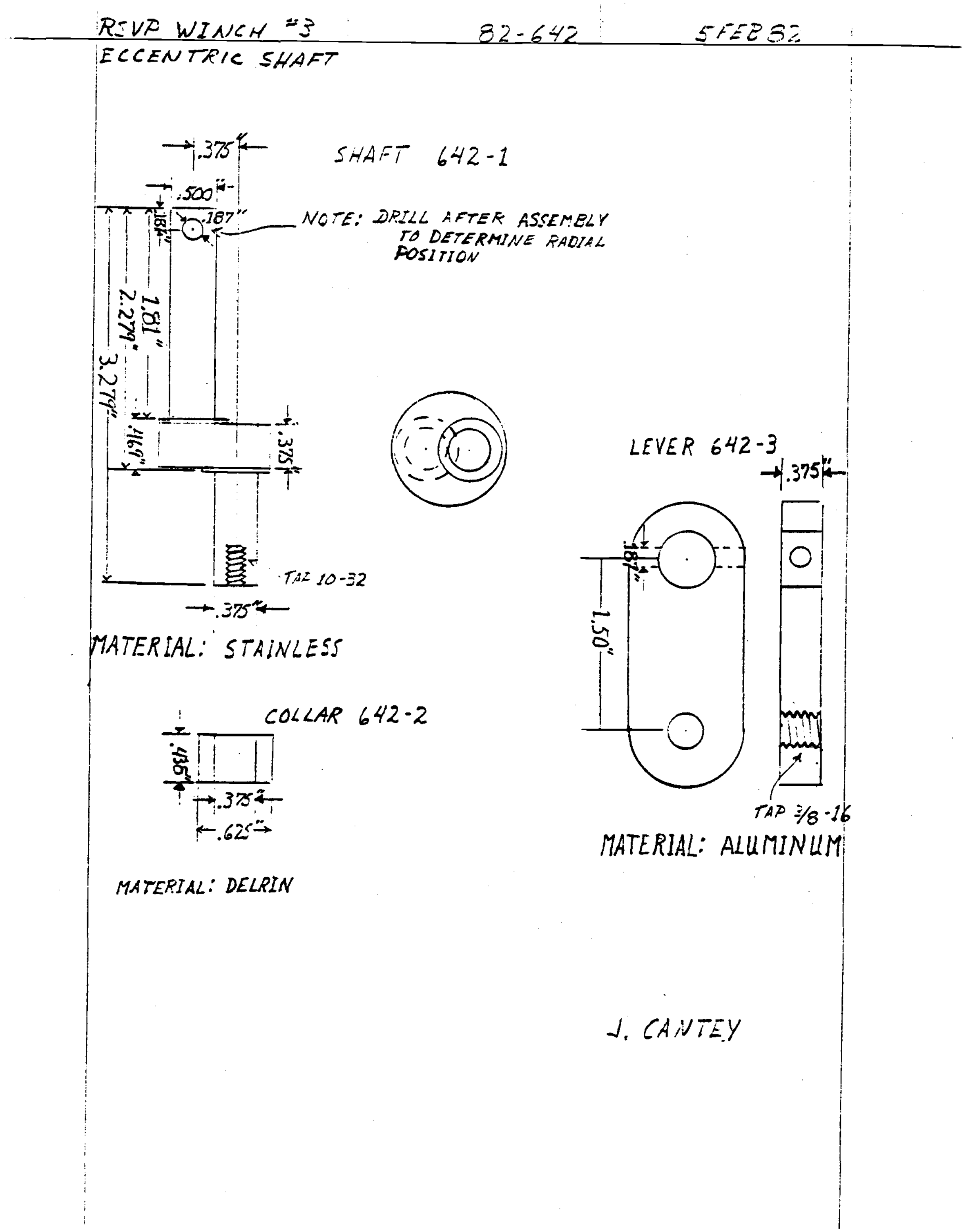


Figure IV-e-8. Eccentric shaft (dwg no. 82-642).

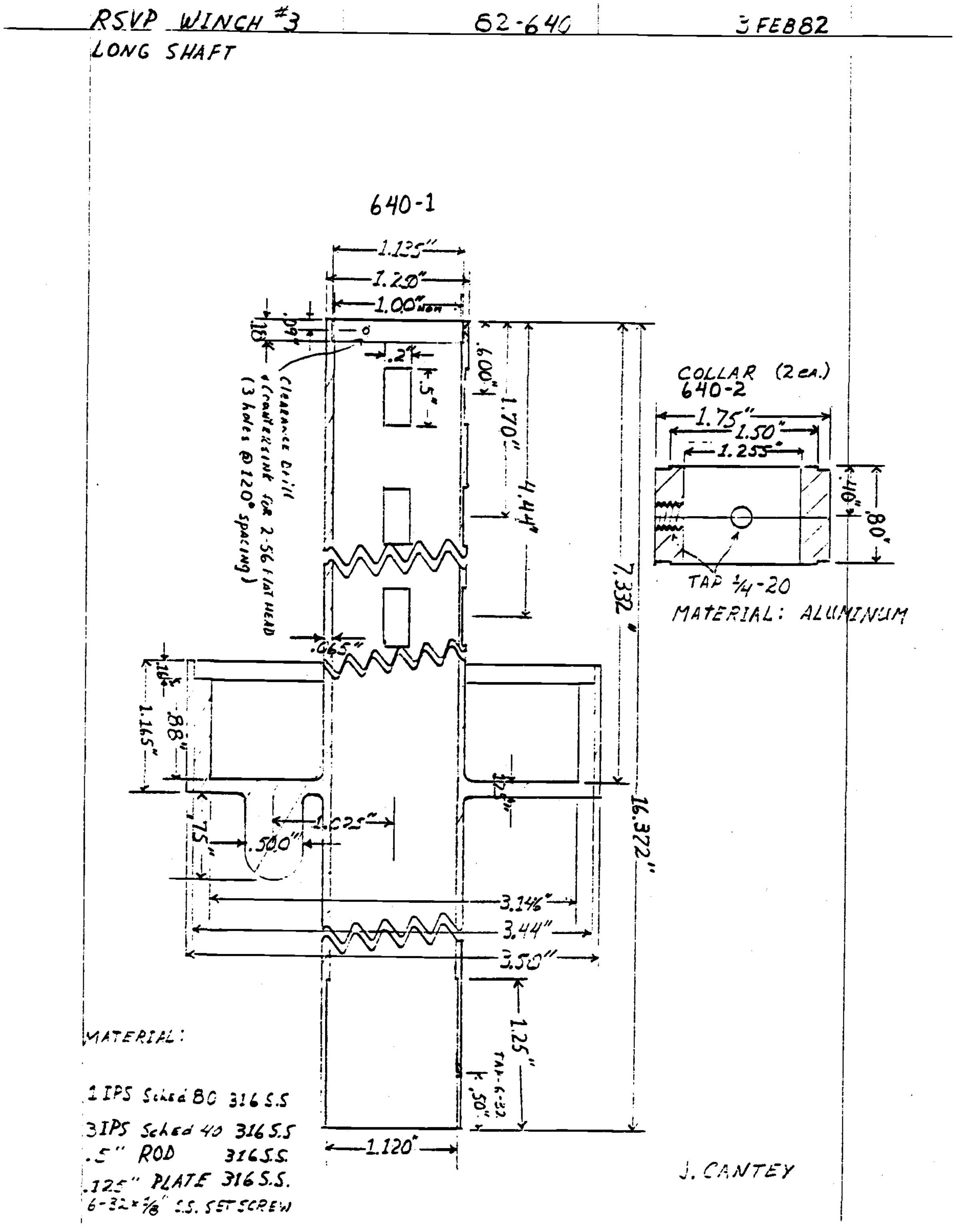
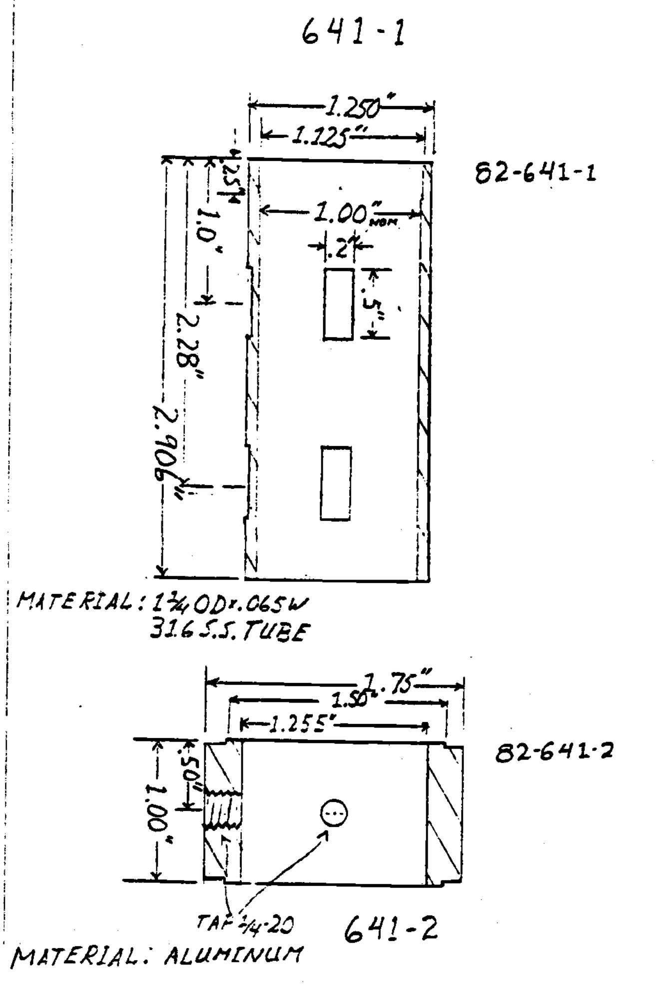


Figure IV-e-9. Long shaft (dwg no. 82-640).

RSVP WINCH #3 82-641 5 FEB 82
SHORT SHAFT



J. CANTEY

Figure IV-e-10. Short shaft (dwg no. 82-641).

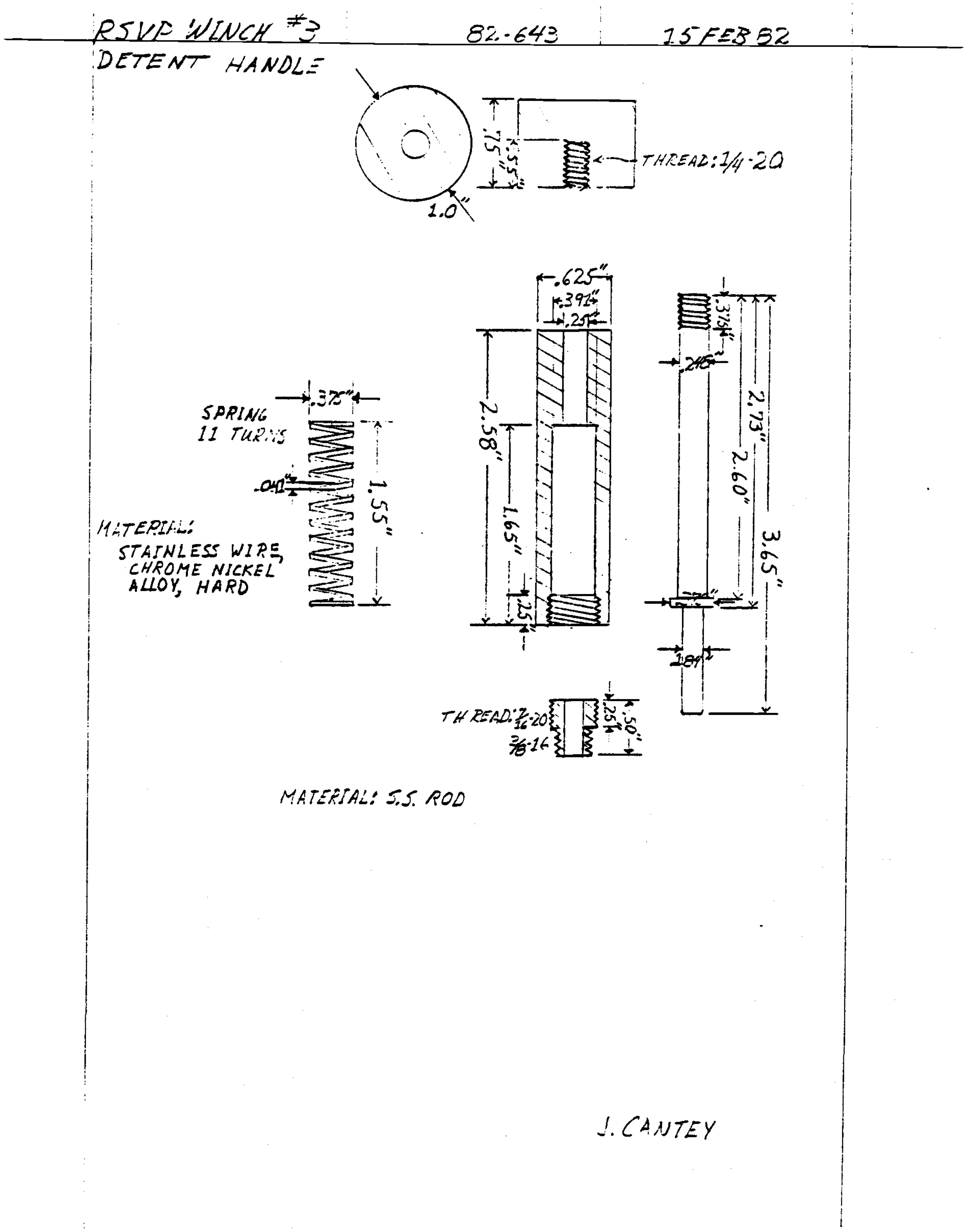


Figure IV-e-11. Clutch detent handle (dwg no. 82-643).

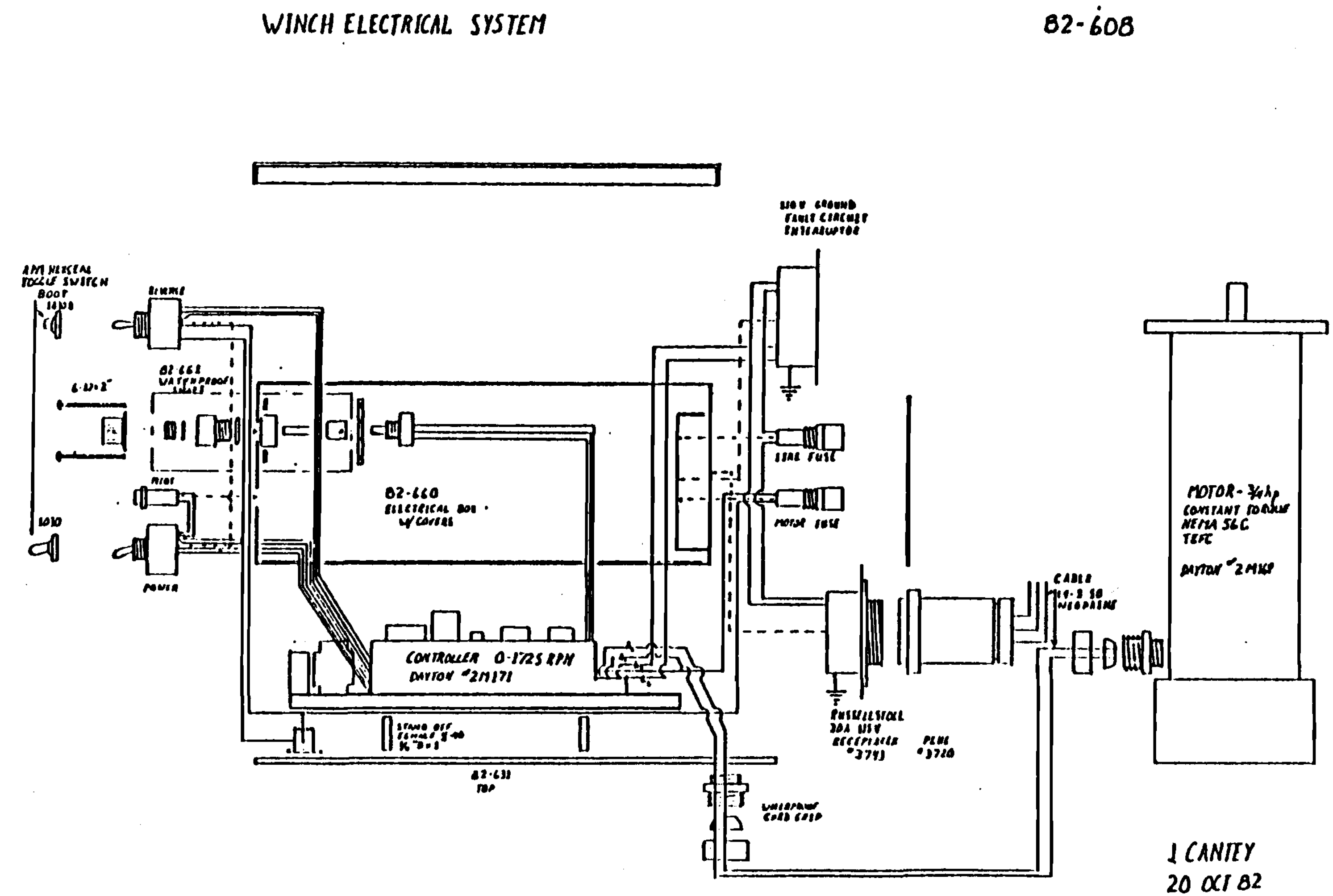


Figure IV-e-12. Winch electrical system (dwg no. 82-608).

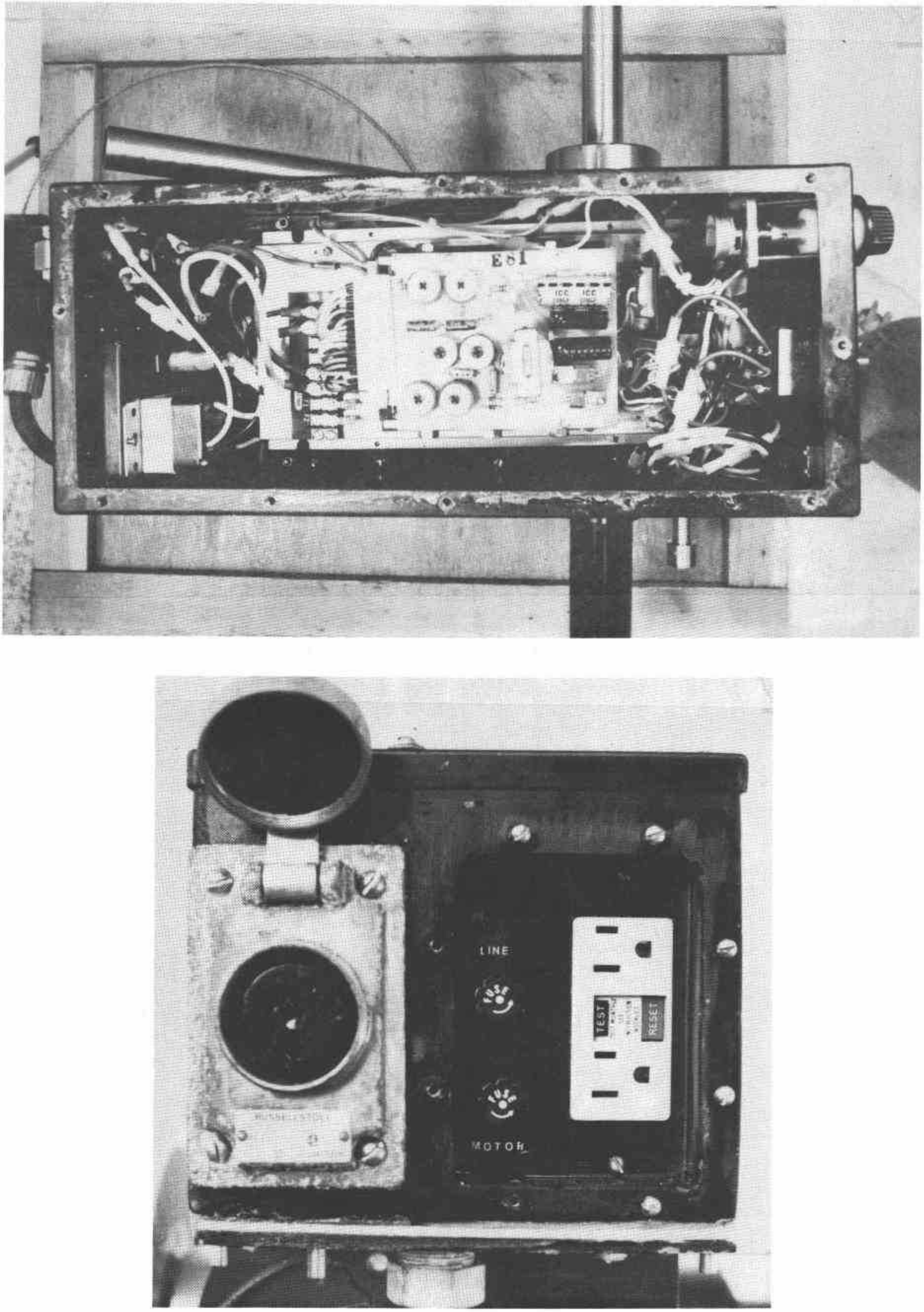


Figure IV-e-13. Photograph of controller and electrical box.

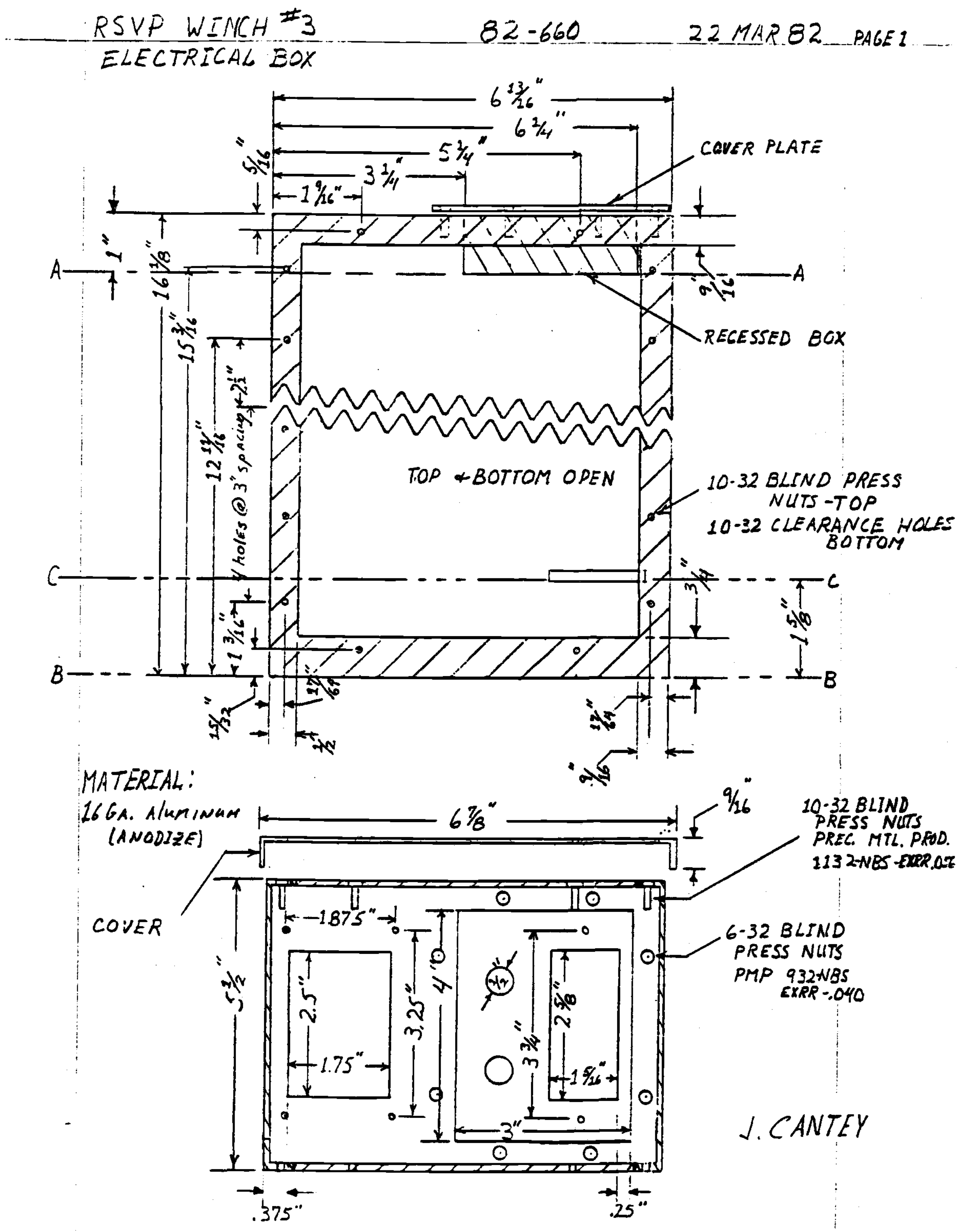


Figure IV-e-14. Winch electrical box specifications (dwg no. 82-660/1).

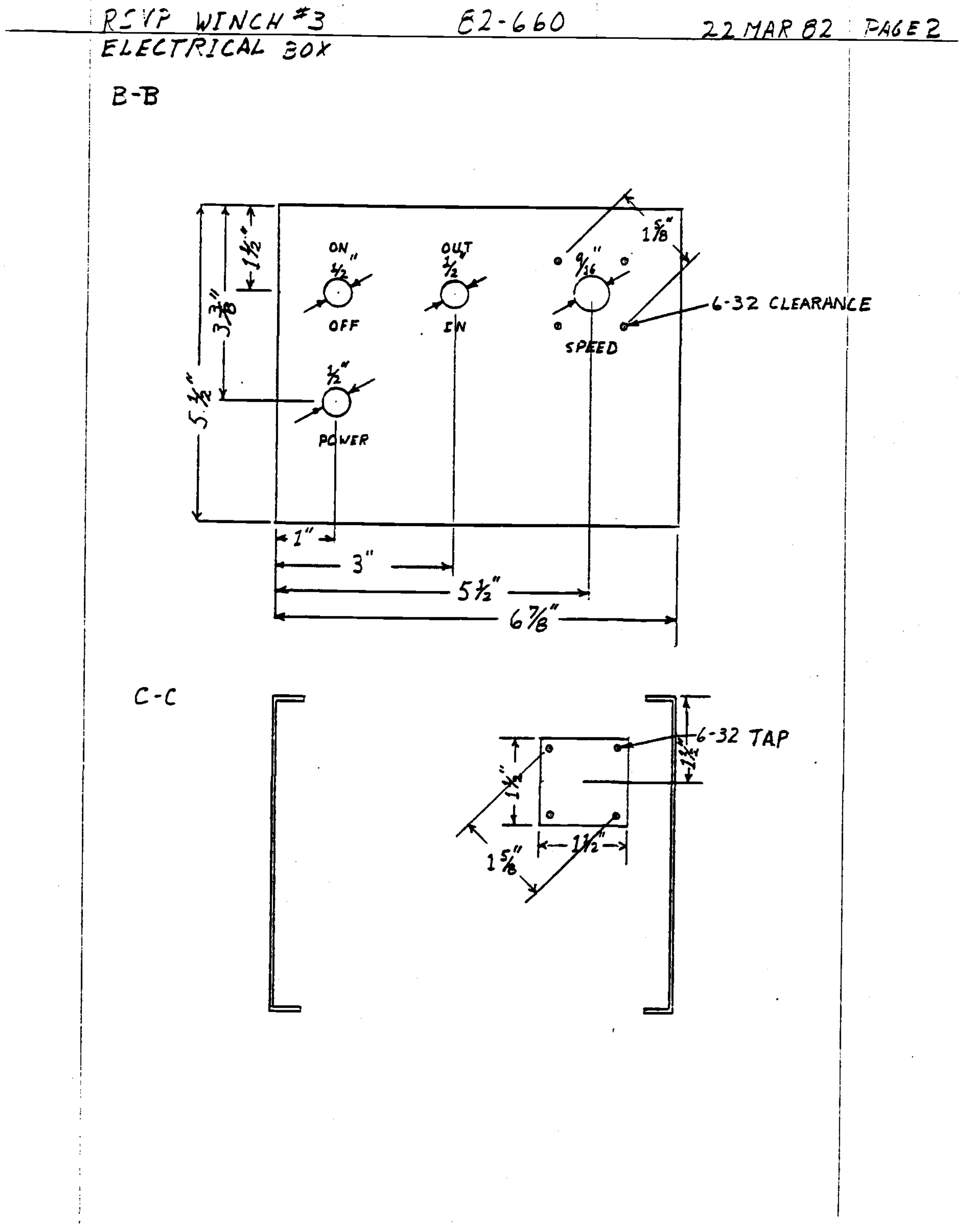


Figure IV-e-15. Winch electrical box controls (dwg no. 82-660/2).

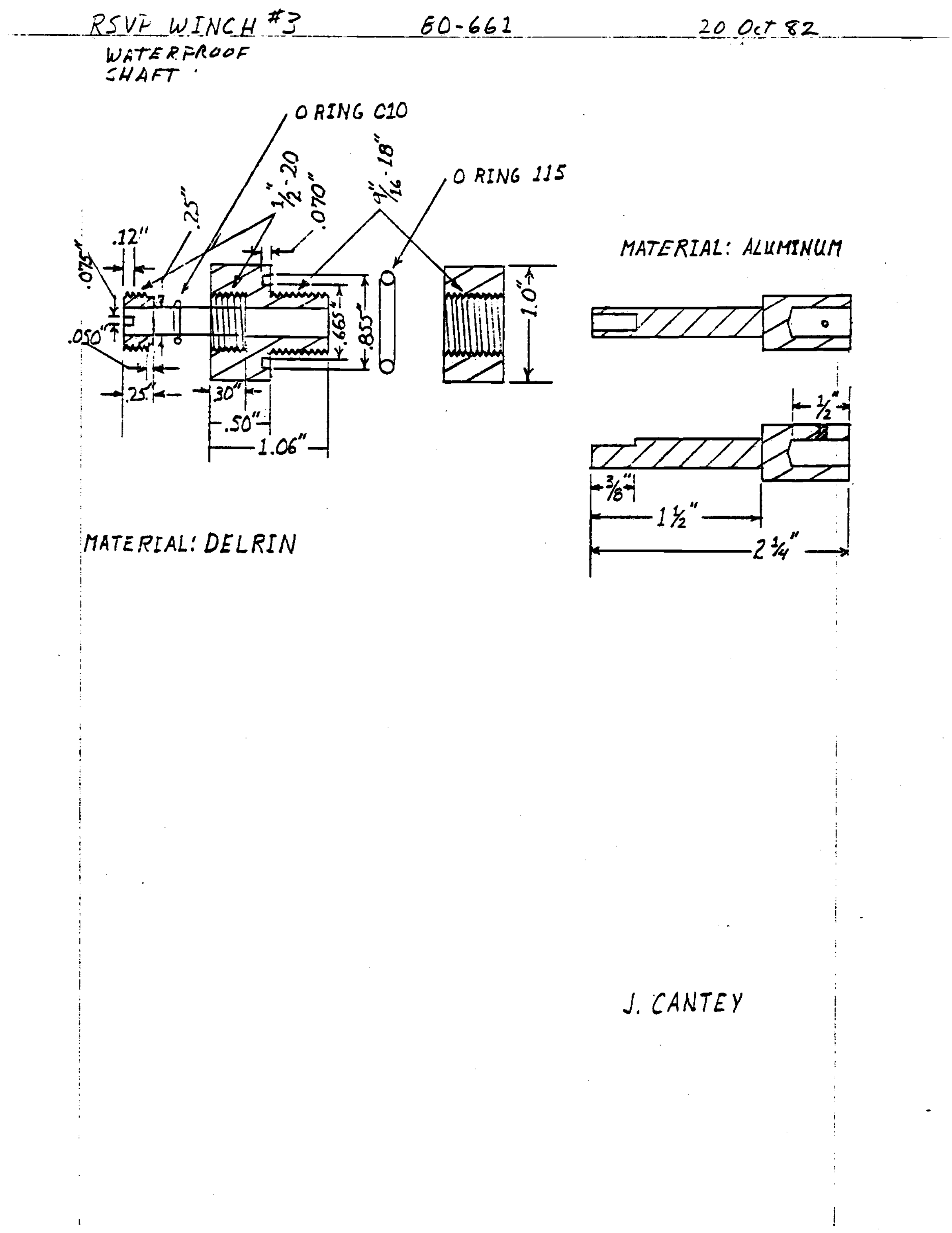


Figure IV-e-16. Winch electrical controls - waterproof shaft (dwg no. 82-661).

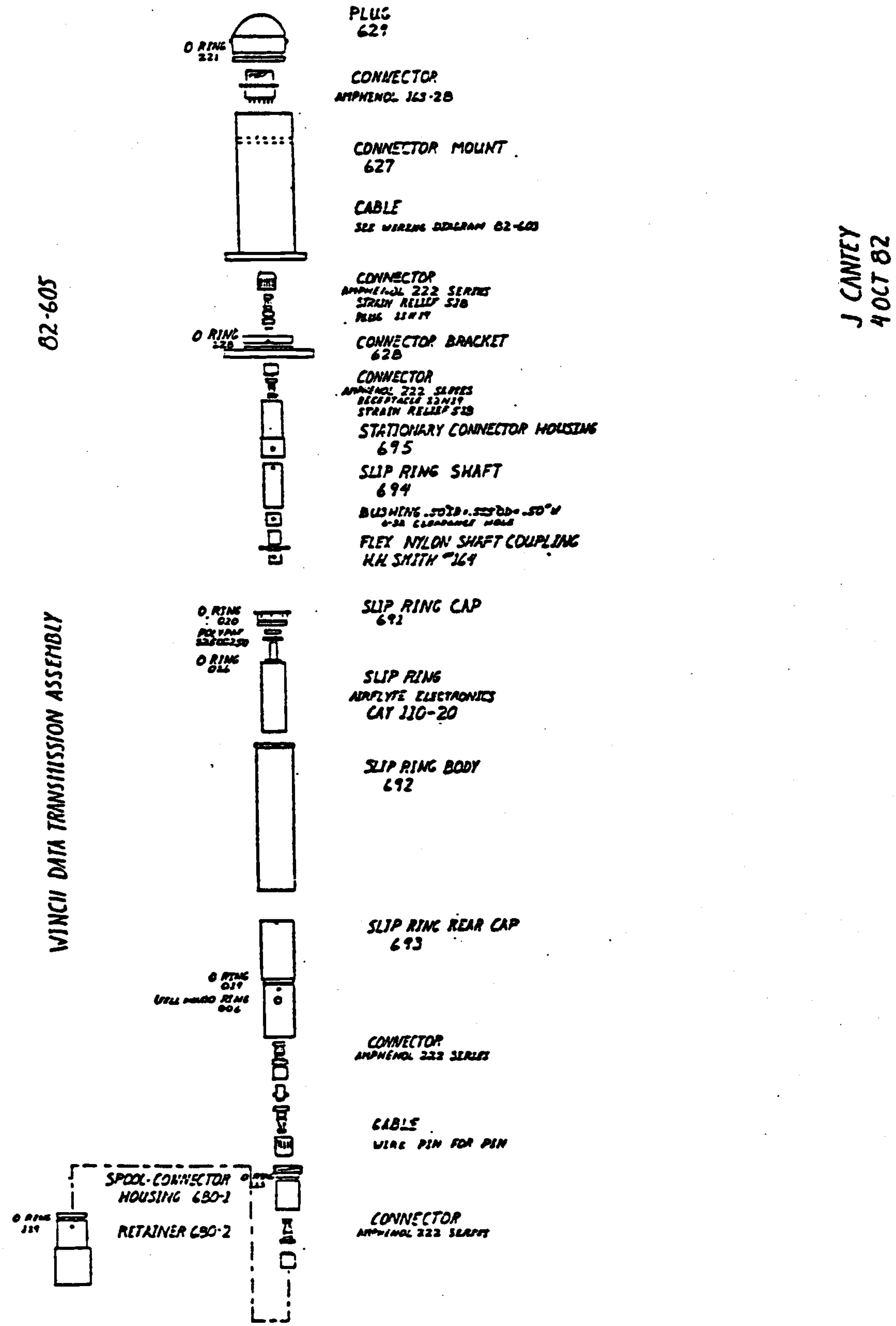


Figure IV-e-17. Winch data transmission assembly (dwg no. 82-605).

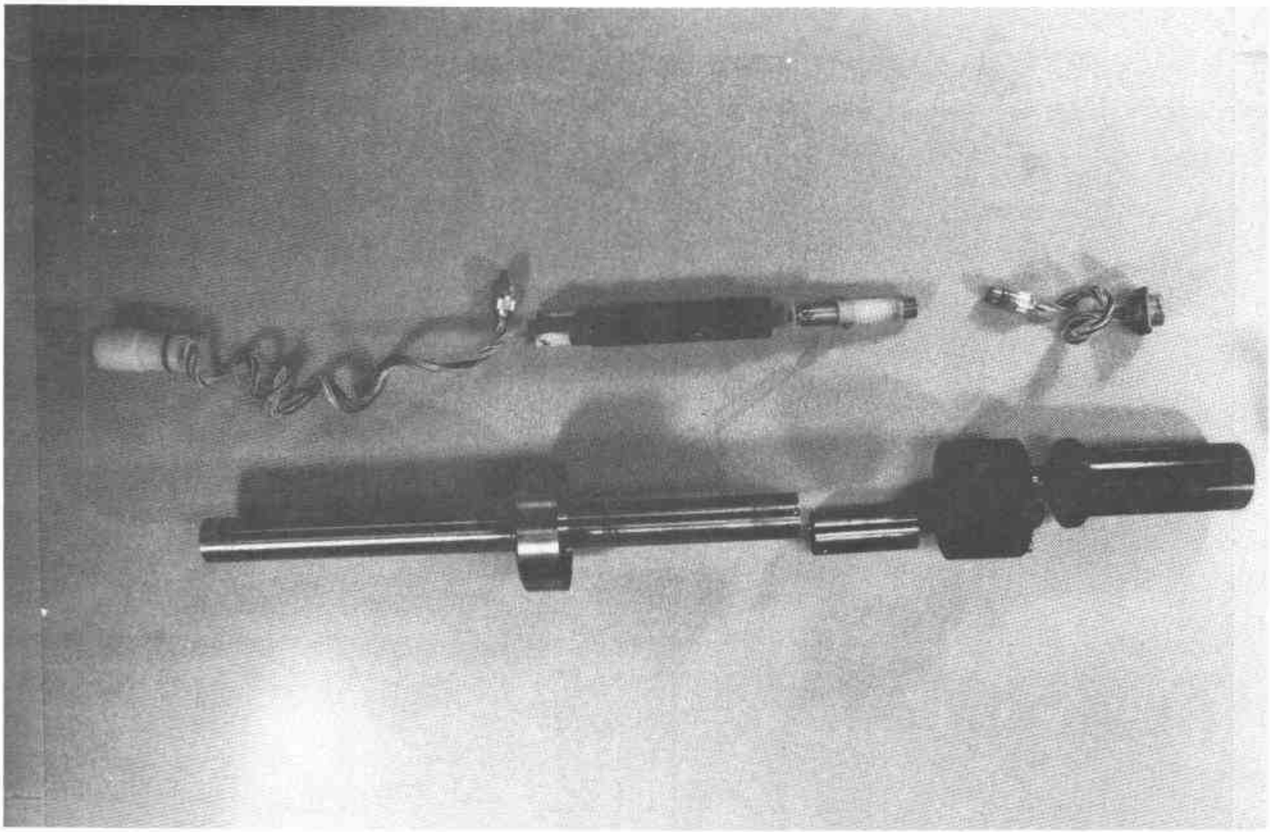


Figure IV-e-18. Photograph of data transmission system.

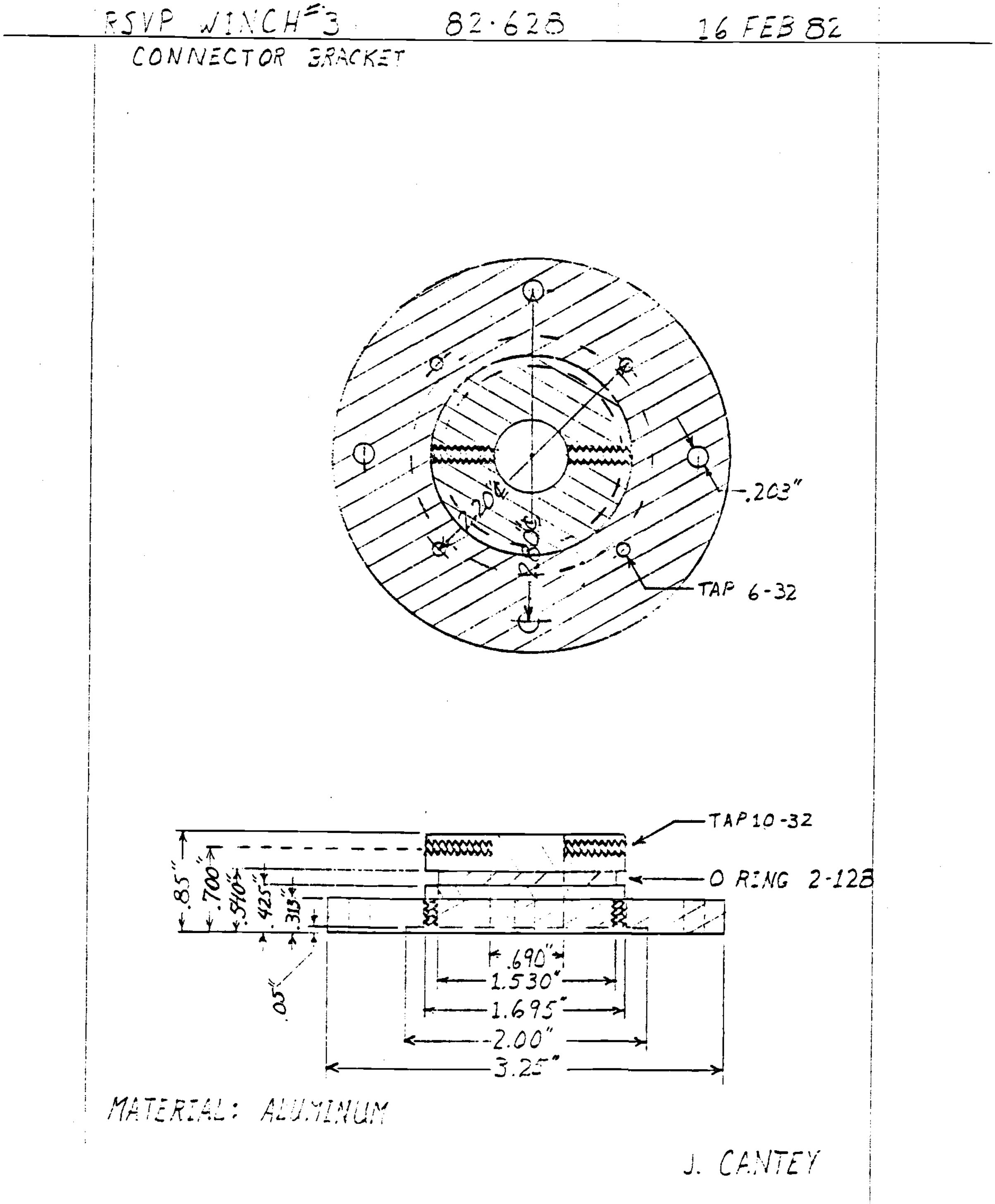


Figure IV-e-19. Connector bracket (dwg no. 82-628).

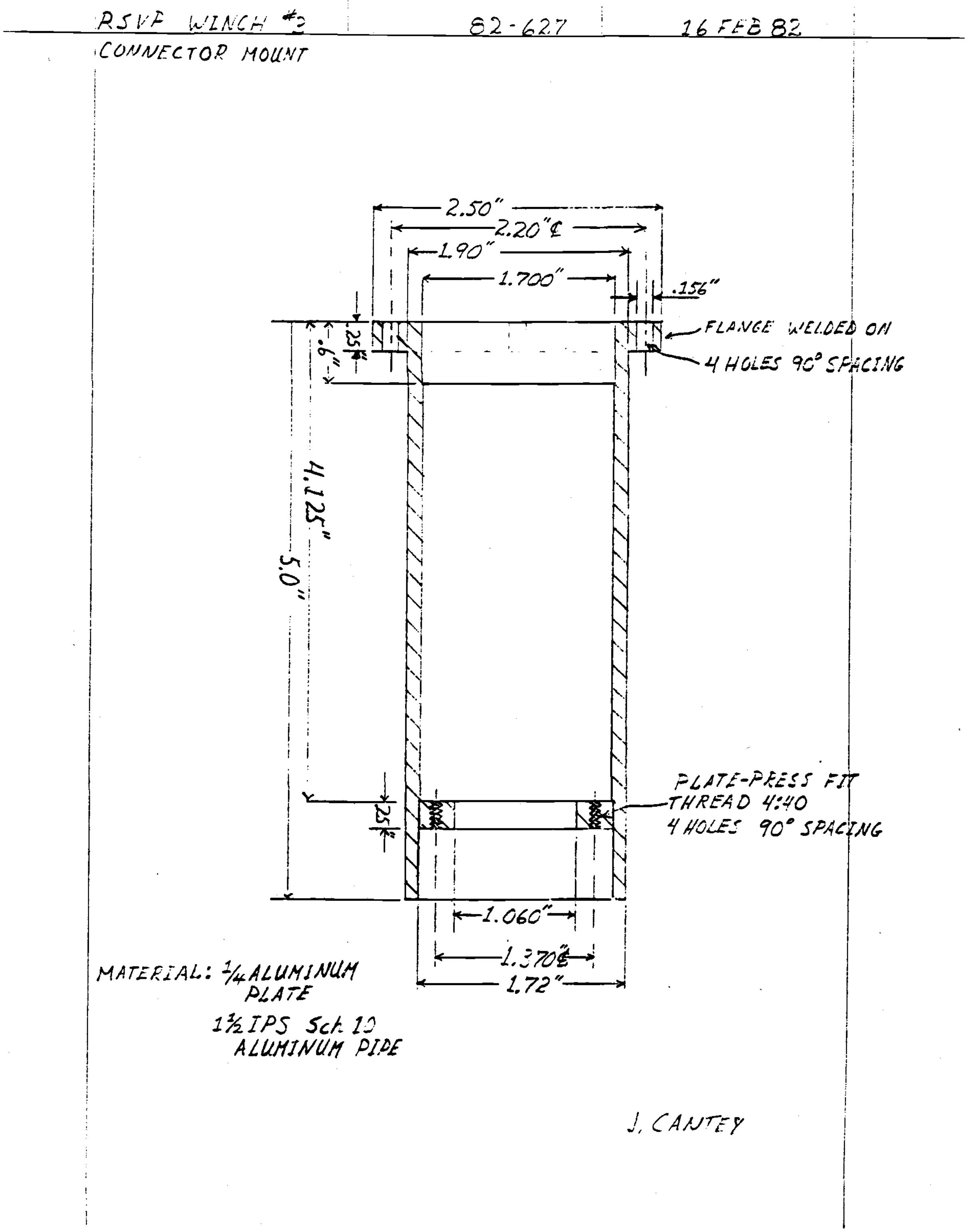
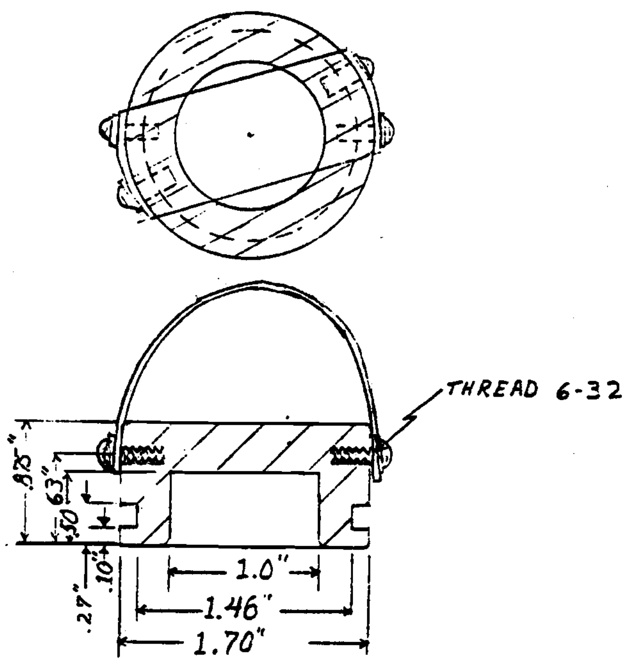


Figure IV-e-20. Connector mount (dwg no. 82-627).

RSVP WINCH #3 82-629 15 JUNE 82
PLUG



MATERIAL:
1.75" PVC ROD
4 ea 6-32 x 1/4" SS SCREW
4 ea #6 SS WASHER
4" NYLON WEBBING 1" WIDE

J. CANTEY

Figure IV-e-21. Waterproof plug (dwg no. 82-629).

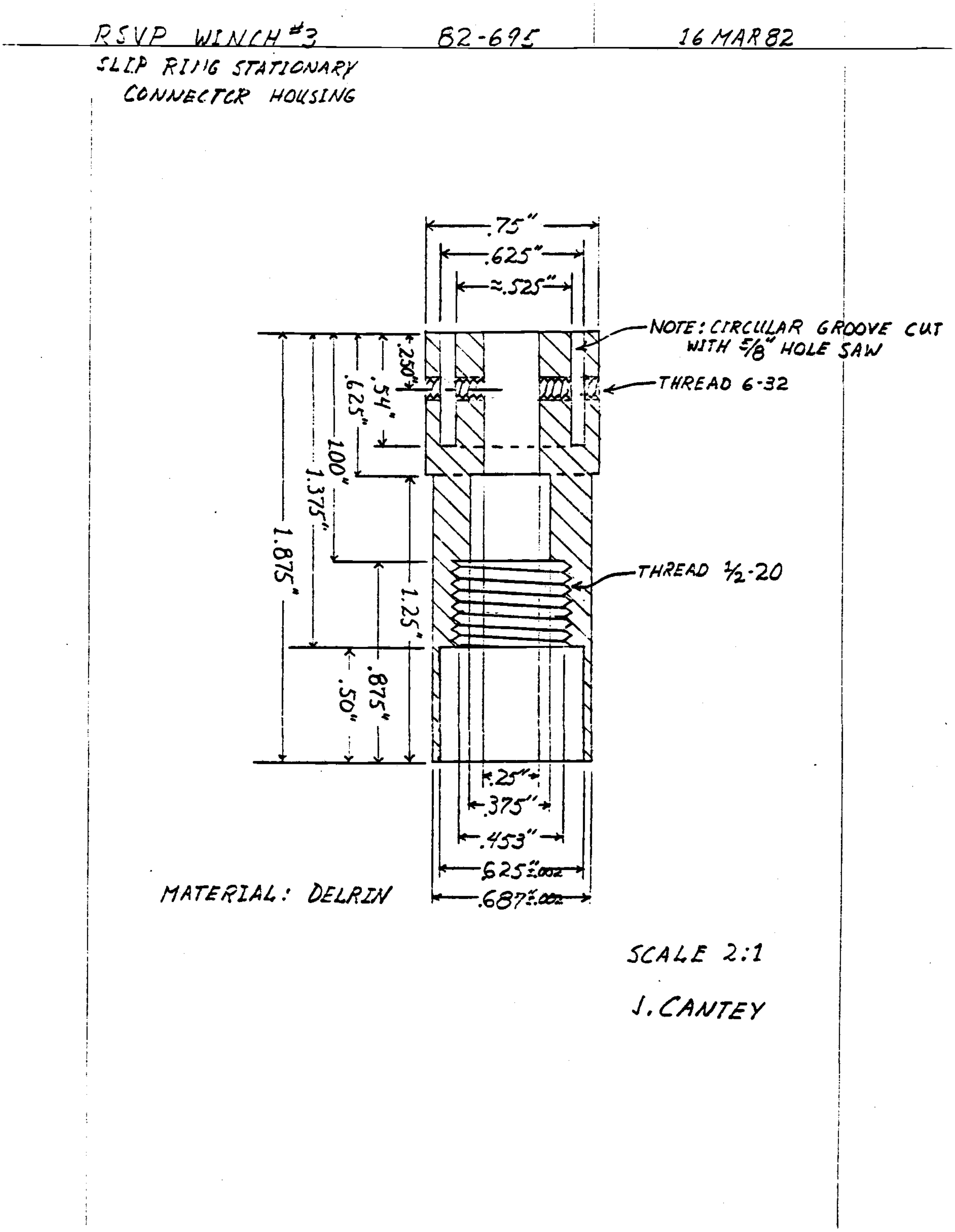


Figure IV-e-22. Slip ring stationary connector housing (dwg no. 82-695).

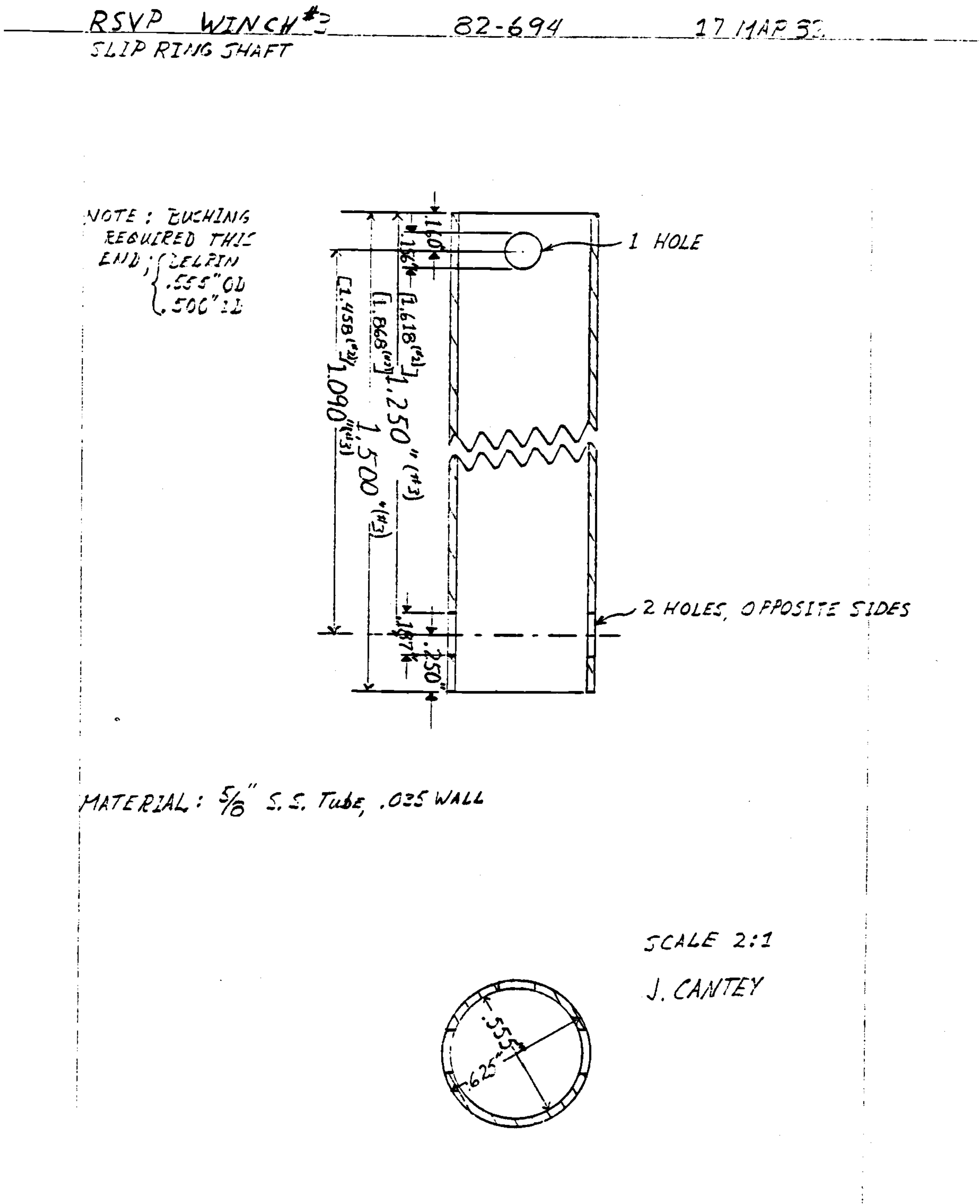


Figure IV-e-23. Slip ring shaft (dwg no. 82-694).

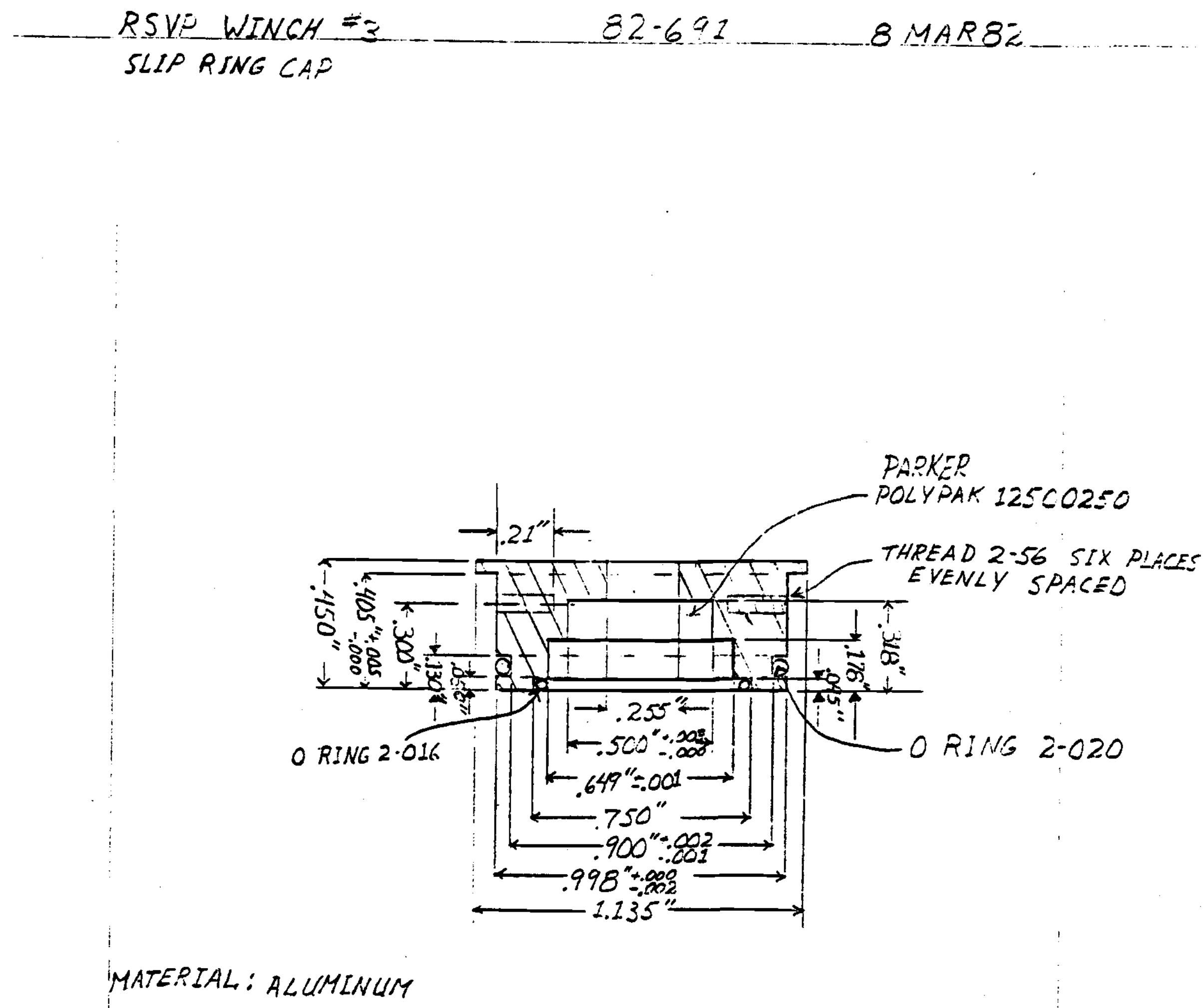


Figure IV-e-24. Slip ring cap (dwg no. 82-691).

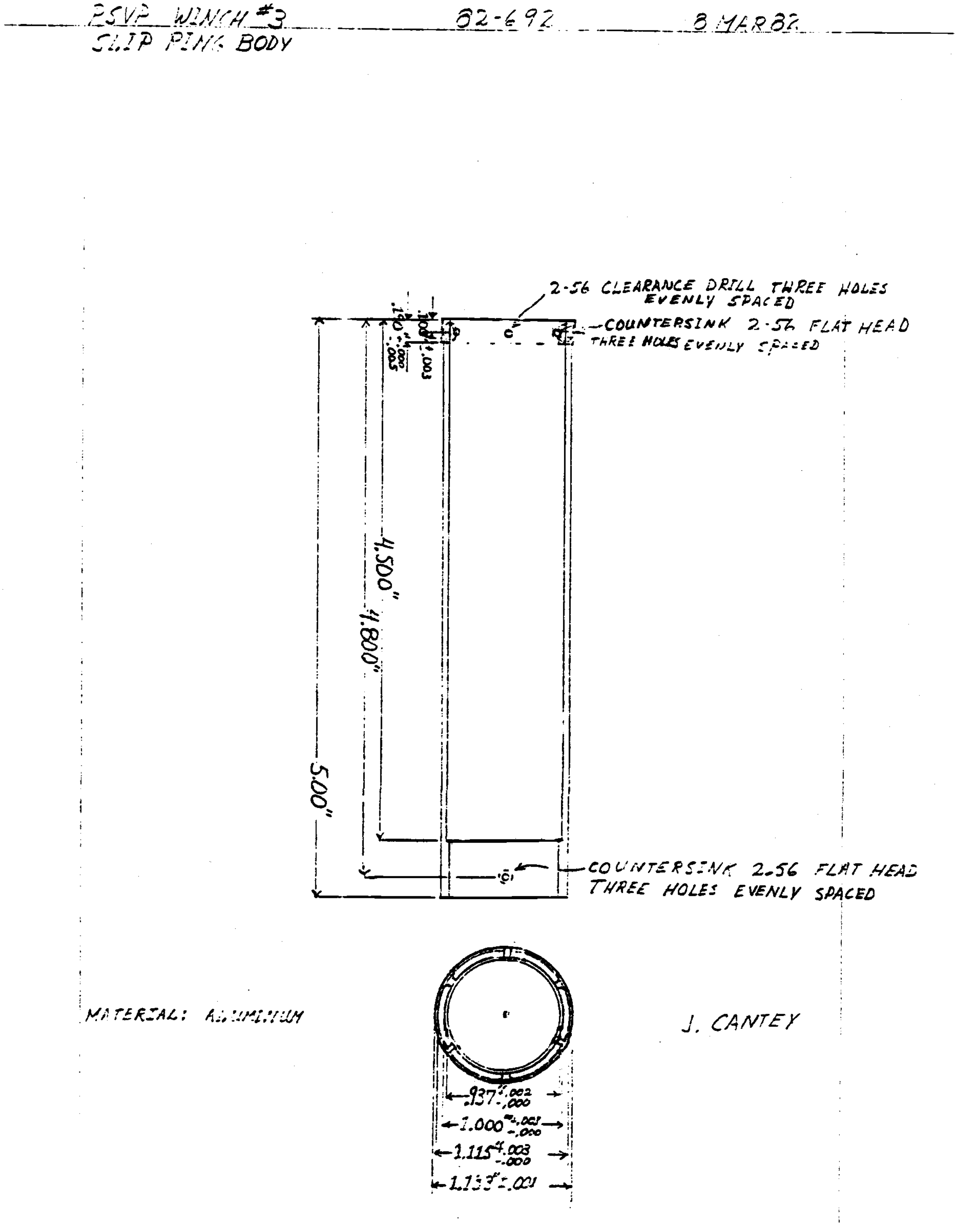


Figure IV-e-25. Slip ring body (dwg no. 82-692).

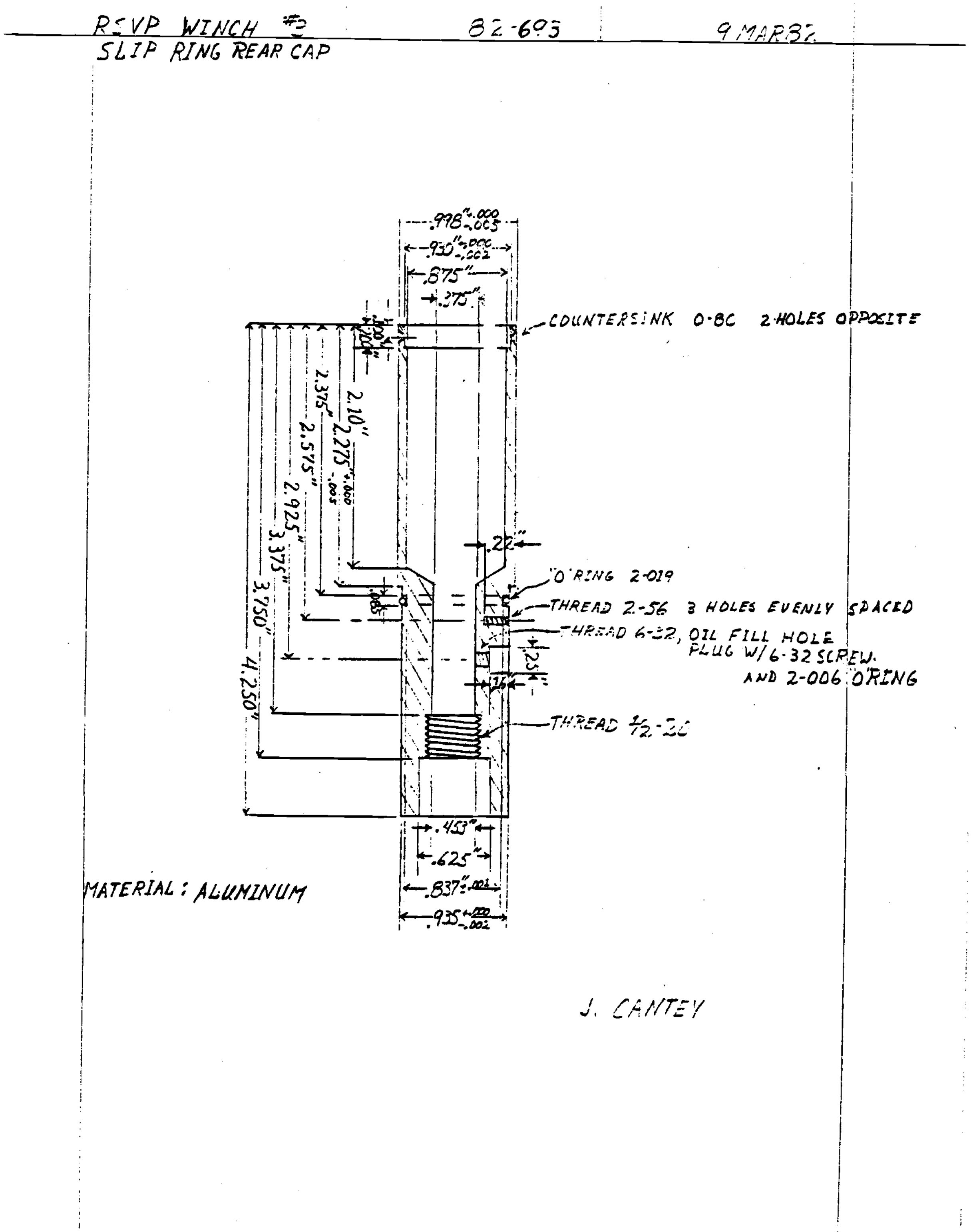


Figure IV-e-26. Slip ring rear cap (dwg no. 82-693).

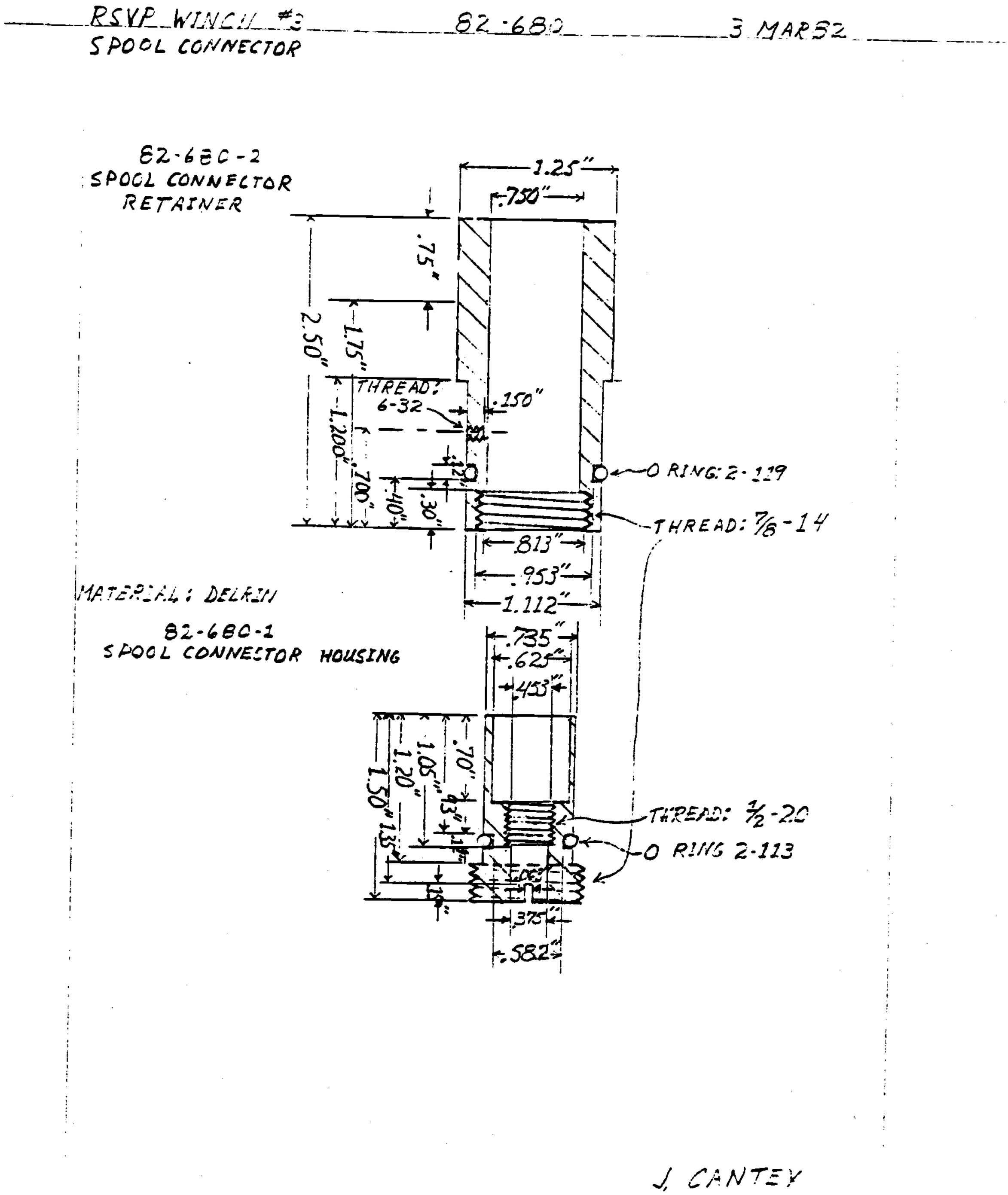
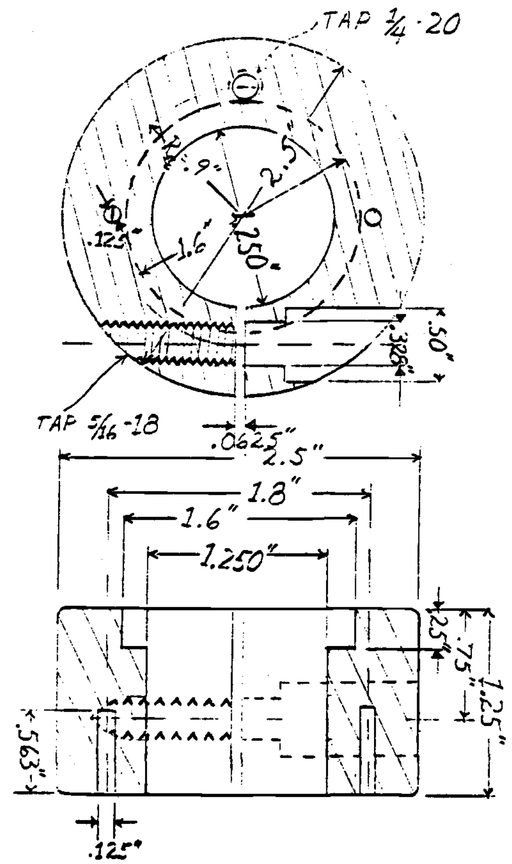


Figure IV-e-27. Spool connector retainer and housing (dwg no. 82-680).

RSYP WINCH #3 82-670 18 FEB 82
SPOOL RETAINER



MATERIAL: PLASTIC
5/16" x 18 x 3/4" S.S. SOCKET HEAD CAP SCREW

J. CANTEY

Figure IV-e-28. Spool retainer (dwg no. 82-670).

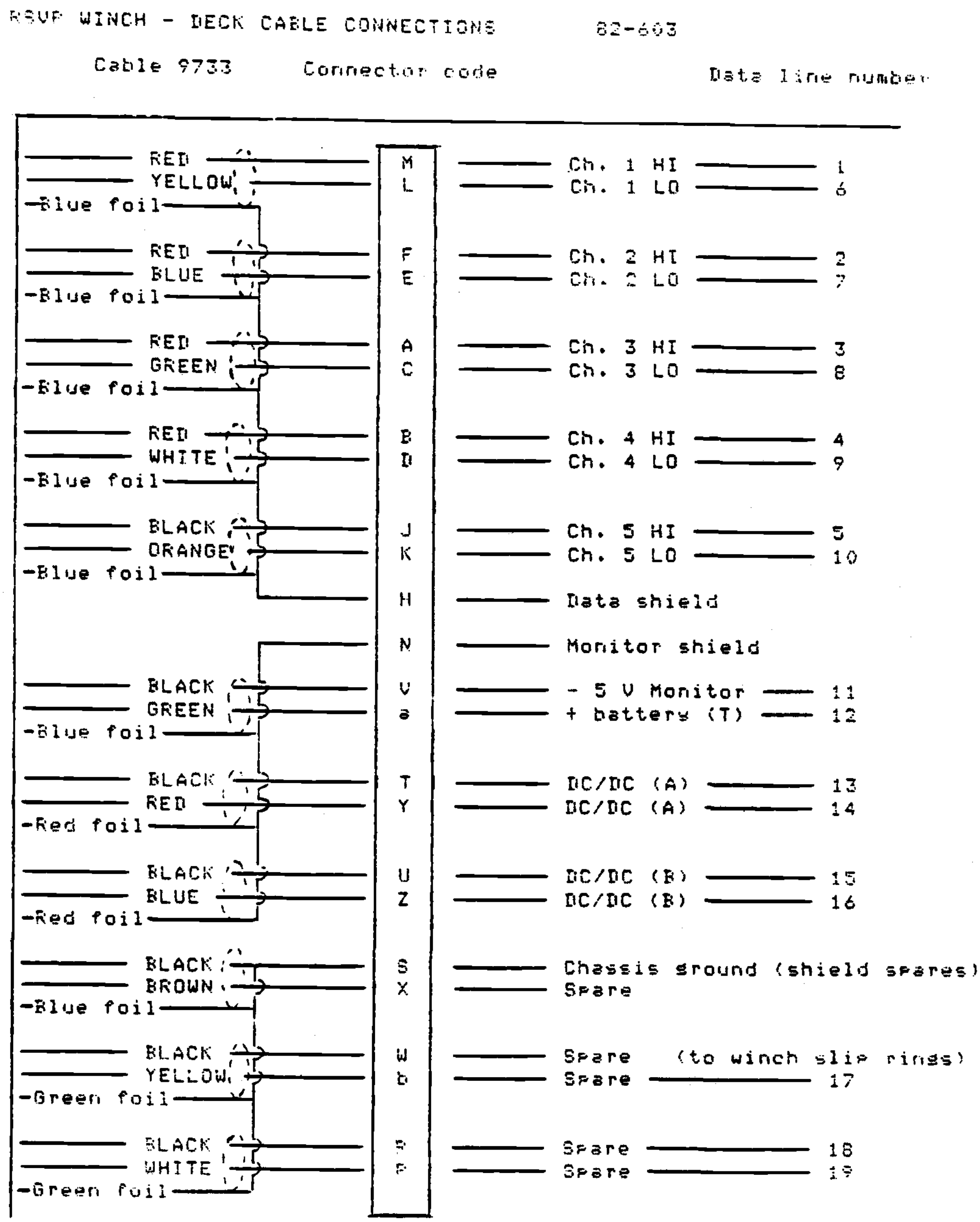
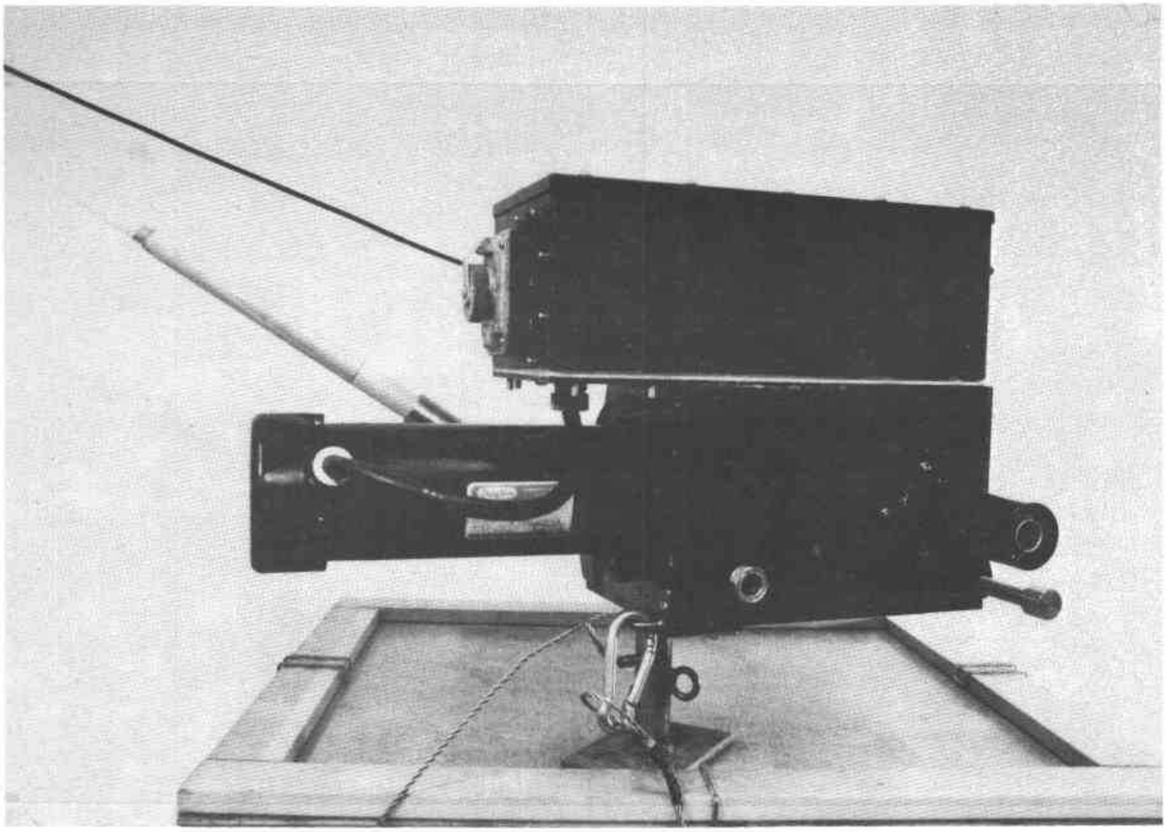


Figure IV-e-29. Deck cable connections (dwg no. 82-603).



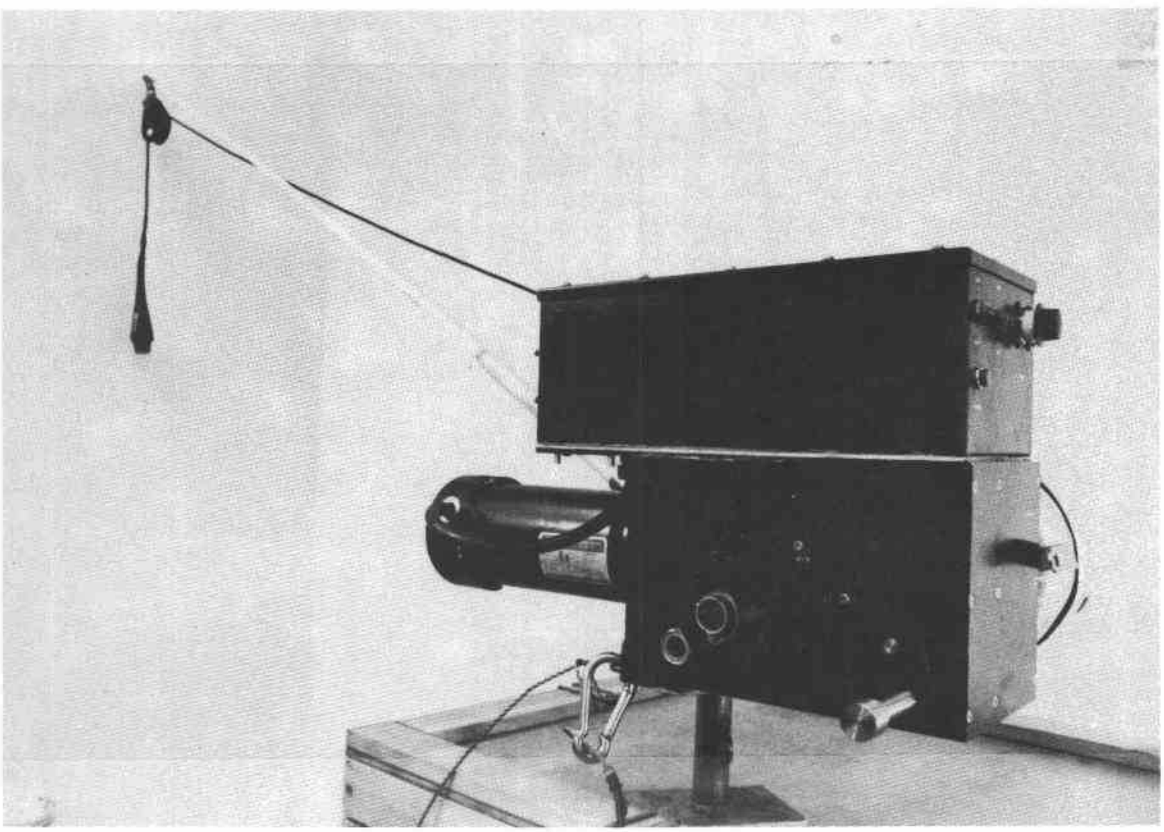


Figure IV-e-30. Photographs of winch frame.

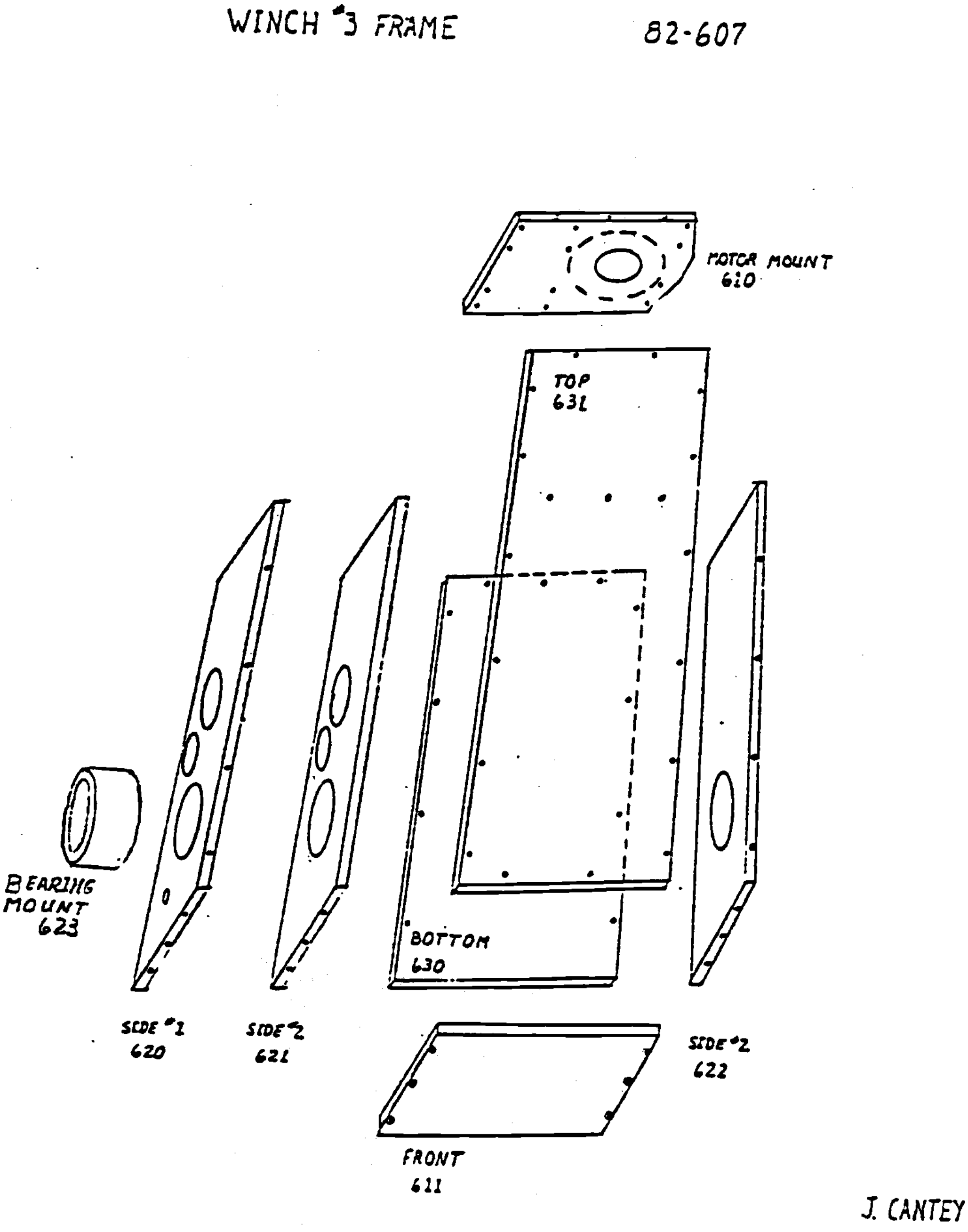


Figure IV-e-31. Winch frame drawing (dwg no. 82-607).

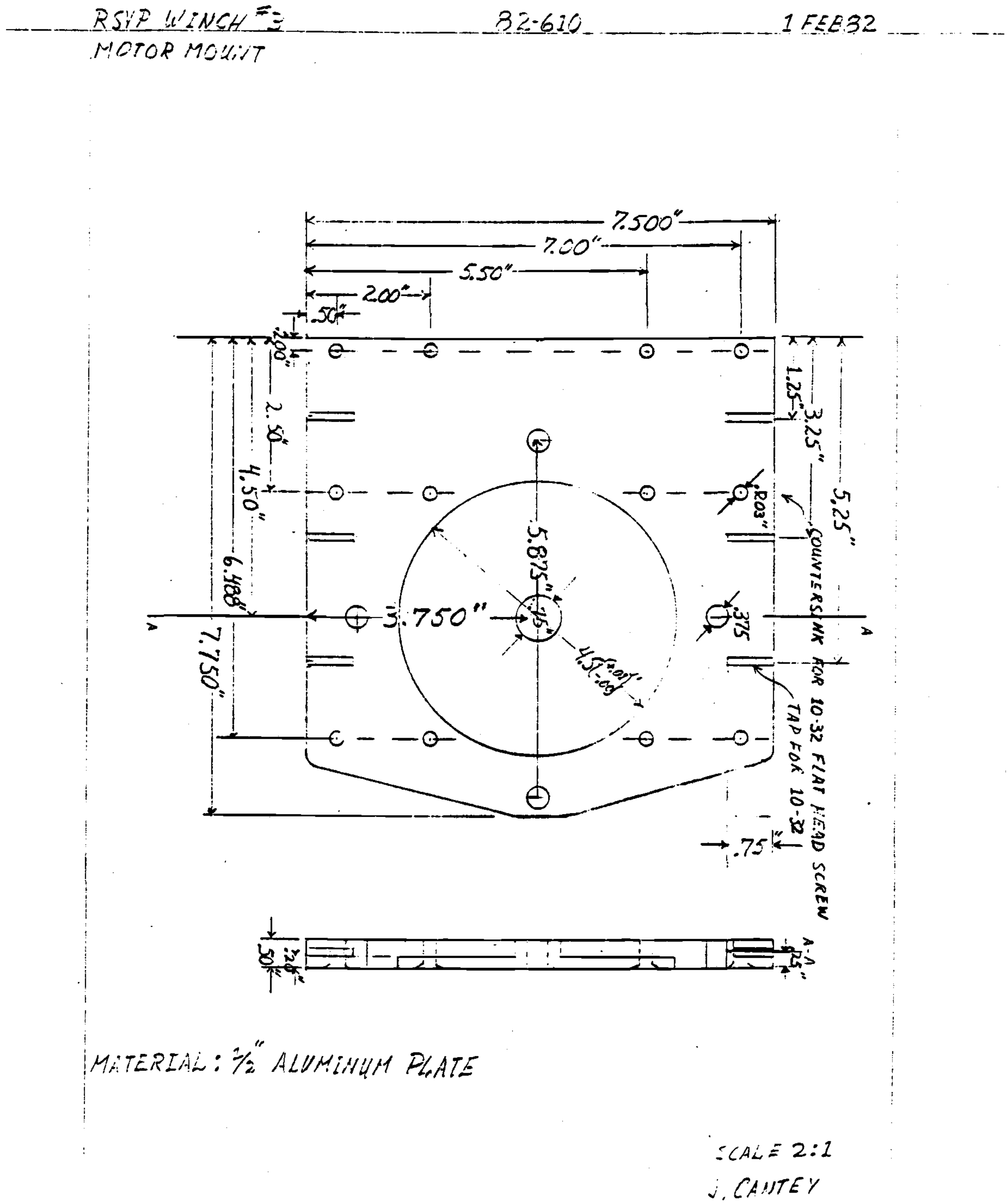


Figure IV-e-32. Motor mount (dwg no. 82-610).

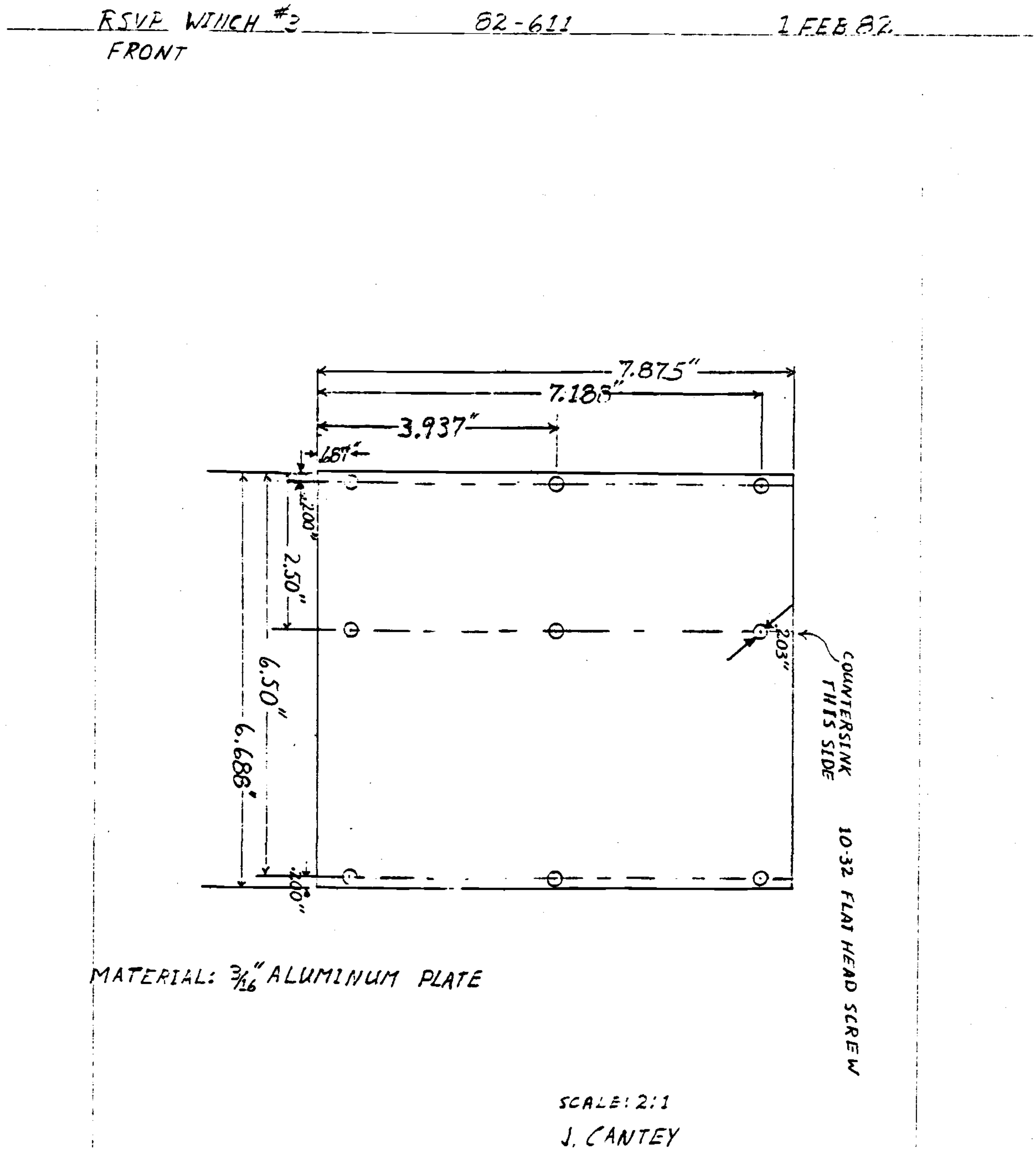


Figure IV-e-33. Winch frame front (dwg no. 82-611).

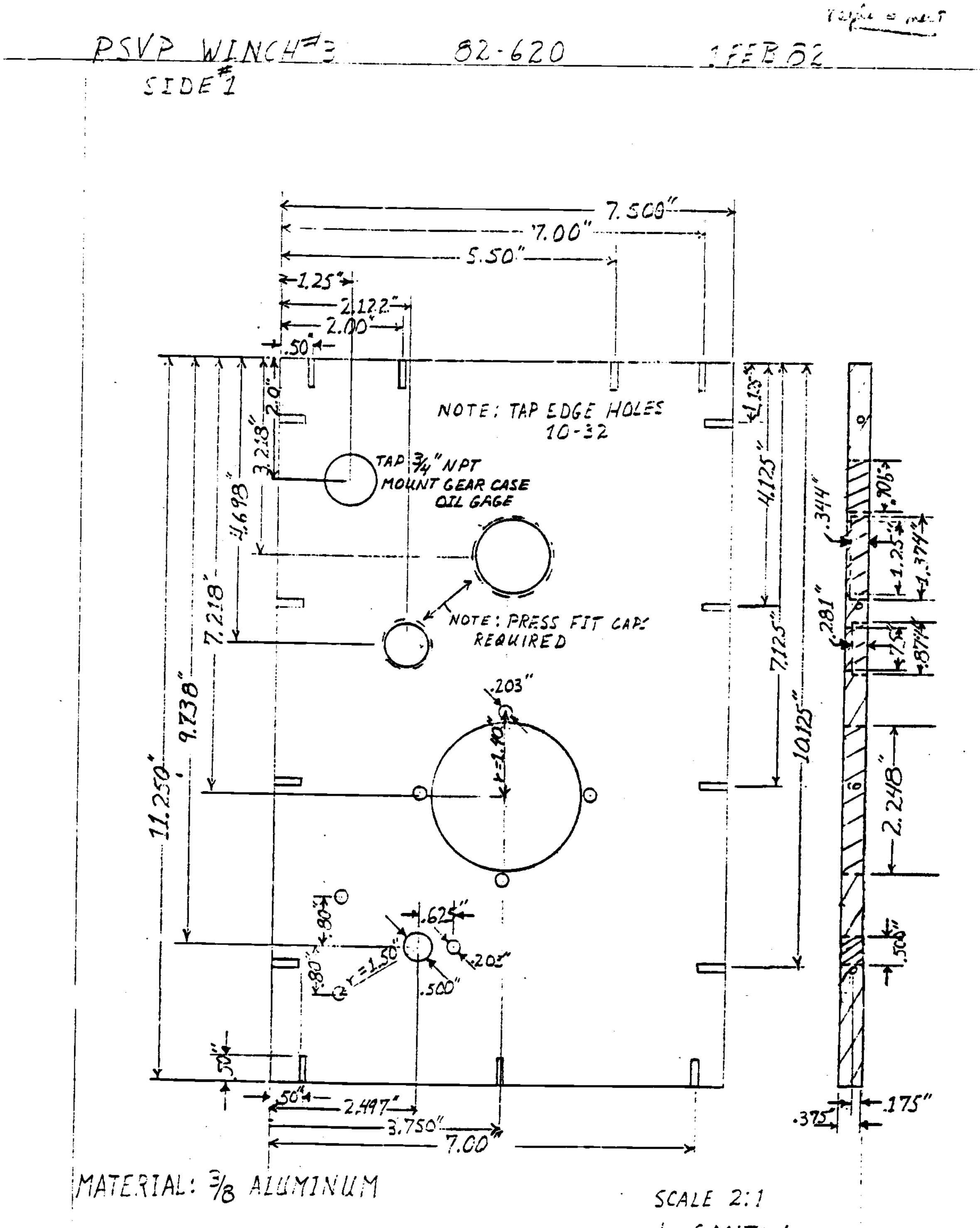


Figure IV-e-34. Winch frame side #1 (dwg no. 82-620).

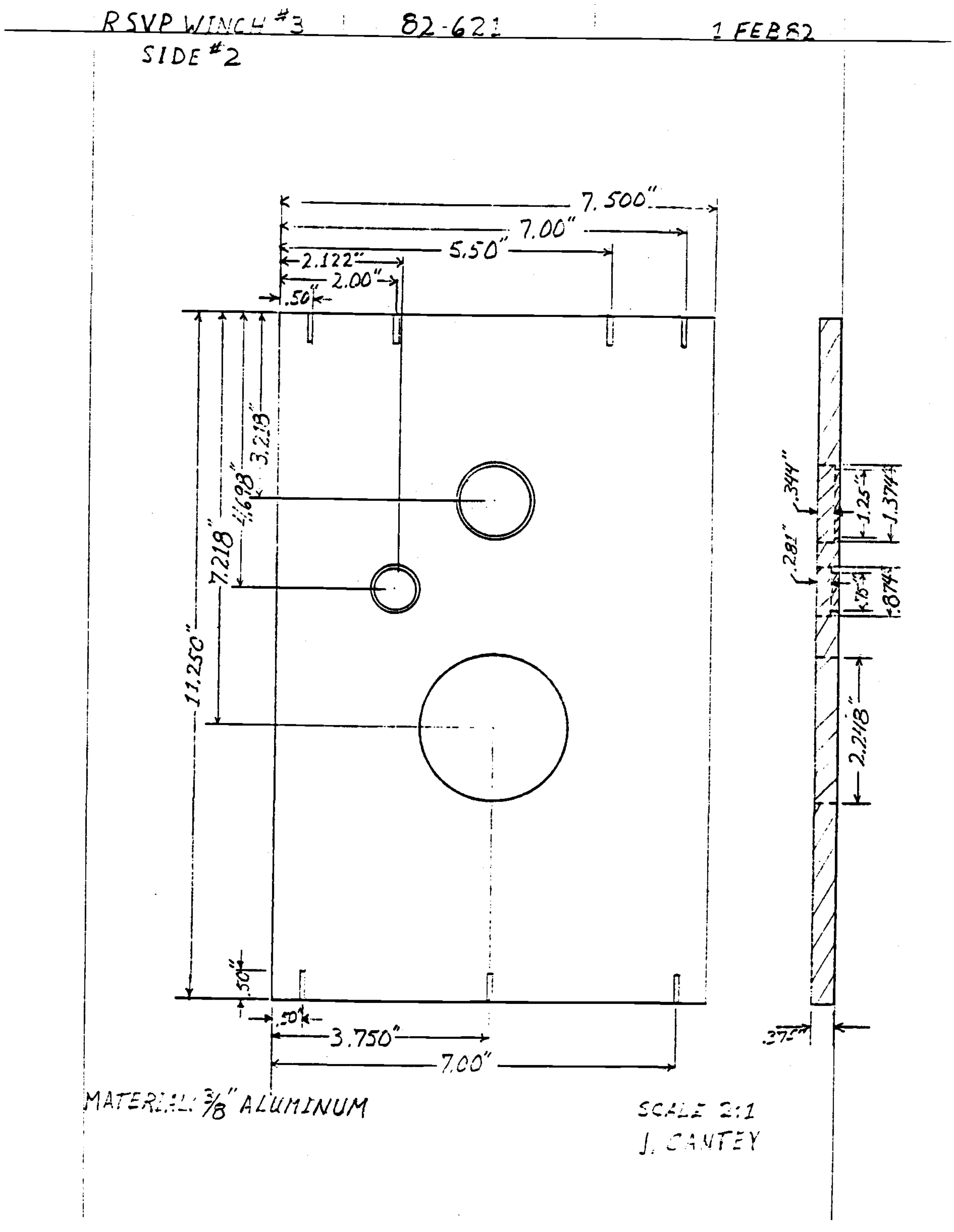


Figure IV-e-35. Winch frame side #2 (dwg no. 82-621).

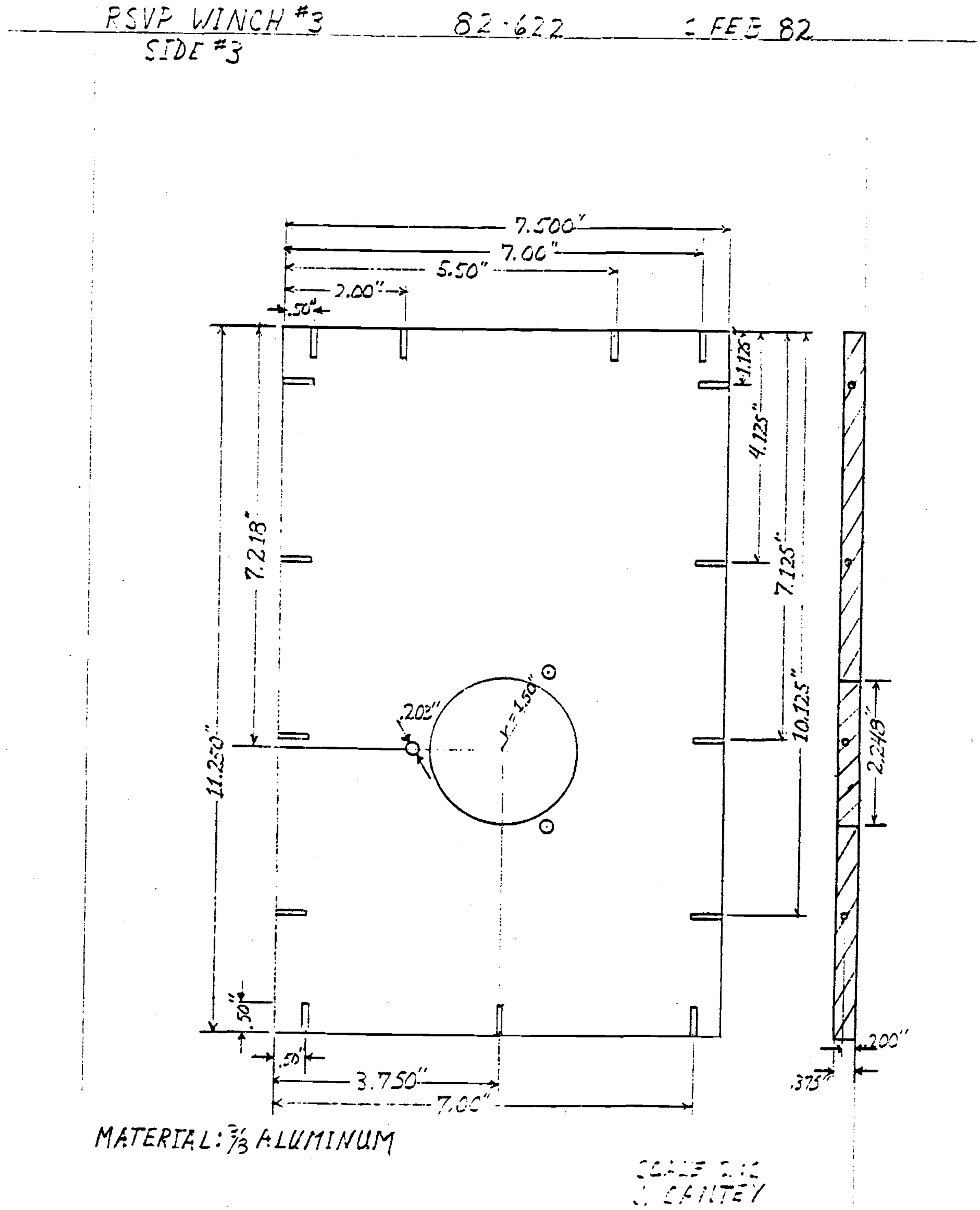


Figure IV-e-36. Winch frame side #3 (dwg no. 82-622).

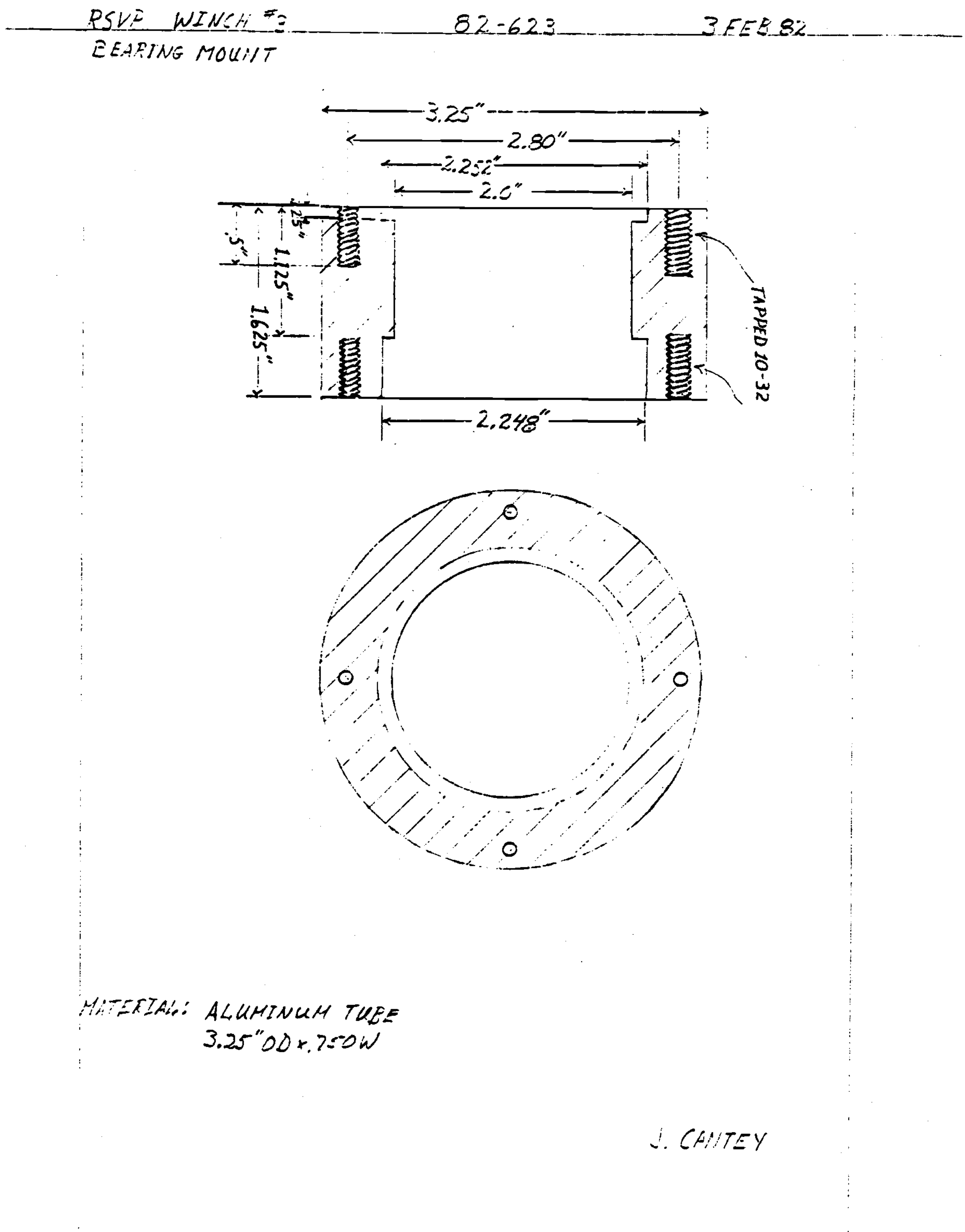


Figure IV-e-37. Bearing mount (dwg no. 82-623).

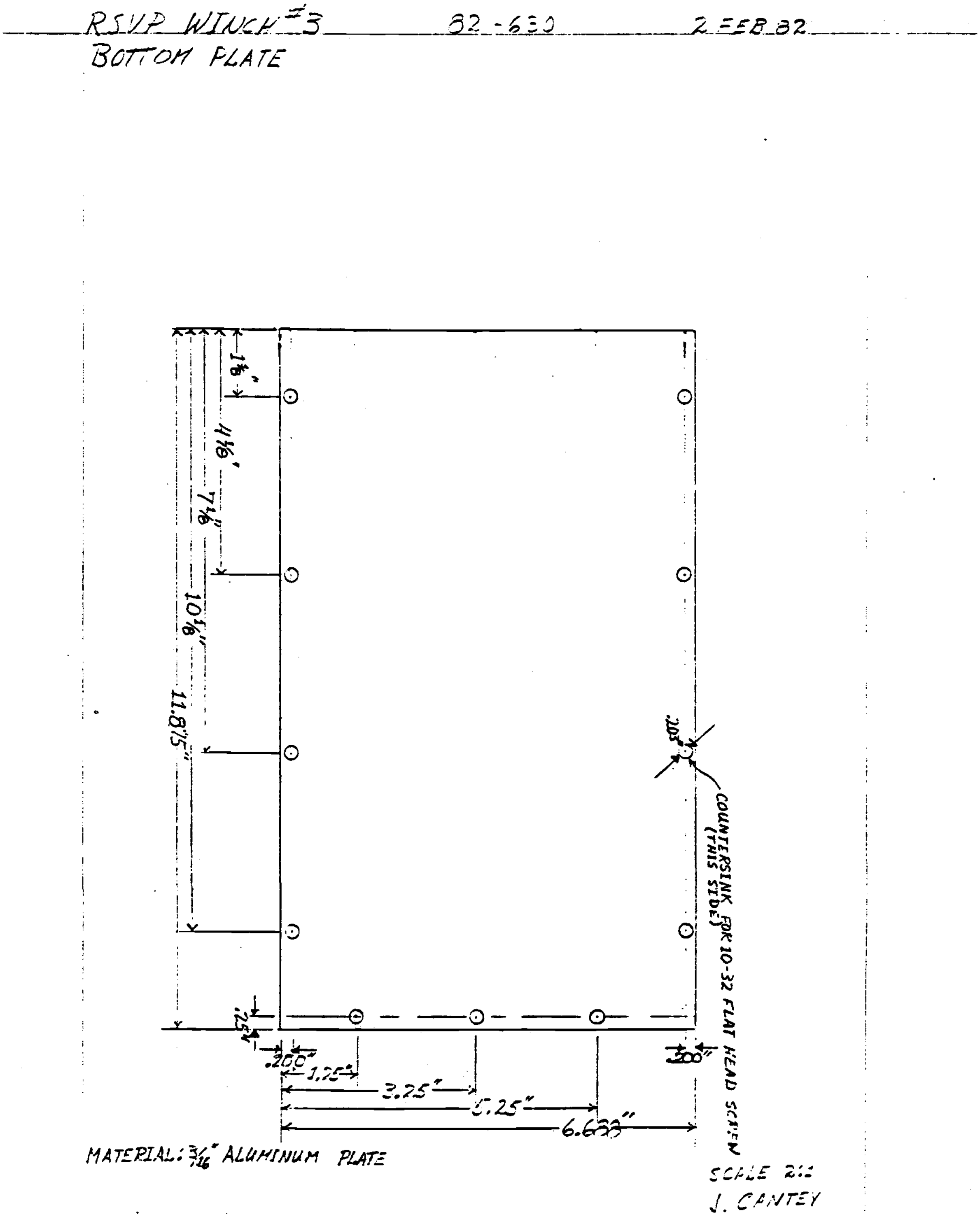


Figure IV-e-38. Winch frame bottom plate (dwg no. 82-630).

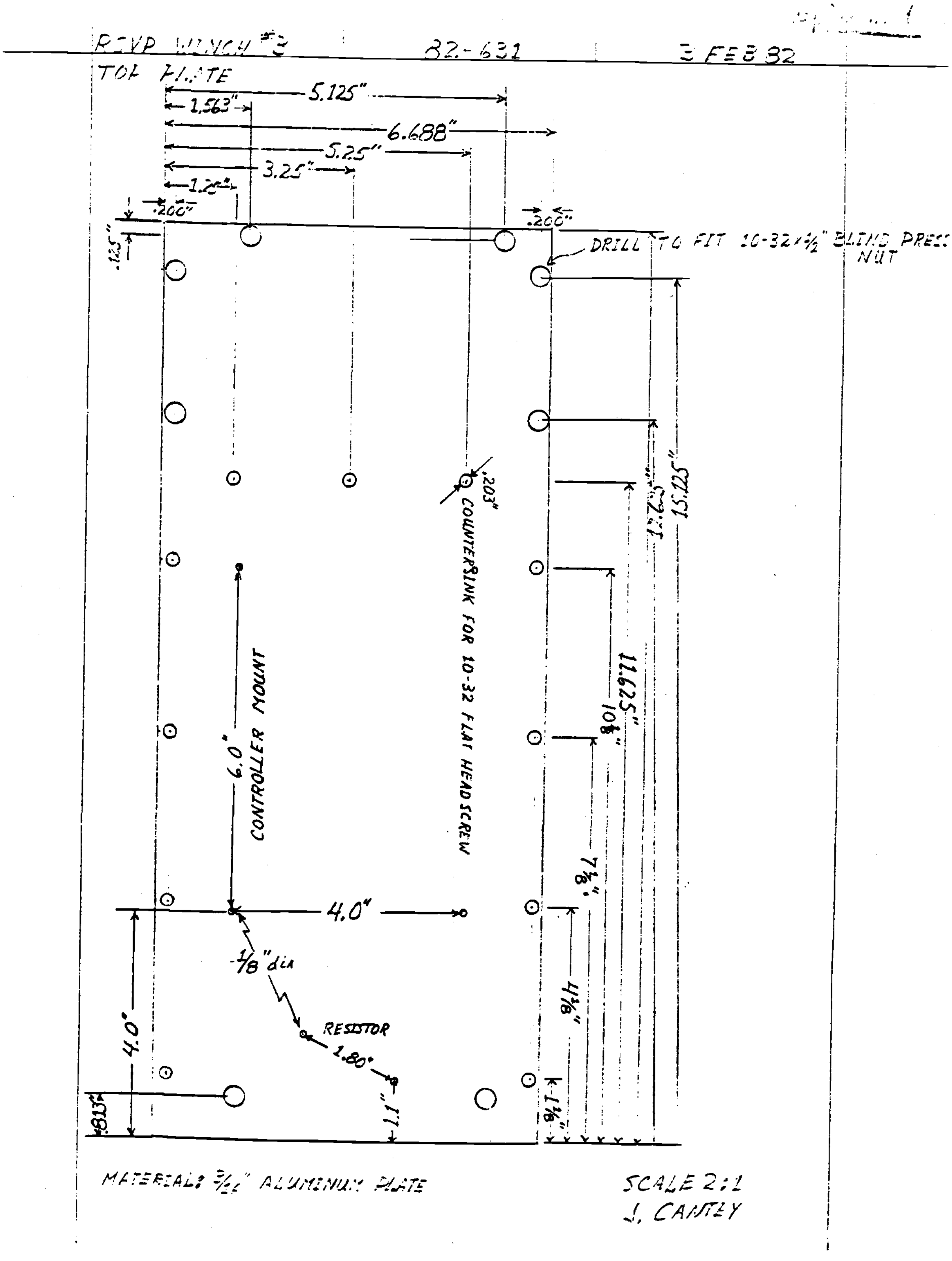


Figure IV-e-39. Winch frame top plate (dwg no. 82-631).

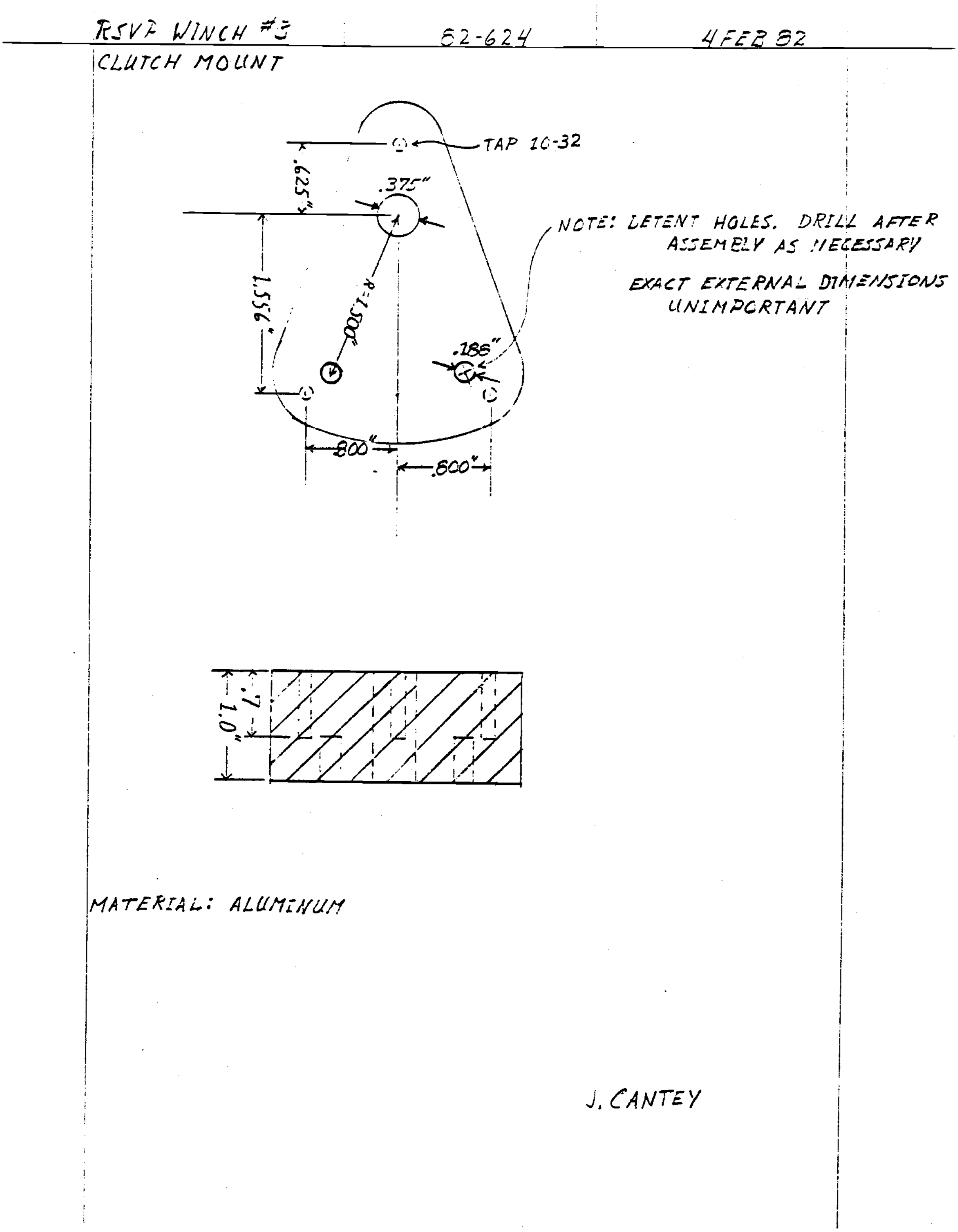


Figure IV-e-40. Clutch mount (dwg no. 82-624).

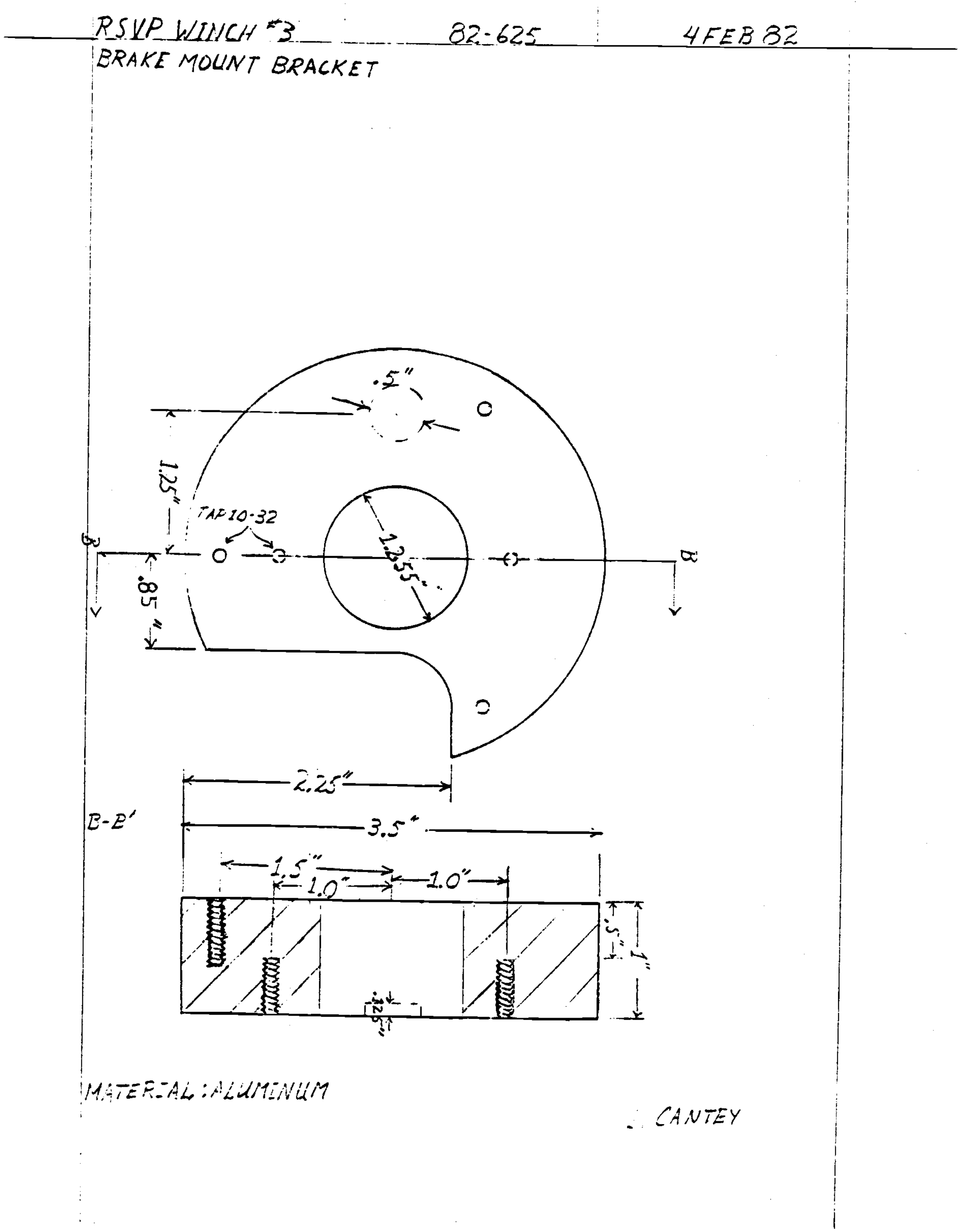


Figure IV-e-41. Brake mount bracket (dwg no. 82-625).

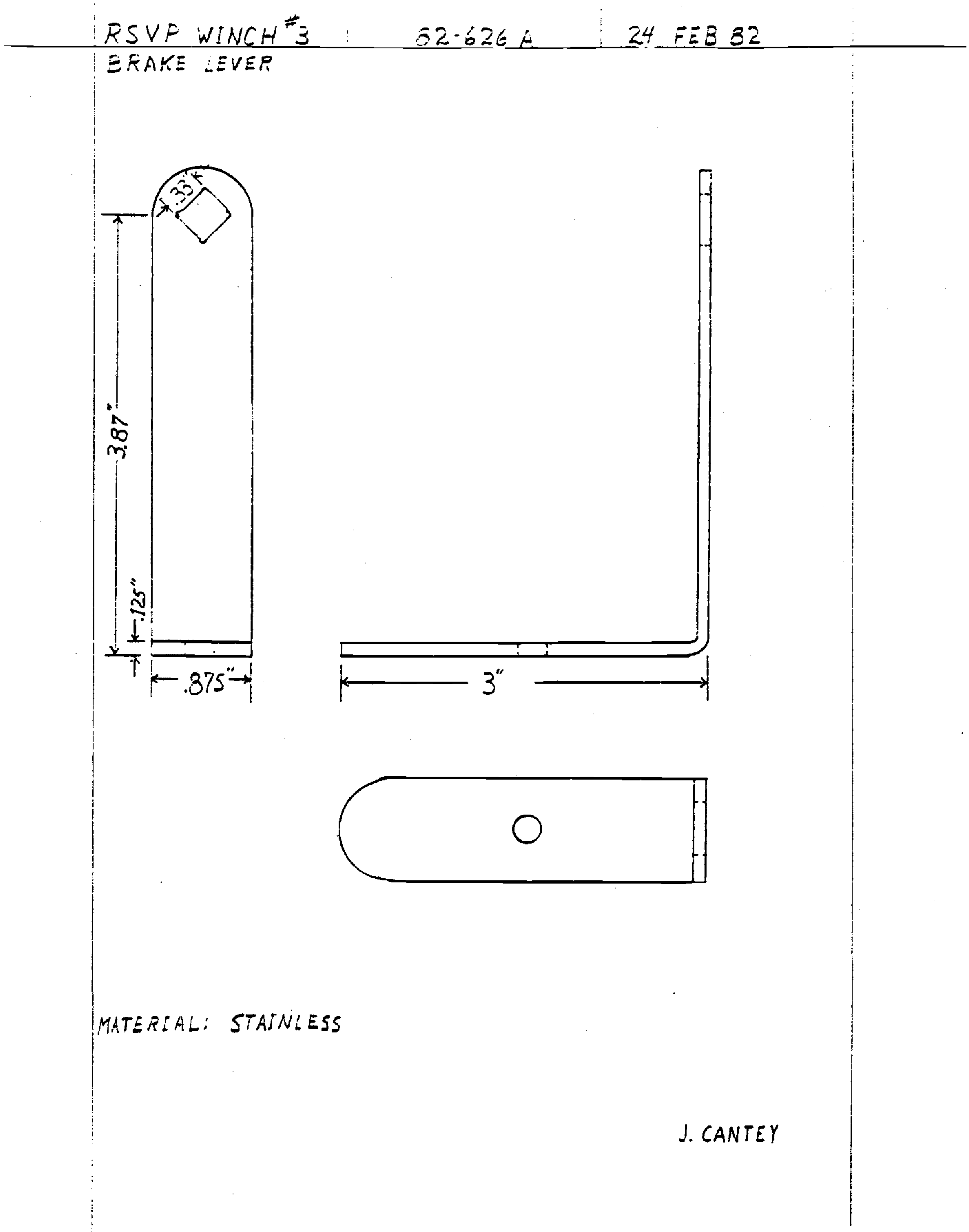


Figure IV-e-42. Brake lever (dwg no. 82-626A).

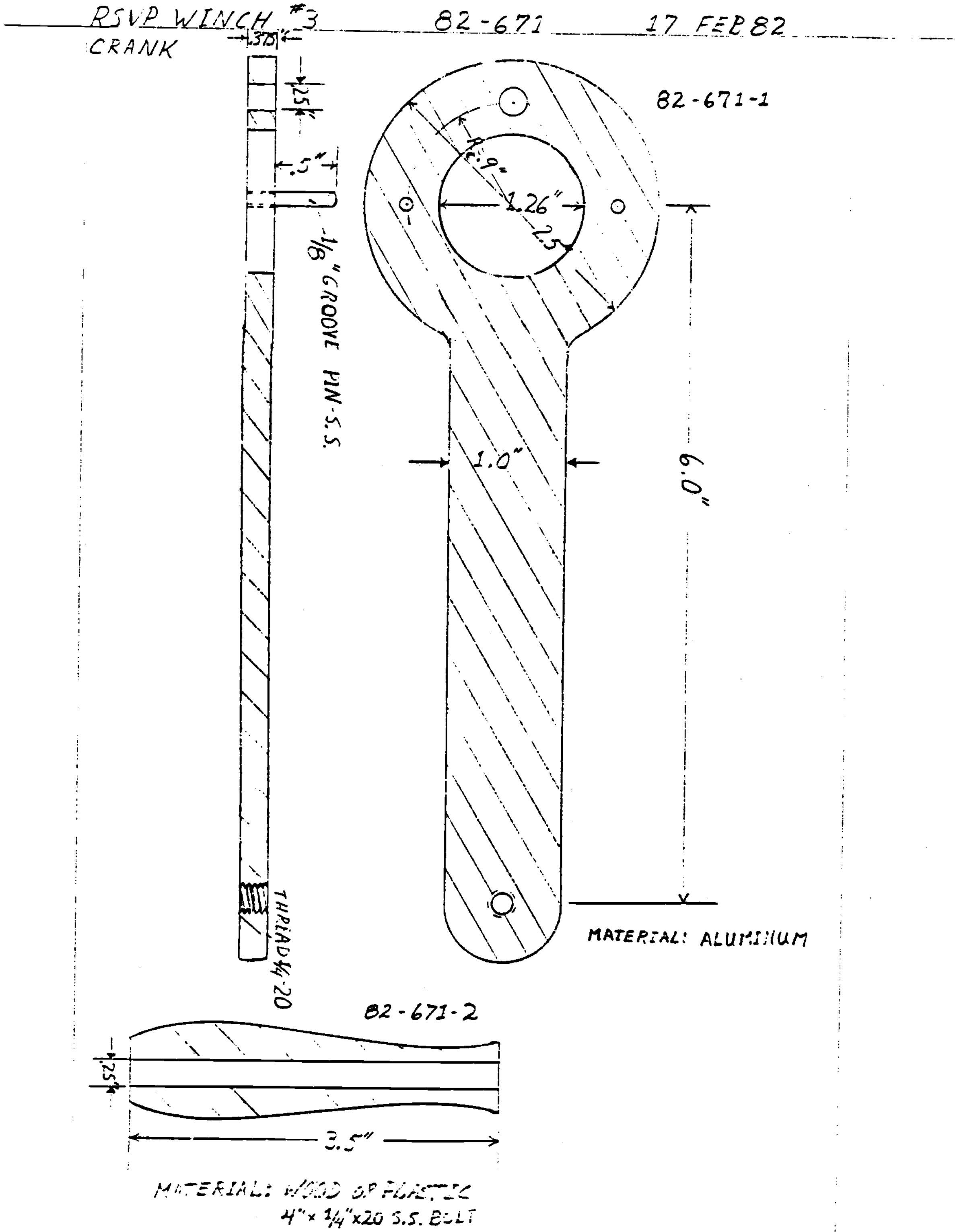


Figure IV-e-43. Crank (dwg no. 82-671).

f) Onboard analog electronics

The signal from the RSVP is transmitted from the probe, through the data link, winch data transmission system and deck cable and through on board analog filters, amplifiers and possibly differentiators before being digitized and recorded. This is accomplished by a dual amplifier-filter unit (Figures IV-f-1, IV-f-2) which can be rack mounted in the ship's laboratory. This module allows the selection (Figures IV-f-3, IV-f-4) of 40 or 80 Hz filters for the undifferentiated signal and 40, 80, 400 or 800 Hz for the signal to be differentiated. Undifferentiated outputs include x1, x1 filtered, x5 and x50. The differentiated signal is output x1, with selectable gain as well as the root-mean-square and the logarithm of the rms. The power is supplied to this unit by a transformer located in the module (Figures IV-f-5, IV-f-6).

The signal from the RSVP unit is received (Figure IV-f-7) by a high -impedance differential amplifier. The selectable filters are fixed frequency low-pass Cauer-elliptic, 7 pole, 0 dB, passband gain filters (Frequency Devices, Inc, model 7438-f).

Undifferentiated signals are offset with voltages from 0.1 to 1.0 V, selectable from the front panel (Figure IV-f-8). The offset signal is passed through a x 5 gain stage. This signal is offset again and an additional x 10 gain applied. A bar display on the front panel (Figure IV-f-9) allows the operator to monitor the amplified voltage levels.

The input signal is also differentiated using an operational-amplifier-based differentiator circuit (Figure f-10). This circuit has a unity gain frequency of 15.9 hz, high frequency corner at 796 hz and a high frequency gain of 50. The gain applied to the differentiated signal is selectable from the front panel. Additional outputs include the rms of the differentiated signal averaged over 0.2 s and the log of the rms.

An older version of this circuitry was used for one RSVP temperature channel and for DC pressure on FRONTS 82 since a sufficient number of the new module was not ready. This has been described by Caldwell and Dillon (1981). An FM discriminator circuit which produced an output voltage dependent upon the pressure oscillator frequency was used to decode the FM pressure signals that were added to the temperature channels in the probe.

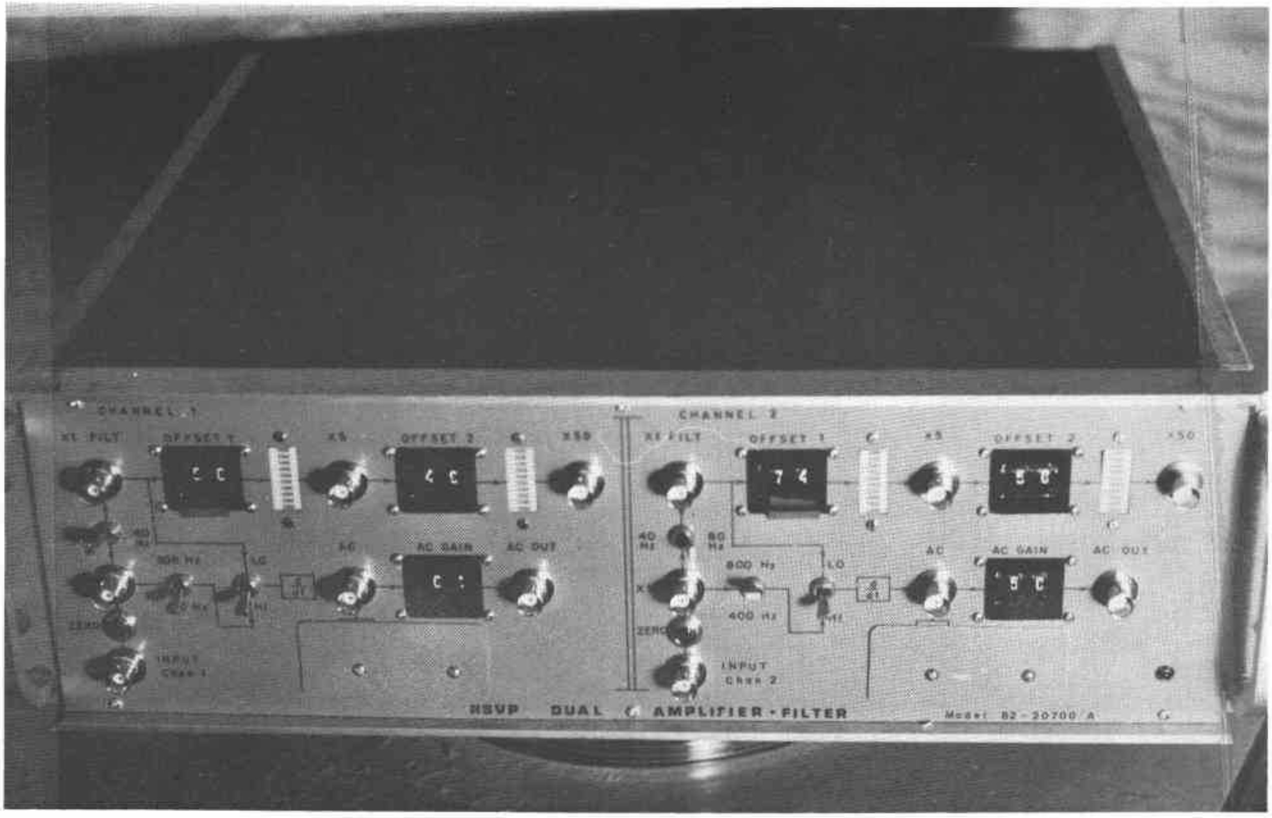


Figure IV-f-1. Photograph of onboard dual amplifier system.

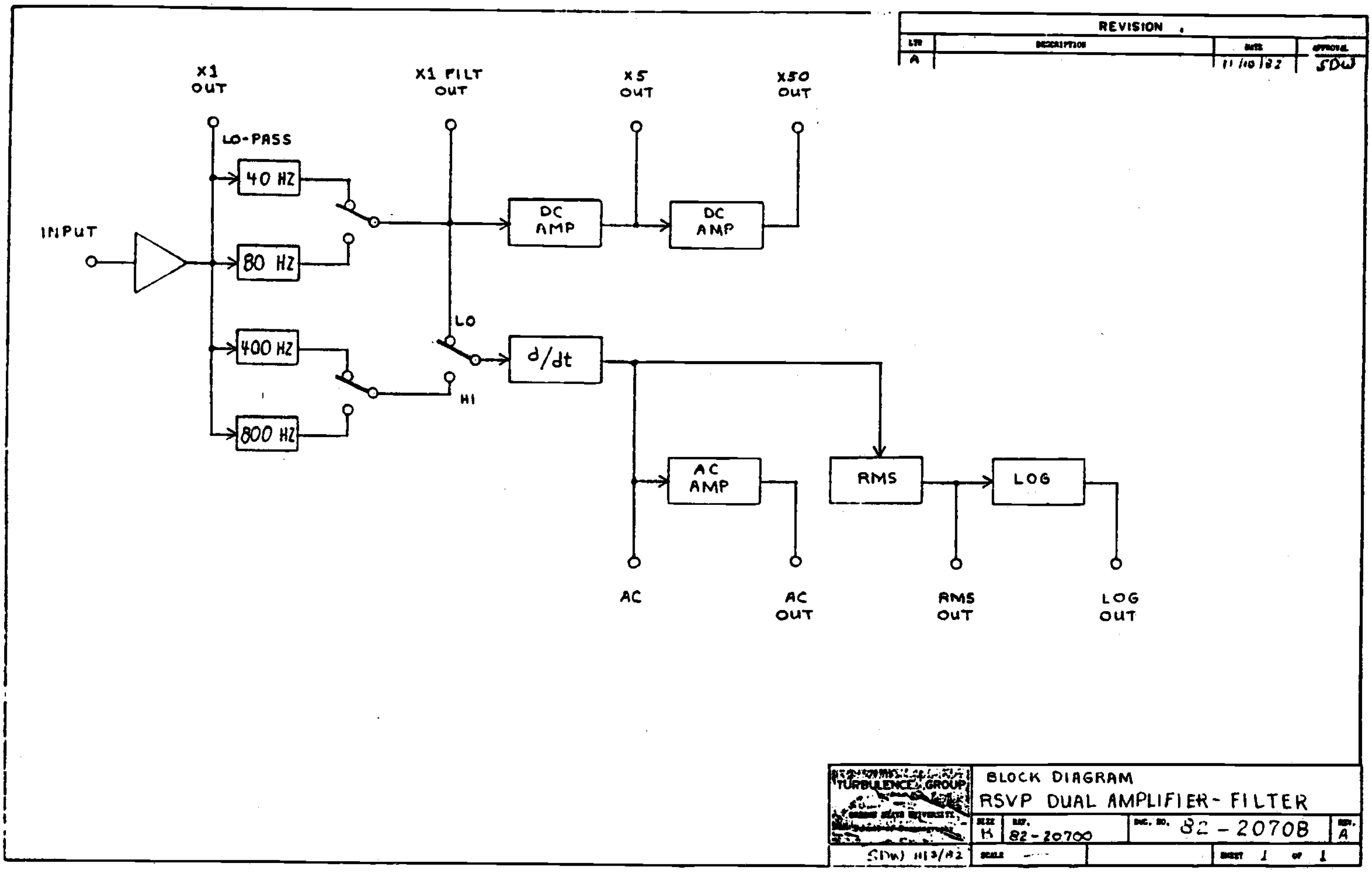


Figure IV-f-2. Block diagram RSVP dual amplifier-filter (dwg no. 82-20708).

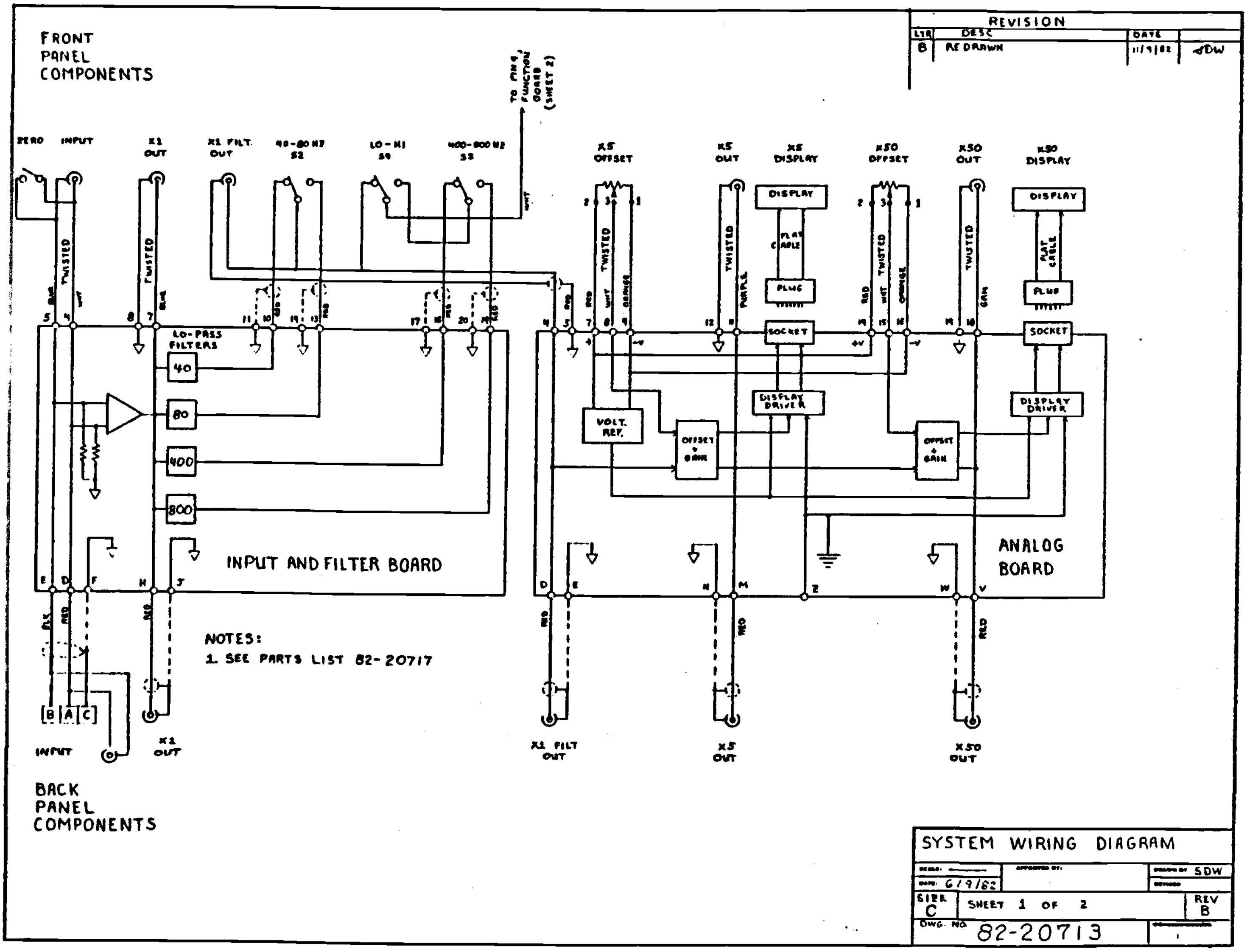


Figure IV-f-3. System wiring diagram - input/filter board, analog board (dwg no. 82-20713/1).

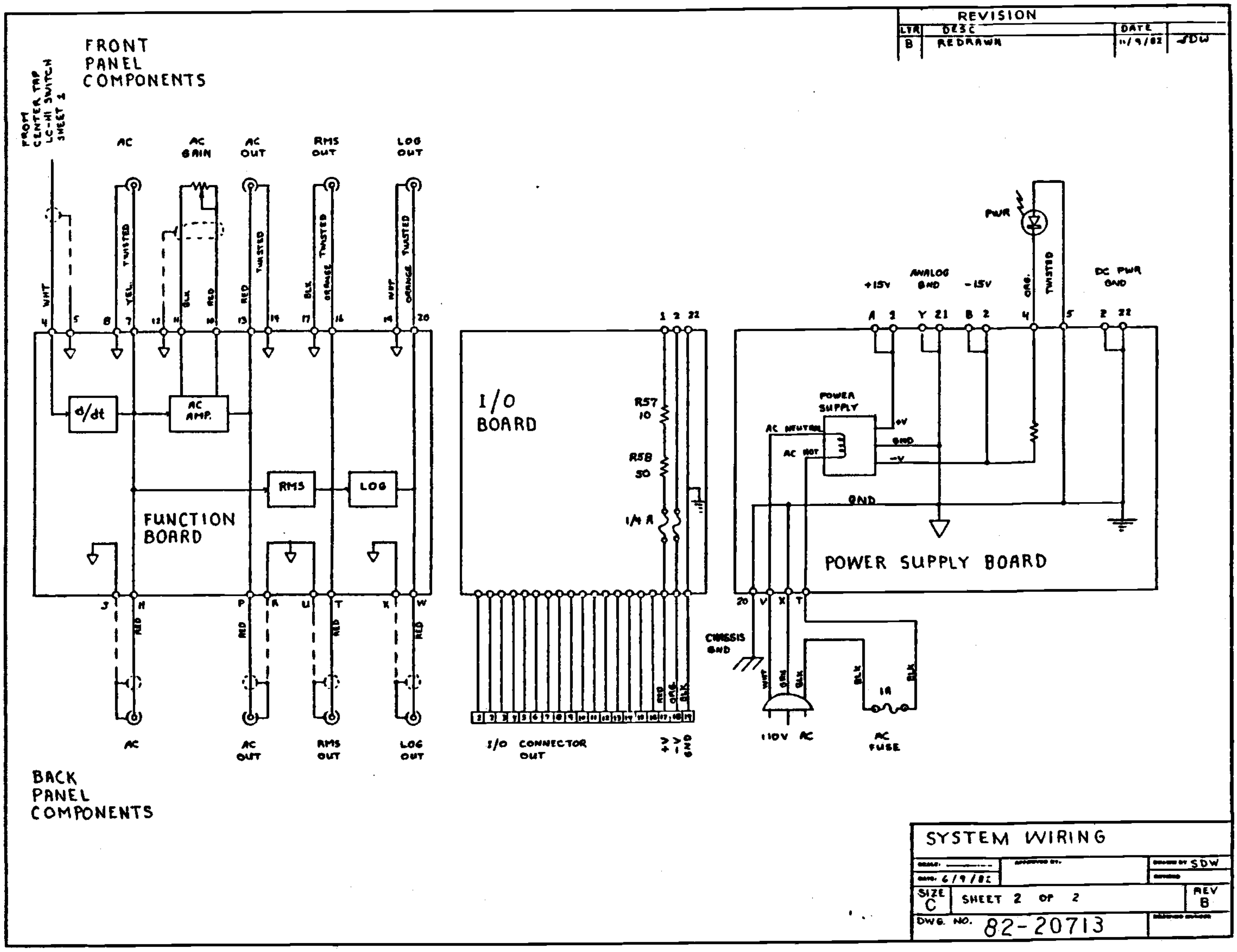


Figure IV-f-4. System wiring diagram - function board, power supply board, I/O board (dwg no. 82-20713/2).

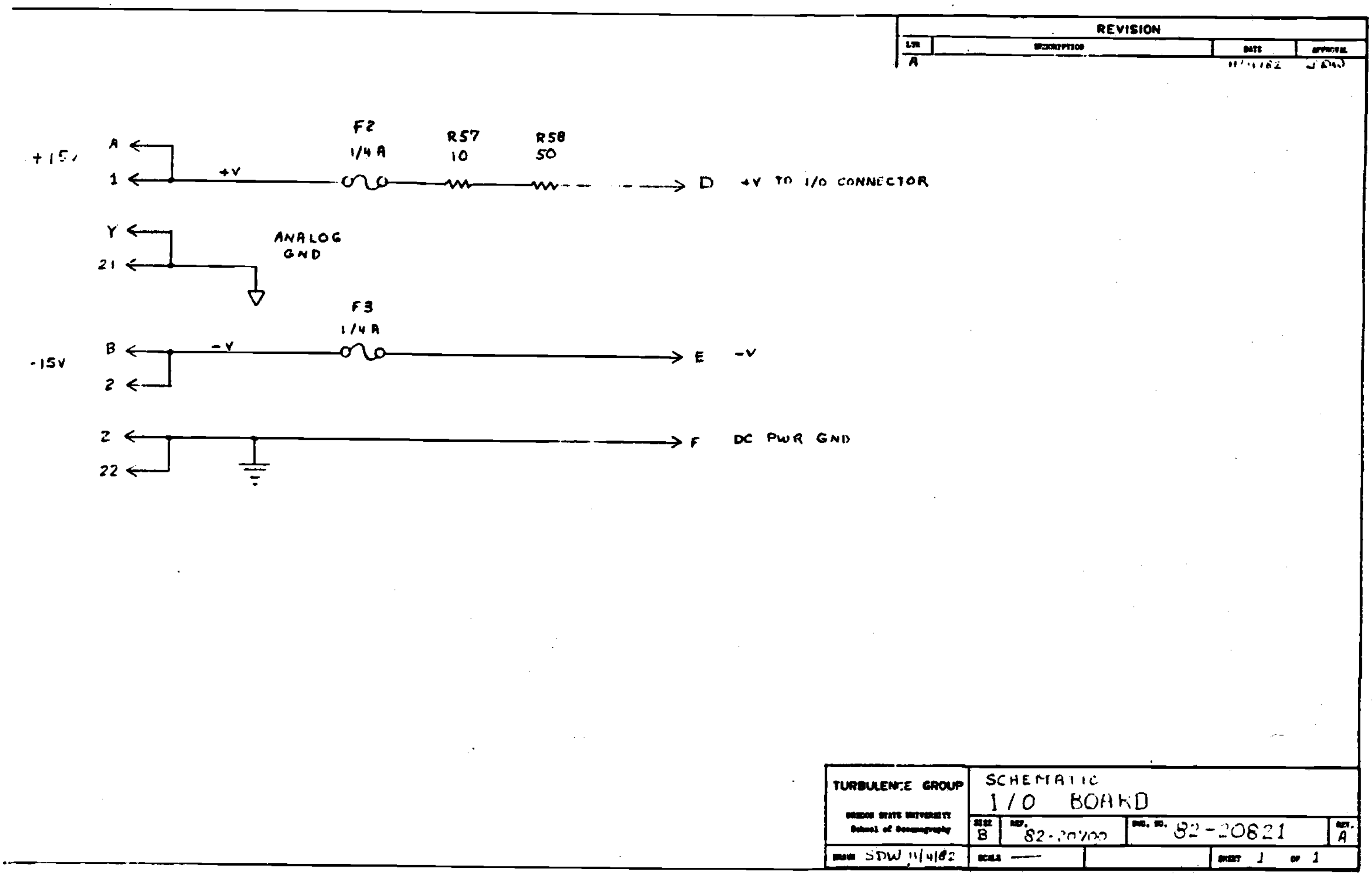


Figure IV-f-5. Schematic: I/O board (dwg no. 82-20821).

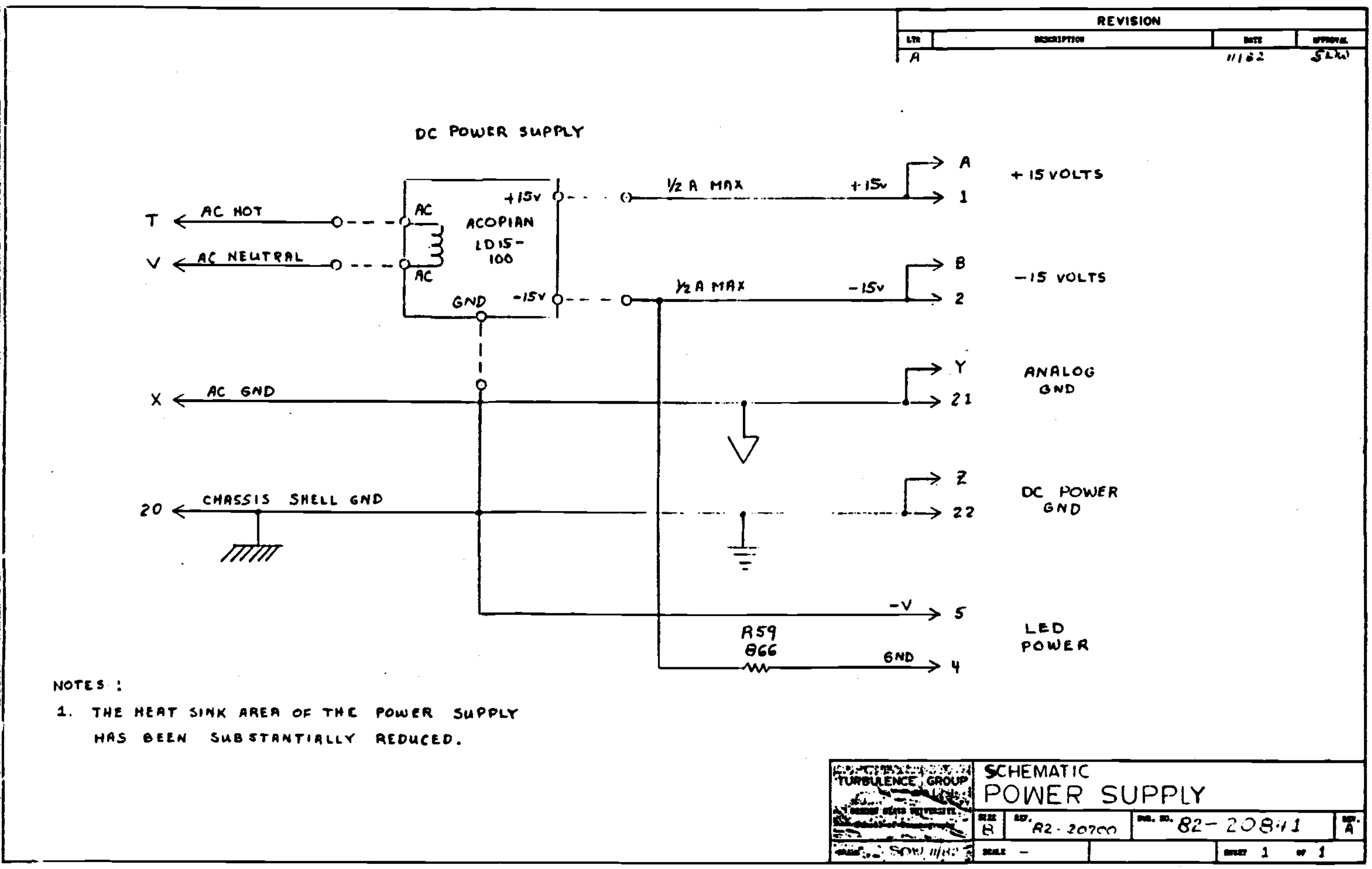


Figure IV-f-6. Schematic: Power supply (dwg no. 82-20841).

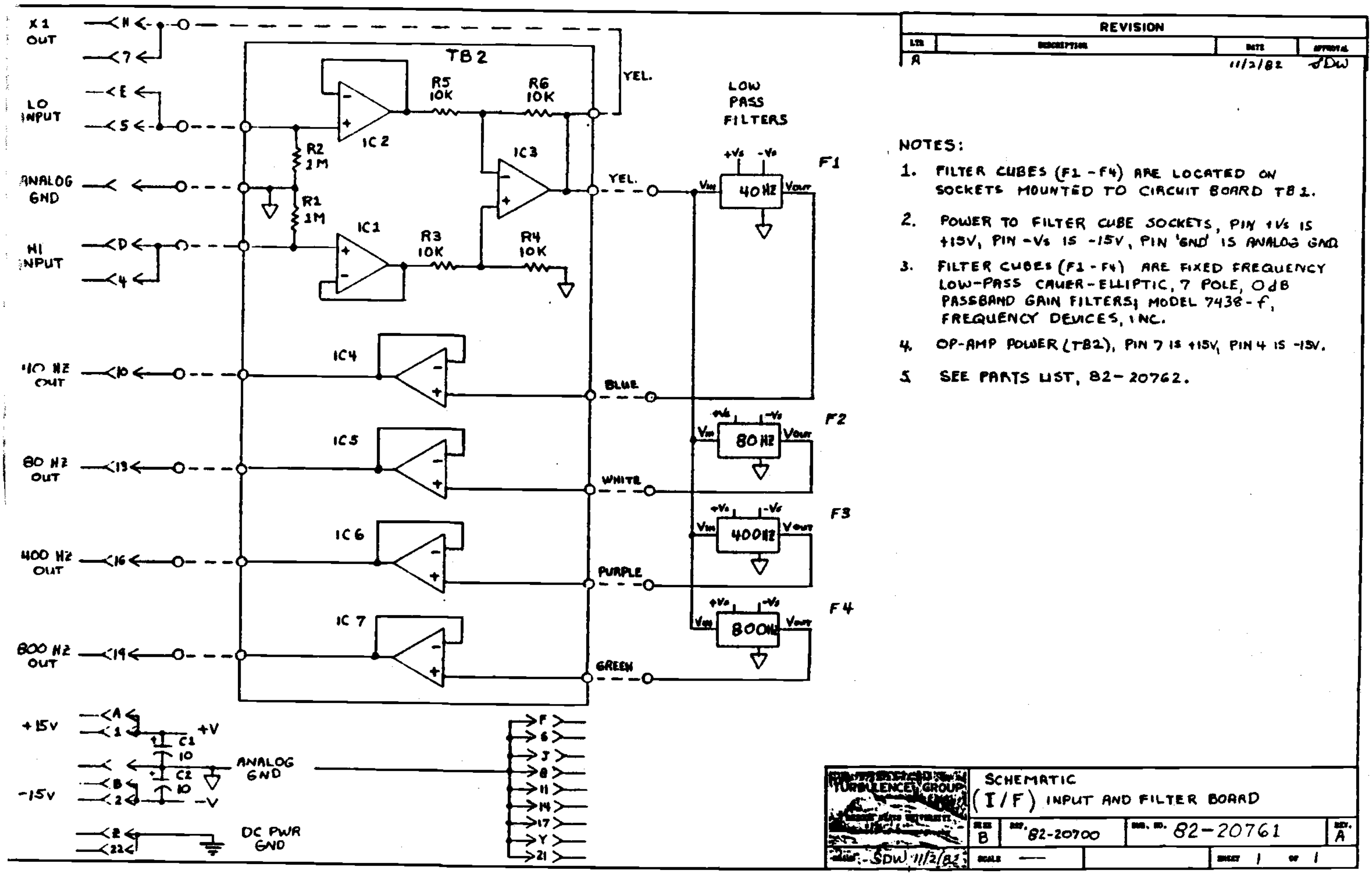


Figure IV-f-7. Schematic: input/filter board (dwg no. 82-20761).

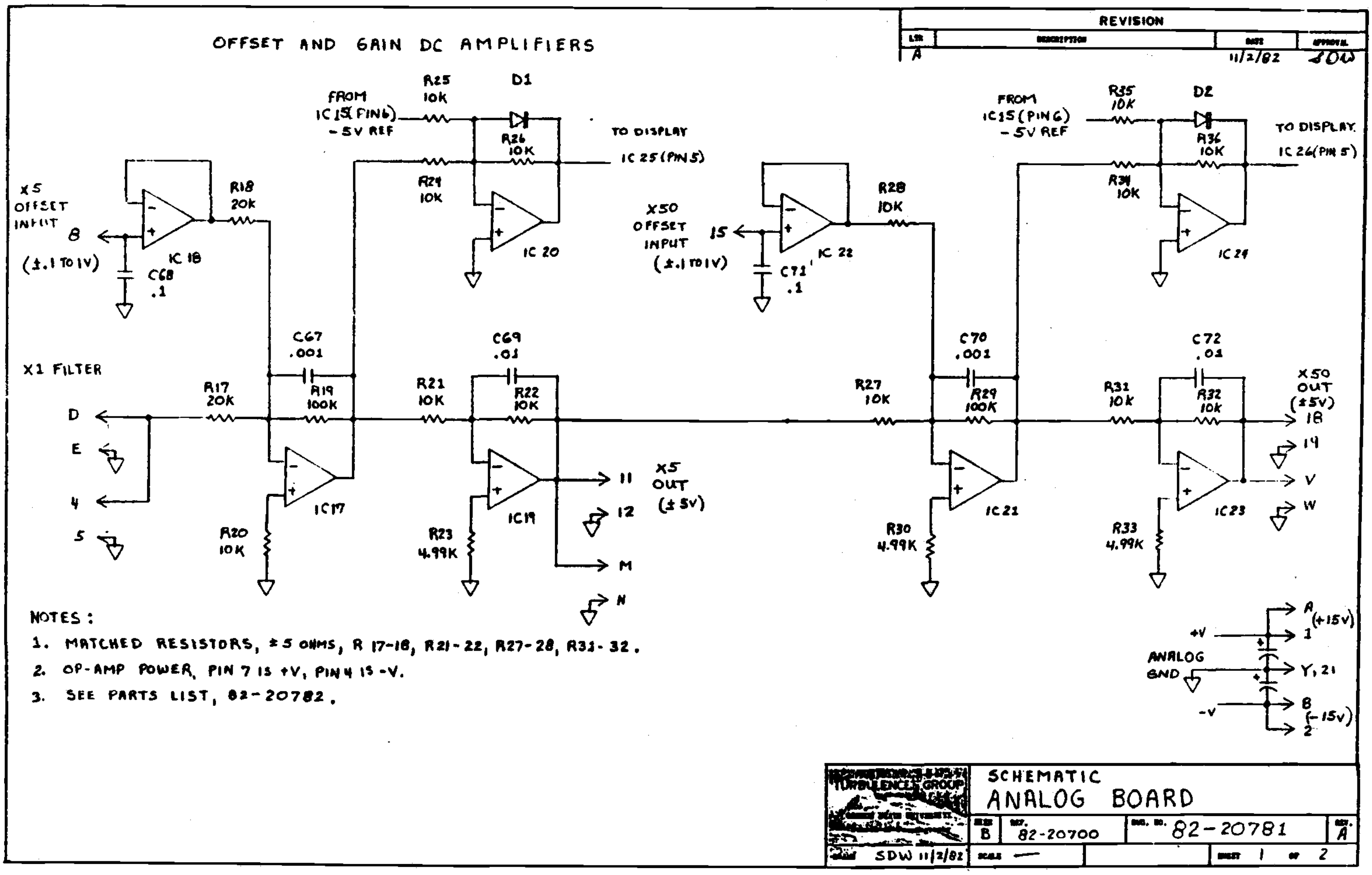


Figure IV-f-8. Schematic: analog board - gain and offset (dwg no. 82-20781/2).

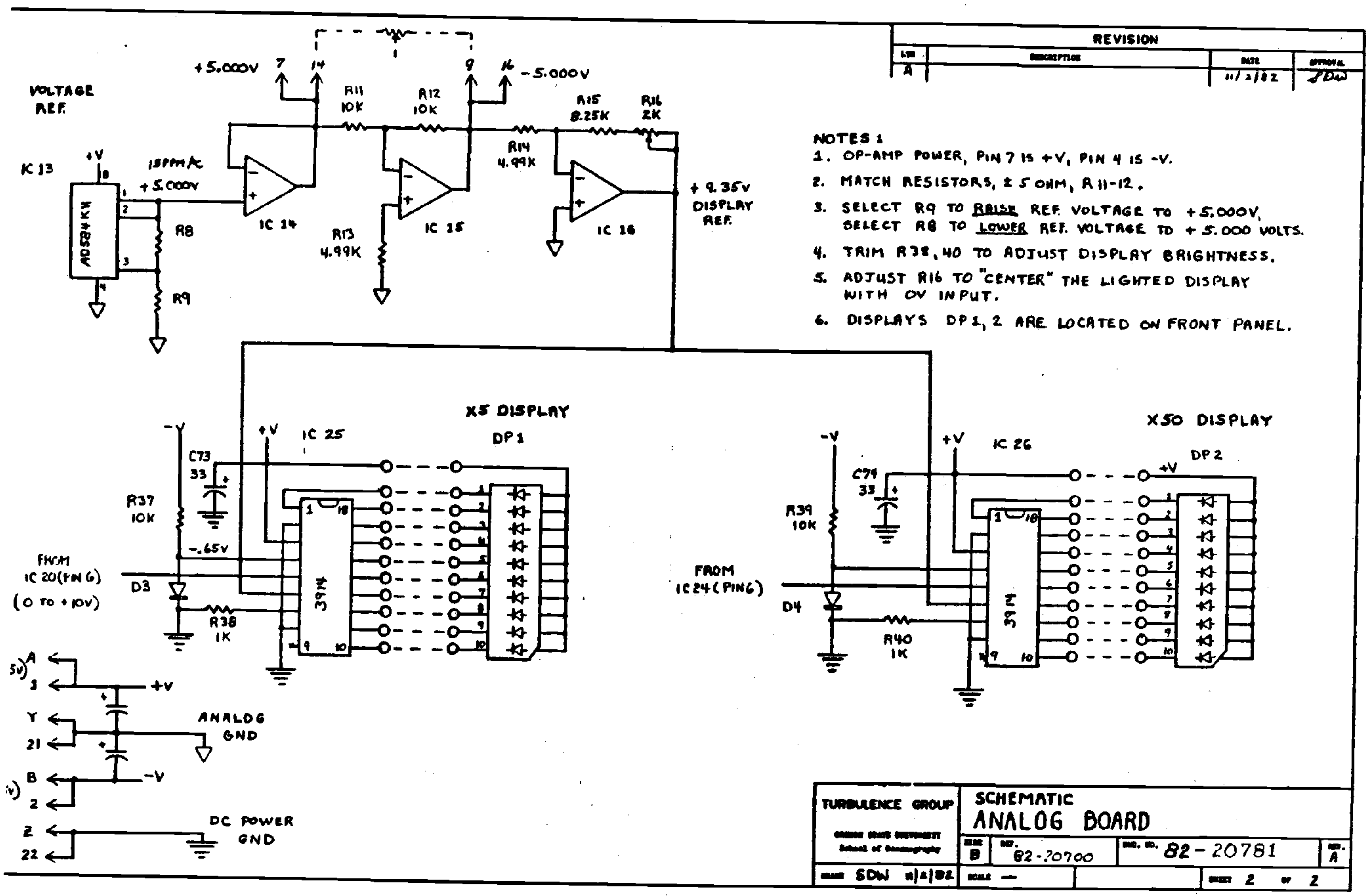


Figure IV-f-9. Schematic: analog board - front panel display
(dwg no. 82-20781/1).

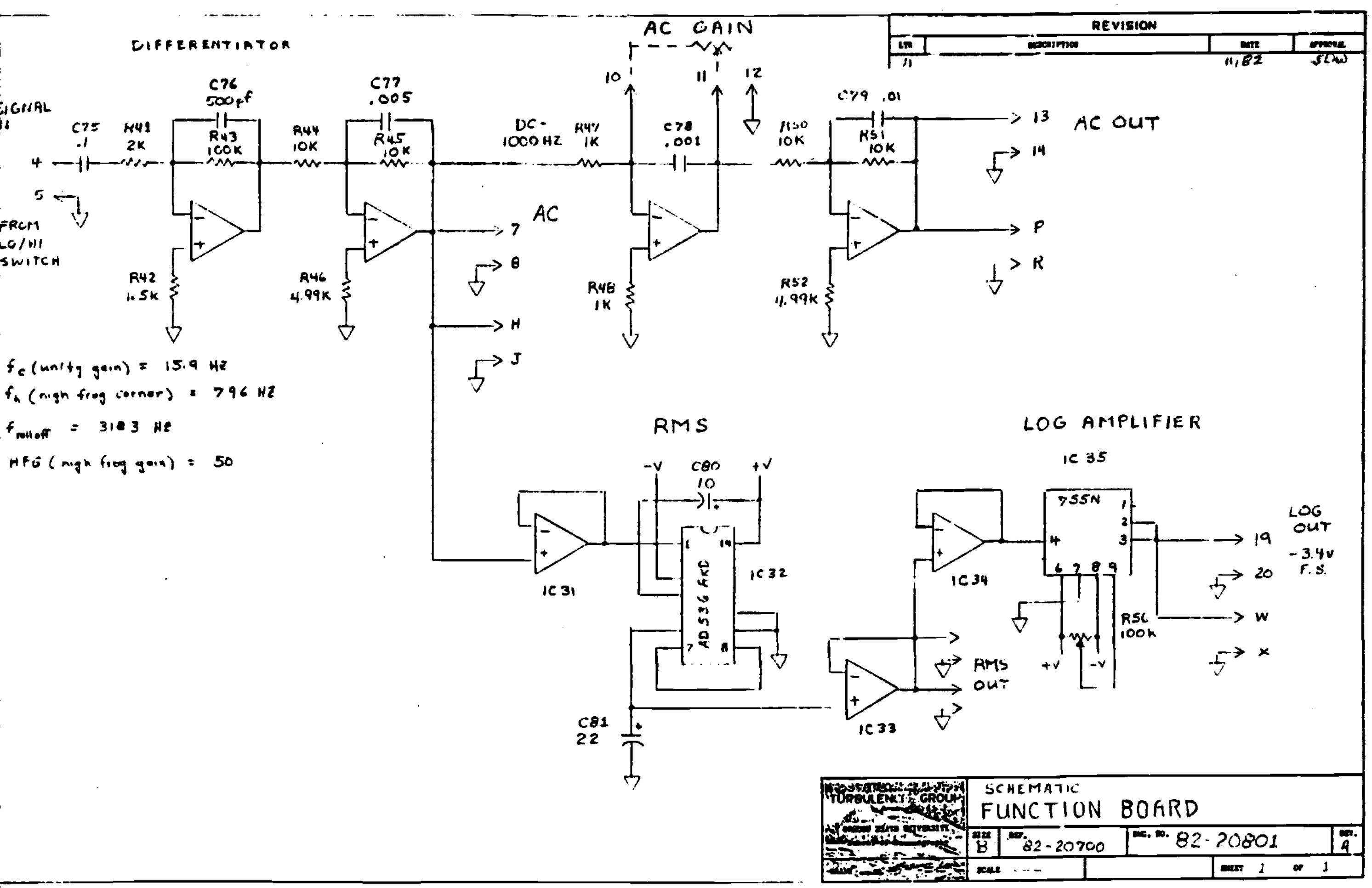


Figure IV-f-10. Schematic: function board (dwg no. 82-20801).

V. The analog to digital system

a) Hardware

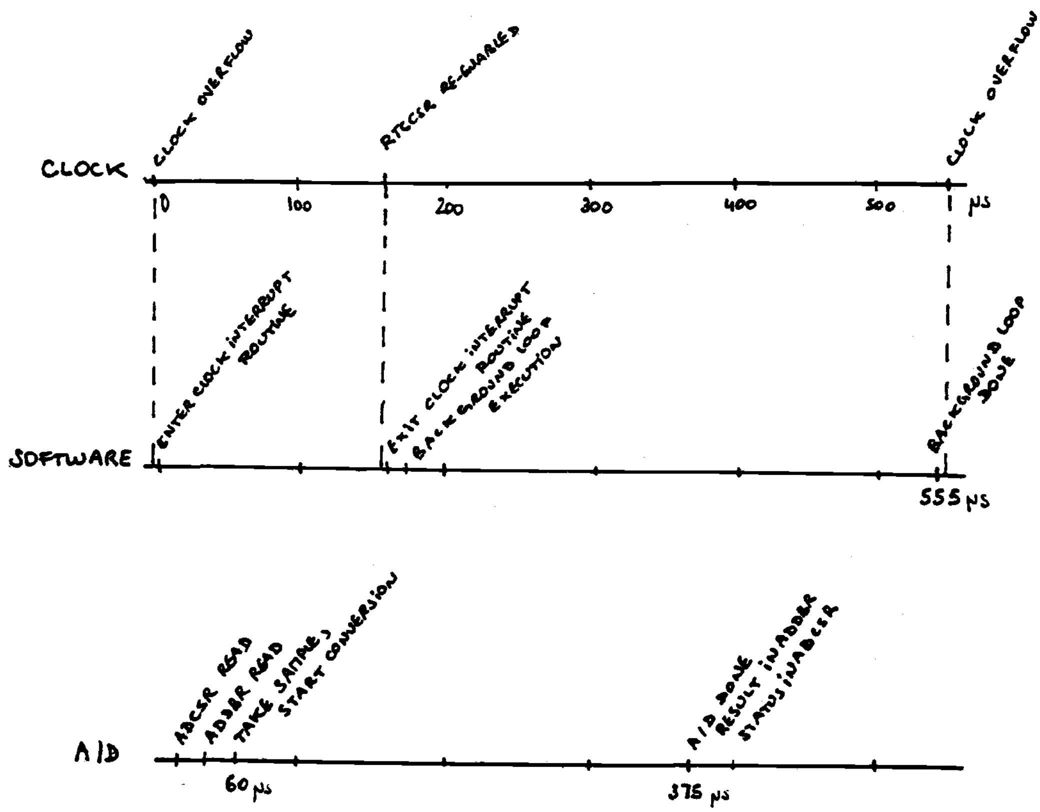
The data acquisition system was based on an LSI 11/23 microprocessor, with a 16-bit data word. To meet the resolution requirement, we use a 16 bit analog to digital converter, with a theoretical static resolution of one part in sixty five thousand. We chose the DATA TRANSLATION DT 2762/5716-SE-B-PGH, with programmable gain and 16 single ended inputs. Even though fewer signals were recorded for any configuration, 16 permanent hardware inputs allow us to operate all our sampling scheme changes in software. High resolution is counterbalanced by slow conversion speed, and care had to be taken to maintain a high throughput rate. A DATA TRANSLATION DT 2769 Real Time Clock was used to generate the sampling interrupts. It was modified to increase its interrupt priority level. The data were written in 800 bpi NRZI to a 7 track magnetic tape, in 'core-dump' mode, 4 tape characters per 16 bit word. We used a CIPHER 80X tape transport with a DILOG DQ120 controller. A DATA TRANSLATION DT 2766 12 bits 4 channels D/A was used to monitor the digitized signal, mainly during development of the software.

LOGIC:
The hardware is controlled directly by the data acquisition program, loaded in resident memory. The RT-11 operating system is bypassed. The sampling rate and number of channels are software selectable. The configuration chosen was 15 channels at 90Hz, that is a 1350 Hz (741 microseconds) throughput rate for the program and A/D. The maximum throughput rate of the software is about 555 microseconds (Figure V-a-1). With a Nyquist frequency of 45 Hz, all harmonics of 60Hz, the line frequency, are aliased to 30Hz, making data processing easier. The 16 hardware channels are scanned following a software-selected configuration, depending on the sensors used. The 4 channels of the D/A are selected at run time.

The sequence of events for one sample is sketched in Figure V-a-1. The clock is set to overflow when a sample is to be taken. The clock status is checked repeatedly by the program. If overflow is detected, the converted value held in the A/D data buffer is read and the next sample is taken immediately (i.e. the sample and hold circuit of the A/D is switched to hold on the next channel).

DATA ACQUISITION PROGRAM

TIMED SEQUENCE OF EVENTS



CSR : control and status register

DBR : data buffer

RTC : real time clock

Figure V-a-1. Timing diagram for the data acquisition system.

b) The data acquisition program

The data acquisition program was written by Bob Eifrig in the C programming language. It uses the 16-bit A/D board and will write data on either magnetic tape or floppy disk. It is designed to be easy to use and to make log-keeping during data acquisition simple and reliable. These goals are met by requiring the operator to select one of three predetermined "formats" and to enter the external parameters such as gains and offsets from the keyboard. A gain of 2 on the A/D board (voltage range of +5 to -5 V) and a scan rate of 90 Hz are set as default values. All parameters are recorded in the "header" column of the tape or disk file. The scan rate and channel assignments of the four D/A's are selected by the commands SETUP or MODIFY. The option to enter all parameters from the key board is retained but was not used during FRONTS 82.

Data are recorded as 16-bit integers. A scan consists of a header channel and fifteen data channels. The header word in each scan is written during overhead time between samples so that the time between the last data word of one scan and the first of the next is the same as between consecutive words within a scan. 2048 integer words (128 scans) are written to a tape record.

The cabling is identical for all of the formats, only the desired inputs are sampled. Fourteen of the fifteen input connectors are used. Fifteen data channels plus the header channel are recorded. The input connectors are assumed to be cabled as follows:

```
INPUT #  1.....RSVP  T1 x 1
INPUT #  2.....RSVP  T1 x 5
INPUT #  3.....RSVP  T2 x 1
INPUT #  4.....RSVP  T2 x 5
INPUT #  5.....RSVP  C x 1
INPUT #  6.....RSVP  C x 5
INPUT #  7.....RSVP  dC/dt x (onboard amplifier gain)
INPUT #  8.....RSVP  pressure
INPUT #  9.....CHAIN T x 1
INPUT # 10.....CHAIN T x 5
INPUT # 11.....CHAIN dT/dt x (onboard amplifier gain)
INPUT # 12.....CHAIN C x 1 x (onboard amplifier gain)
INPUT # 13.....CHAIN dC/dt x (onboard amplifier gain)
INPUT # 14.....CHAIN pressure
INPUT # 15.....SHORT
```

CONFIGURATIONS:
There are four choices of configuration, the three predetermined formats and the general configuration. Each is identified by a number which is recorded in the header column of the data file. The configurations and their identification numbers are:

1. GENERAL: Number of channels, A/D board gains and channel assignments are set at run time. No questions about external parameters are asked.

2. RSVP with Neil Brown conductivity:
The following inputs are recorded. The program asks for the external parameters listed in parenthesis.

a) RSVP temperature channel 1:	x 1 x 5 (OFFSET)
b) RSVP temperature channel 2:	x 1 x 5 (OFFSET)
c) RSVP conductivity	x 1 x 5 (OFFSET)
d) RSVP pressure	
e) CHAIN microconductivity	x 1 dC/dt (GAIN)
f) CHAIN temperature	x 1 x 5 (OFFSET)
g) CHAIN pressure (Paulson)	

Data file configuration:

data channel	input connector	name
1	1	RSVP T1 x 1
2	2	RSVP T1 x 5
3	3	RSVP T2 x 1
4	4	RSVP T2 x 5
5	5	RSVP C x 1
6	6	RSVP C x 5
7	8	RSVP pressure
8	13	CHAIN dC/dt
9	14	CHAIN pressure
10	13	CHAIN dC/dt
11	9	CHAIN T x 1
12	10	CHAIN T x 5
13	12	CHAIN C x 1
14	13	CHAIN dC/dt
15	13	CHAIN dC/dT

3. CHAIN microconductivity:

The following inputs are recorded. The program asks for the external parameters listed in parenthesis.

a) CHAIN microconductivity
- x 1
- dC/dt (GAIN)

b) CHAIN temperature
- x 1
- x 5 (OFFSET)
- dT/dt (GAIN)

c) CHAIN pressure (Paulson)

Data file configuration:

data channel	input connector	name
1	9	CHAIN T x 1
2	10	CHAIN T x 5
3	13	CHAIN dC/dt
4	13	CHAIN dC/dt
5	12	CHAIN C x 1
6	13	CHAIN dC/dt
7	13	CHAIN dC/dt
8	13	CHAIN dC/dt
9	14	CHAIN pressure
10	13	CHAIN dC/dt
11	11	CHAIN dT/dt
12	13	CHAIN dC/dt
13	13	CHAIN dC/dt
14	13	CHAIN dC/dt
15	13	CHAIN dC/dT

\# 4. RSVP with microconductivity:
The following inputs are recorded. The program asks for the external parameters listed in parenthesis.

a) RSVP temperature channel 1:	x 1
	x 5 (OFFSET)
b) RSVP temperature channel 2:	x 5 (OFFSET)
c) RSVP conductivity	x 1
	dC/dt (GAIN)
d) RSVP pressure	

Data file configuration:

data channel	input connector	name	
1	1	RSVP	T1 x 1
2	2	RSVP	T1 x 5
3	7	RSVP	dC/dT
4	7	RSVP	dC/dT
5	5	RSVP	C x 1
6	7	RSVP	dC/dT
7	7	RSVP	dC/dT
8	7	RSVP	dC/dt
9	8	RSVP	pressure
10	7	RSVP	dC/dt
11	4	RSVP	T2 x 5
12	7	RSVP	dC/dT
13	7	RSVP	dC/dT
14	7	RSVP	dC/dt
15	7	RSVP	dC/dT

RUNNING THE PROGRAM:
The data acquisition program is run on an LSI 11/23 equipped with a video terminal and printer. The operator enters commands and parameters from the video terminal (the console device); a log is kept on the printer. The RT-11 assignment command can be used to run the program from the printing device.

Three types of questions are asked by the program:

a)"COMMAND (list)" type: The answer is the first letter of the desired command. The list includes all available commands.

b)"Default" type: The question includes a value for the answer. Hit [RETURN] to keep the displayed value. Enter the desired value and [RETURN] to change.

c)"YES/NO" type: In response to anything except a yes or no the program will repeat the question.

To return to command mode while being asked a question type [ESC] then [RETURN]. To abort recording, printing or scrolling and return to command mode just type [ESC].

COMMANDS:

FORWARD (F):	The tape proceeds forward until the next EOF is reached. The tape is positioned at the beginning of the next file ready to read or write data. Control is returned to the operator's console only after the operation is complete.
BACKWARD (B):	The tape moves backward until an EOF is encountered. If the tape had been at the beginning of a file, BACKWARD will move it to the beginning of the previous file. Control is returned to the console only after the operation has been completed.
REWIND (R):	Rewinds to beginning of tape at fast speed. Control is returned immediately so that non-tape operations can be carried out.
OFFLINE (O):	Takes tape drive off line.
WRITEEOF (W):	Writes EOF on tape and positions tape for next file.
VERIFYTIME (V):	Displays time currently in memory in a "default" type question so it can either be checked or set.
QUIT (Q):	Leaves the program and returns control to the operating system (RT-11). Do not use if running from a bootable tape.
PRINTERLOG (P):	Acts as a toggle switch for the printer. If the printer and the console are the same device the PRINTERLOG switch should be off.
SETUP (S):	Selects a setup configuration (GENERAL, NEIL BROWN RSVP, CHAIN MICROCONDUCTIVITY, MICROCONDUCTIVITY RSVP) and asks for external parameters, scans per seconds and D/A assignments. Except for general, specifying a setup configuration automatically specifies the assignment of tape channels to input connectors, and determines the questions to be asked about external parameters. After entering the "S" command, the operator is asked for choice of setup. This is a command type question to be answered by the first letter of the configuration and

[RETURN]. The program then asks the questions appropriate for this choice. All questions must be answered. If a question is not applicable, the answer must be "9999", not zero. The only exceptions are the "SCANS/SEC" and D/A assignment questions which are of the default type.

MODIFY (M): Modifies parameters within a given set-up configuration. Values previously entered are displayed in a series of default type questions.

LISTPARAMS (L): Lists the current parameters entered by SETUP or MODIFY. "L" does not change values.

HALTINGLIMITS (H): Limits the number of records for recording or playing back data. The limit is in effect only for the first run after "H" is commanded. To limit a series of files "H" must be commanded before each.

ANALOGOUT (A): Plays back previously recorded data through the D/A converters.

TAPERUN (T): Records data on tape using the most recent set-up. "Tape name?" and "Batch?" are of the default type. The batch number is incremented automatically. If PRINTERLOG is toggled ON, the set-up parameters are printed. Answer Yes [RETURN] to begin recording. If PRINTERLOG is ON a startup message is printed.

To stop recording, hit [ESC]. The computer will write the current buffer to the tape, write 2 EOF's and retreat to the first of these EOF's, ready to write the next file. If PRINTERLOG is ON, a message is logged. Control is returned to the console with another "Tape name?" question so that data recording can continue without returning to command mode.

To leave the TAPERUN loop and return to command mode, hit [ESC] and then [RETURN].

DISKRUN (D): Records data on disk using the most recent set-up. Once the program is in memory, both floppy drives can be used for data recording. The file name is of the form DATA REF NAME>. BATCH NUMBER>. Recording starts on the "primary device" (DY0: or DY1:). When the "primary device" is full, recording switches to the other, creating a file with the same name, and so on until [ESC] is hit to stop recording. The operator must change disks as needed.

Before using QUIT the system disk must be replaced or the system will crash.

NOWRITERUN (N): The same as TAPERUN except that the data is not written to tape and the batch number is not incremented. It is used to check the system by means of D/A outputs, for example. Messages are printed if PRINTERLOG is ON.

EXAMINE (E): Examines data previously recorded on tape or disk. The tape must be positioned at the beginning of the desired file before the command is given. "RECORD:1?" is of the default type. Answer 0 to begin at the current record. Answer "Read from tape?" with "No" to read from disk. "SCAN:1?" is of default type and may be used to select starting scan.

EXAMINE will read an entire file and then stop. To abort, hit [ESC]. The tape will now be positioned in the middle of a file and a "B" or "F" is required to get to the beginning of a file.

The parameter values in effect are not changed by EXAMINE.

EXAMINE displays on the "operator's console". To obtain a permanent record control must be changed to the printer using the RT-11 assign command before running the program. PRINTERLOG must be toggled off to run from a printing device.

CHECKTAPE (C): Summarizes the files on a tape and the header information in each file. Before starting, the tape must be positioned at the beginning of the desired file. Checking continues until EOI is reached. The tape is positioned at the first of the two EOF's that constitute the EOI.

Because it leaves the tape in position to begin writing the next file, CHECKTAPE can be used to reposition the tape for the resumption of data acquisition.

GENBOOT (G): Creates a bootable tape of the program. A blank, write-enabled tape must be ready at the load point and the tape drive must be on-line before this command is used.

To use a tape created by GENBOOT, use the following ODT commands, entered from the console:

772522/10000	resets CSR of tape controller
772524/177777	
772522/60011	tape spaces forward one record
772522/60003	tape spaces forward one record
$S/350 [CR]	load PSW with 350
R7/0 [CR]	load PC7 with 0
P [CR]	starts system

This will boot the system from the tape and enter the command mode of the program. The program tape can then be rewound and removed, and a data tape mounted. All commands are effective except QUIT which will crash the system.

HEADER FORMAT:
One header word is written at the beginning of each scan. These provide a description of the instrument used, the gains and offsets (external parameters) as well as the tape name, run and batch number, date and time recorded, inputs sampled, scan rate and other internal parameters of the data acquisition program. All values are biased by 10,000. to prevent zero or negative values.

SCAN NUMBER	HEADER (Number on tape - 10,000)
1.	Number of data channels (0 - 15)
2.	Record number (1, 2, 3,...)
3.	Seconds (0 - 59)
4.	Hours x 100 + minutes (0 - 2359)
5.	Month x 100 + day (101 - 1231)
6.	Year x 100 + program version number
7.	Batch number (position of file on tape)
8.	Run number (number of file from entering data acquisition loop ie. TAPERUN or DISKRUN)
9.	Clock rate: 1 => 1MHz, 2 => 100KHz, 3 => 10KHz,...
10.	Scans per second
11. - 25.	Input connectors for each channel
26. - 40.	Gain for each channel
41. - 44.	Channel number for four D/A outputs
45.	Set-up identification 1 => General 2 => RSVP with NBIS conductivity 3 => CHAIN microconductivity 4 => RSVP with microconductivity
46. - 53.	Data set name (Tape name or disk file name) (1 7-bit ASCII character per word)
54.	RSVP unit number
55.	RSVP first thermistor module number
56.	RSVP second thermistor module number
57.	RSVP conductivity module number
58.	RSVP pressure module number
59.	RSVP voltage regulator module number
60.	RSVP DC/DC power module
61.	RSVP thermistor number
62.	RSVP conductivity sensor number
63.	CHAIN unit number
64.	CHAIN thermistor module number
65.	CHAIN conductivity module number
66.	CHAIN DC/DC power module
67.	CHAIN thermistor number
68.	CHAIN conductivity sensor number
69. - 83.	Offset or gain for each channel (zero if not specified)
84. - 128.	Integers 84 to 128 respectively

VI. Processing the data

The data must be read from the tape, calibrated, manipulated and presented in such a way that they can be used and understood. We use an LSI 11/23 based microcomputer to collect and to analyse the RSVP data. The programs used are written in Fortran. Each program reads the output of the previous stage, acts on the data and writes to disk. All output files are in the same format so that actually (but not logically) the programs, except for the one that reads the magnetic tape, can be run in any order. This allows considerable flexibility in data analysis and will allow easy modification of the analysis process as changes are made to the instrumentation. For instance, we expect that the amount of filtering required will be less as changes now being planned (section VII) are incorporated. Use of command files make it possible to run the entire analysis with one or two commands from the keyboard.

We have recorded the data on magnetic tape on a seven track tape transport so that the first step is to read and unpack the 16 bit words. Channels to be analysed are selected and calibrated. The standard selection for FRONTS 82 is temperature (x1 and x5), conductivity (x1 and for Neil Brown equipped units x5) and depth (pressure). The program reads the tape name, conductivity type, gains, offsets and other required parameters from the header words on the tape. The operator selects only the name of the output file, the tape files to process, the depth range and the name of a file of weights to be used to filter the depth series. The filter used is a triangular running filter, the usual length is nine points (0.1s or from 20 - 40 cm). Longer filters are used if the depth record is noisy because of the voltage regulator oscillation (section VII-a) or the absence of analog filtering (section VII-f). Calibration coefficients are read from a data file and applied to the data. The calibrated data is then written to a disk to await further processing. At this point there has been no averaging and only the depth record has been smoothed.

The unaveraged series are next treated to remove "spikes" inserted by the digitizer (section VII-g). A scheme to identify spikes in terms of the difference between successive points is used and points identified as spikes are replaced by interpolation. This scheme is only successful if real differences between successive points are less than the criteria selected and if the spikes in question are isolated points.

At this point there is a difference between the treatment of the Neil Brown and microconductivity data. At the probe descent rates (200 - 400 cm/s) used on FRONTS 82 the spatial response of the Neil Brown conductivity cell and the thermistor is comparable. No correction is needed to calculate salinity, and then density from the calibrated conductivity and temperature. The Michael Head microconductivity sensor is much faster. Large spikes are calculated in the salinity each time the probe passes through a sharp temperature gradient. We are attempting to use the microconductivity data to better understand the thermistor response so that the temperature can be corrected carefully before computation of the salinity. At present we are using a much simpler and not totally satisfactory correction. Examination of salinity plots indicates that for a drop speed of about 300 cm/s and sensor placement as on the current instrument a lag of the temperature by 3.5 samples (about 0.03s) reduces the spiking. This correction compensates for the vertical displacement of the two sensors and partially for the relative slowness of the thermistor. It is certainly not ideal and much work remains to be done. It does allow the calculation of salinity and density profiles that are useful except possibly at the smallest scales.

The series have still not been averaged or smoothed in any way. Spikes have been removed and the temperature series has been modified if it is to be used with microconductivity to calculate salinity. The temperature and conductivity series are next filtered to remove noise above 20 Hz. A five point weighted mean (1-3-4-3-1) is used. Sampling at 90 Hz, 60 Hz noise is aliased to 30 Hz so that the filter is designed to remove this frequency completely.

Five-centimeter averages of the data are computed next. At the descent rates used on FRONTS 82 this means a 1 or 2 point average near the surface (descent rate of about 400 cm/s) increasing to 4 or more as the instrument slows.

Salinity is calculated from the five-centimeter averaged temperature, conductivity and depth series. A polynomial fitted to 660 points generated with the conductivity equation of Accerboni and Mosetti (1967) with the pressure corrections of Bradshaw and Schleicher (1965) is used for this calculation. The standard error of this fit is 1.7 parts per million. The program used to calculate salinity includes the options of calculating potential temperature (Bryden,1973), density, sigma t, buoyancy frequency (using the UNESCO high-pressure equation of state, Millero, Chen, Bradshaw and Schleicher,1980) and the arc tangent of the stability ratio (Ruddick,1981). Density or sigma t and the buoyancy frequency are routinely calculated.

The five-centimeter averages of temperature, salinity, and density form the basic data set which is used in further analysis.

An abbreviated procedure may be used to generate series for plotting. Spike removal and filtering are omitted and an averaging interval of 20 cm is used. Temperature to be used with microconductivity must still be modified to prevent spiking in the calculated salinity. The plots in section III were generated in this manner.

VII. Equipment and software performance

Many of the problems encountered on FRONTS 82 were developmental. Some of the variations tried clearly worked better than others, some circuits require modification to work well in the complete system and some combinations interacted badly. Other problems arose from our lack of experience with this instrument system and with the 16 bit analog to digital converter. For the most part the system functioned well and choices for the final design are being made on the basis of ease of operation and manufacture or for the better of two acceptable alternatives.

a) Electronics

After the cruise each of the overboard electronics units was bench tested extensively and data from each was analysed to determine noise levels and to identify the problem areas. Several problems have been identified and are being corrected.

1) Module connection failure

The most damaging problem was the failure of the module hold-down system. Shrinkfit bands used to secure the modules swelled with exposure to oil allowing modules to unplug. Difficulty in opening the case made breakage likely whenever the probe was opened and thus compounded the problem. The modules were sucessfully, if messily, held in place by a combination of Scotch 810 Magic Tape and lacing twine. The modular concept has been required in the design and development stage. In the future the basic RSVP circuitry will be mounted on a single board. Modules required for specialized applications or for further development will be attached to a motherboard with a screw down system. The change to single board construction will also make it easier for less skilled personnel to build the system and reduce construction time.

2) DC to DC power interaction with the voltage regulator

Higher noise levels were found on units 2 and 3, both of which were powered from the surface through DC to DC converters. Post-cruise bench tests show that an interaction between the DC to DC converter and the voltage regulator resulted in a 500 - 600 mV peak-to-peak complex triangular waveform at 1.5 kHz on the output of the voltage regulator. This resulted in a 30 - 40 mV peak-to-peak noise on the temperature output and for unit 3 on the direct-current pressure output as well. Capacitors added to the voltage regulator input lines have corrected this problem. These capacitors are included in the schematic (Figure IV-a-10).

3) Sensor wiring cross talk

Unshielded wires through the nose cone were used to connect the sensors and the electronics. The conductivity sensor is driven at a frequency of 3 kHz. This frequency is picked up by the temperature and adds a 6-8 mV peak-to-peak noise to the temperature channels. Shielded cable, made as short as possible, will be used in the future. The distance between the sensors and the input ampilfiers will be reduced by moving the DC to DC converter module to the top of the unit. This will also prevent the power wires from the surface from extending down the length of the electronics, a possible source of additional noise.

Routine difficulties:

The difficulty in opening the units resulted in breakage of several kinds: module failure, bent pins on modules, broken wires on modules and motherboard, broken wires on the instrument connector. These problems have been solved by several modifications which make it possible to open the instrument without struggle.

Wiring mistakes and bad solder joints occurred when sensors were replaced. The oil coating over the instrument makes it difficult to handle and careful cleaning with freon is required before soldering. Increased protection of the sensors will result in less damage and make sensor replacement even less frequent than on FRONTS 82 where only one thermistor and one microconductivity sensor were replaced.

The lids of the DC/DC power chips came off, probably as a result of cycling from the surface to 240 m, but the units continued to operate exposed to the oil. A shield can be purchased for this chip and as additional protection we plan to cast it in hard epoxy.

There is an 800 kHz, 5 mV peak-to-peak noise on the temperature channels of units with DC/DC power that is not found in battery powered units. Since the temperature signal is filtered at a much lower frequency before recording and since the level is very small, this noise is not significant. We will use power from the surface in the standard RSVP unit. The advantages are that it will be unnecessary to open a unit routinely to change batteries and we will be able to increase the voltage regulator output level thus increasing the output voltage range.

In the past a major problem has been interaction between the oscillators in the conductivity and the frequency-modulated pressure circuitry. This problem has been reduced to the point that it is not evident in the processed data by isolating the conductivity circuit. Beating as the pressure oscillator frequency changes can still be seen on an oscilloscope in the laboratory. Since the DC pressure module worked well and removes any possibility of oscillator beating this pressure circuitry will be used in the future.

Additional changes to the electronics:

1) The conductivity circuit will be changed to take advantage of the availability of single chip differential amplifiers and to include a single chip signal isolation stage. Additional filtering will be done to remove the 6 kHz ripple on the output.

2) The body diameter has been increased to 2.25" to allow for redesign of the electronics packaging.

b) Sensors

The thermistors and the Neil Brown conductivity cells have been used for many years and continue to behave satisfactorily. The mounting system used on this cruise was successful with no leaks developing after many profiles to 240 m. The FP07 thermistors used this time have a faster time constant (and thinner glass over the bead) than the FP14 thermistors used in the past. Only one was broken while in use in the course of the cruise indicating that the faster thermistors can be used. The Michael Head Systems microconductivity probe was tried with one of our instruments for the first time on FRONTS 82. The extremely small size of this sensor may allow us to determine the temperature microstructure from rapidly-falling or towed instruments. For all of the sensors the greatest risk of breakage occurs in handling rather than in use.

Preliminary examination of the data shows that the first microconductivity sensor used provided usable measurements of the salinity and that the differentiated conductivity may be used to determine some of the parameters of the turbulent mixing. This sensor was broken during the cruise and replaced by another, apparently the same. With this sensor the salinity appeared to change abruptly in the course of a profile and surface values from closely spaced profiles varied by several parts per thousand. It has not yet been determined what the difference between the sensors was or how to distinguish between them easily. Pressure tests will be carried out on the newly acquired sensors.

c) Probe mechanical design

Mechanically the RSVP instrument worked well. Better sensor protection and easier opening are the main improvements needed. Some design changes to make the instrument easier to manufacture and assemble are also being made. An increase to a 2.25" body diameter is required to allow for redesign of the electronics package.

Design changes for easier assembly are being made primarily to the instrument termination. The diameter has been increased by 0.25" to increase space for keying and other minor modifications. This will allow lengthening the oil-fill plug so that threads will be engaged until the o-ring is freed. The glued joints in this section have been difficult to assemble and unreliable. Screwed and pinned joints will be used in their place. Polyurethane will be used for the oil-bladder as it is not affected by the freon used to clean the probe. Additional drain holes have been added to increase the speed of filling and draining the oil from the instrument.

The major difficulty with the probe was the force required to open the unit after it had been assembled for long periods. Damage to the electronics occurred almost every time the probe was opened. The o-ring compression has been reduced slightly by deepening the grooves in which they are mounted. A lever-type instrument opener has been built and provisions for its use incorporated into both the redesigned nose cone and body plug.

To prevent even the infrequent damage to sensors that occurred on this cruise the nose cone is being redesigned. If possible the sensors will be enclosed within the nose cone in such a way that water circulation around the sensors is good. At present we are considering mounting all of the sensors into 0.25" stainless tubes and using a standard mount similar to that used with the microconductivity.

d) Cable and termination

Six lines were used during FRONTS 82, four with 16 conductors, two with 10 conductors. Of the 16-conductor lines two apparently failed after 100 drops, one after 400 drops and the other is still good after 120. One of the 10-conductor lines failed electrically after 145 drops, the other snagged on the pulley and tore after 9. These represent worse case estimates of line/termination durability. The line was changed whenever there was any possibility that it was failing.

Lines which have been in salt water under pressure for several hours and wet for days may show faults that do not appear in laboratory tests. The same type lines will be used on the MILDEX experiment of October/November 1983 and additional evaluation of the lines will be made at that time.

The termination procedure will be changed and simplified. The safety line proved to be unnecessary and will not be used. The line termination will be cast in one-piece and be reusable. These changes will make the assembly easier and the one piece construction will prevent any strain between the two pieces.

The line is twisted in the course of each drop. The cause of the twisting is not known. A large number of sharp bends form in the line after 200 drops. This twisting seems to be one of the factors limiting the lifetime of the line.

e) Winch

The changes to the winch system are minor, mostly for ease of operation, construction or maintenance.

The winch is mounted so that it can be turned about a vertical axis. For this cruise the axis passed approximately through the center of mass of the winch system. This made mounting the winch on the ship's rail easier, however a large force from the operator was required to keep the winch correctly aligned. The swivel axis will be moved to the corner between the motor and the spool in the future.

Occasionally the line overruns while free-wheeling out due to the large inertia and low friction of the system combined with the wave-caused motion of the ship. The slack line can snag on any nearby protrusion including the pulley itself. By-passing the pulley during the free-wheeling phase will prevent snagging on it, but does not solve the fundamental over-running problem and fouling on other obstructions can occur. An operator with minimum training can overcome this problem by damping out the line surges with light finger friction on the spool.

The drive train performed as expected with no malfunctions or excessive wear. A minor problem discovered during teardown was compression of the long shaft at the set screw flats, making it difficult to remove the slip rings. Smaller set screw flats and not tightening the set screws so tightly should prevent this problem.

To prevent oil leakage into the motor, oil seals will be added to the clutch mount. The brake mount will be modified to completely cover the bearing mount hole and to include a seal. With this modification the splash shield can be eliminated.

The size of the cable spool is marginal for the amount of cable now used. A larger spool would allow use of longer or thicker cables as well as allowing elimination of the line-restraint plates.

Sealed bearings have been used wherever possible to prevent corrosion but open bearings are used on the long shaft to decrease drag when the cable is free-wheeling. Z RUST, used in the winch box, apparently substantially decreased corrosion of bearing races and gear shoulders below the levels found after the cruise of January 1981.

The data transmission assembly functioned with no difficulties throughout the cruise. To increase the rate at which the slip ring housing can be filled with oil the o-ring of the slip ring rear cap will be moved 0.5" toward the base line. Filling can then be almost accomplished before the slip ring cap is closed. Minor oil leakage was noted in the connector mount area. This can be stopped by adding an oil seal to the short shaft and o-rings to the bearing mount and short shaft spacer.

The deck-cable connector was disconnected at the end of each working period. Pins were occasionally bent when the cable was reconnected. One connector had to be replaced due to an intermittent open condition in one conductor. The present connector will be replaced by a screw-on type requiring redesign of the connector mount, connector bracket and plug.

It was discovered that, if forced, the data link connector can be mated 180 degrees out of phase. The spool connector housing must be completely seated in the retainer, engaging the connector keys prior to the o-ring, so that the feel of keying is obvious.

The top of the winch frame was designed to serve as the bottom of the electrical box. To facilitate assembly and maintenance a separate electrical box bottom will be used in the future. An oil seal should be added to the motor mount to prevent oil accumulation in the motor and fouling of the brushes.

All aluminum parts must be heavily anodized to prevent corrosion.

f) On-board analog electronics

There were no problems with the dual amplifier modules during the cruise. The older amplifiers such as that used for one of the redundant temperature channels are less convenient and are being phased out. The amplified temperature signal from the old amplifier contains bursts of 60 Hz noise presumably radiated by some equipment aboard ship. This noise, if present at all, is much smaller on the other temperature channel, within the noise level of the instrument.

Some problems in data analysis were created by choices made in setting up the on-board electronics. For FRONTS 82 the x1 and x5 output of the two temperature and the conductivity channels were digitized and recorded. The overboard gain in the conductivity and temperature circuits was too high for the x5 output to remain on scale throughout a profile in the southern region where surface water was warm. A gain of four would have enabled the operator to offset the temperature signal once for a working period and be assured that the signal would remain within the proper range. The overboard voltage range will be increased on the new model and the onboard gains adjusted accordingly.

Direct current signals were intended to be filtered at 40 Hz before digitizing. During the FRONTS 82 cruise the unfiltered x1 temperature output through the old amplifier was used instead of the x1 filtered. The DC pressure output was also recorded unfiltered. As a result the pressure signal required heavy digital filtering before use.

g) Analog to digital system

A/D CONVERTER:
The theoretical resolution of a 16 bit board is one part in sixty five thousand, called a least significant bit (lsb). In all situations, we found that, intermittently, for any analog input the occurences of samples around the mean were not normally distributed. For a signal with a mean of digital value n, the digitization noise rms was 1 to 2 lsb, but the distribution of samples around the mean had relative peaks away from n, at n+4, n+8, n-4, n-8, or similar values. In some cases, such peaks would be as far away from the mean as n+16, n+32, increasing the digitization rms noise level to 5 lsb. The spectrum of this noise is flat to 675 Hz. The recorded signal exhibits spikes of magnitude 4, 8, 16, 32 lsb. Easily recognizable when looking at the difference between consecutive samples, these spikes are removed during processing (section VI).

The intermittency of the phenomenon makes it difficult to diagnose. After trying all hardware combinations and different softwares, we believe the noise source is the A/D board or the computer backplane. These two possibilities will be investigated as more hardware becomes available.

Changes to the digital system will include:

D/A CONVERTER:
To examine the variations of the digitized signal in real time, the D/A will be programmed to display the 12 lsb of the difference between two consecutive samples if required.

MICROPROCESSOR BACKPLANE:
The PLESSEY backplane used was bulky and badly ventilated. It will be replaced by a smaller backplane. The ideal replacement would have a mechanical attachment of the boards.

TAPE TRANSPORT:
The CIPHER 80X tape transport performed well but was damaged on the way back to OSU. Despite manufacturer's attempts to repair it, only 'core-dump' mode is usable. It will be replaced by a 9-track drive, to minimize the amount of tape required.

DATA ACQUISITION PROGRAM CHANGES:
The data acquisition program caused no problem. Improvements under way are:

Replacement of ESCape by H as a control character to exit the recording loop, making it impossible to exit accidentally by leaving the finger on the key.

Implementation of a display subroutine to examine the recorded data between drops.

Display on the D/A of the 12 lsb of the difference between two consecutive samples for detection of digitization spikes.

Write-up of a complete description of the steps necessary to change or create a set-up in the field.

VIII. References

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