FINAL REPORT

BONAPARTE GULF, NORTHERN COAST OF AUSTRALIA

O.P. 2 and O.P. 83

HYLAND
MARINE SEISMIC SURVEY

for

AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

by

WESTERN GEOPHYSICAL COMPANY OF AMERICA
MARINE PARTY 87

AUGUST - OCTOBER 1967.

WESTERN GEOPHYSICAL

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ABSTRACT

Western Geophysical Company of America conducted a reflection seismograph survey for the Australian Aquitaine Petroleum Proprietory Limited in the Joseph Bonaparte Gulf, offshore Northern Territory, Australia. Digital recording techniques were used to record reflection data, using a two-boat system, conventional explosives charges, and three separate detector cable configurations. Operations began on 20th August, 1967, and were completed 6th October 1967. Electronic positioning control was provided by Compagnie Generale de Geophysique using the TORAN SYSTEM. Marine Geophysical International, Inc., provided ARCER service in conjunction with the conventional seismic survey. The base of operations for the entire survey was Darwin, Northern Territory.

I. GENERAL INFORMATION

A. Location of Area.

A reflection seismic survey was conducted by Western Geophysical Company of America, Party 87, in the offshore Northern Territory, Australia area of the Joseph Bonaparte Gulf. This area was bounded by Longitudes 129° and 130° East, and by Latitudes 11° and 15° South and included permits O.P. 2 and O.P. 83. The survey was situated in close proximity to the Australian Mainland in shallow sea area with water depth increasing to the north and west.

B. Base of Operations.

The base of operations for the duration of the survey was Darwin, Northern Territory. This is the only seaport in the area, and although isolated, provided a fair source of supply. Harbour facilities though crowded were adequate.

C. Chronology.

20th August:	Underway to Hyland survey.
21st August:	Operations Underway.
26th August:	Shooting suspended.
29th August:	Boats sailed for Darwin to effect repairs and change cable from 7644' to 5344' configuration.
2nd September:	Resumed operations with 5344' streamer cable.
7th September:	Suspended shooting due to heavy seas.
9th September:	Resumed shooting.
19th September:	Boats sailed for Darwin to change cable from 5344' deep running to 1200 meter floating.
25th September:	Start shooting with 1200 meter cable.
6th October:	Completed operations.

D. Contractors.

The survey was conducted by Western Geophysical Company of America, 933 North La Brea Avenue, Los Angeles, California U.S.A. Navigation and shotpoint location services were provided by

Compagnie Generale de Geophysique, Paris, France. Marine Geophysical International, Inc., provided ARCER services. ARCER sections and an operations report is submitted as a separate report.

E. Operational Remarks.

1. Surveying Technique.

TORAN SYSTEM navigation and shotpoint location was provided by Compagnie Generale de Geophysique. For full station descriptions and techniques see "TORAN" final report. A qualified celestial navigator was aboard the vessels at all times to position them for TORAN calibration.

2. Weather.

During the entire survey the weather was relatively calm with the exception of two days during which operations had to be suspended due to very heavy seas.

II. OPERATING PROCEDURE AND TECHNIQUE

A. Major Boat Equipment.

1. Recording Boat: M/V Western Geophysical I - a 112 foot steel hulled twin-screw vessel of American registry, powered by two general motors V12 marine diesel engines; capable of 10 knots cruising speed, and fitted with R.C.A. radar with a range of 32 miles, ship-shore 150 watt R.C.A. radio and two Bendix DR-25A depth sounders with a range of 200 fathoms.

2. Shooting Boat: M/V F.B. Walker - a 96 foot steel hulled twin-screw vessel of American registry, powered by two general motors 6/110 marine deisel engines; capable of 10 knots cruising speed, and fitted with Decca 202 radar with a range of 24 miles, ship-shore 150 watt R.C.A. radio and a Bendix DR-25A depth sounder with a range of 200 fathoms.

3. Shooting Boat: M/V Nelma - a 74 foot steel hulled single-screw vessel of Australian Registry powered by one Perkins marine diesel engine; capable of 10 knots cruising speed, and fitted with a 60 watt ship-shore radio and a depth sounder. This vessel was used as an alternate shooting boat due to the large quantities of explosives used and the great distance involved between the supply point and shooting area.

B. Instrumentation.

1. Digital: Redcor 210, 9 track digital recorder equipped with 24 binary gain amplifiers designed to record on ½ inch gapless I.B.M. compatible format. Also equipped with 8 special water break amplifiers and digital to analog converter. Filter used - 8-64 cps pass band. (see appendix number 1 and 2).

2. Analog:
   a) Amplifiers - 24 channel Western FA-50-high gain.
   b) Tape Transport - Western Techno AM-dual drum.
   c) Filters - 10.5-48 cps, 2 section.
   d) Playbacks - For field sections - 70mm VA film corrected for normal move-out.

C. Detector Cables. (See Plates II, III, and IV).

1. 7644' Streamer Cable: A neutrally buoyant oil-filled streamer cable equipped with 4 depth detectors was used. The cable was balanced to maintain a constant depth while under tow.

2. 5344' Streamer Cable: This cable was the same as the 7644' cable with the exception that 100 feet of dead section was removed between groups resulting in the centers of groups 1 and 24 being 5244' apart.

3. 1200 meter floating cable: This cable was equipped with 24 seismometer groups of 4 seismometers per group, with a constant spacing of 41' between seismometers, allowing recordings of 600-600 meters.

D. Recording Technique.

The two-boat suspended charge method was used throughout the reflection survey.

1. 7644' Streamer Cable: During operations with this cable, the shooting boat cruised parallel to the detector cable, offset approximately 250 feet from a buoy towed 250 feet from the end of the cable. When on shotpoint, the shooting boat released the charge which was suspended 3-5 feet below the surface. The charge was then detonated from the recording boat by a radio "sync-fire" system. Shot spacing was 200 meters providing subsurface coverage of 600%.

2. <u>5344' Streamer Cable:</u> During operations with this cable, the shooting boat cruised parallel to the detector cable at the center and offset approximately 250 feet. Firing of the charge was done as with the 7644' cable. Shot spacing was 833 meters giving subsurface coverage of 100%. Shooting of one line was at 137 meter shot spacing providing 600% subsurface coverage.

3. <u>1200 Meter Cable:</u> During operations with this cable, the shooting boat cruised parallel to the center of the detector cable, offset approximately 250 feet, giving 600-600 coverage. When the cable was towed into position, the recording boat backed down to minimize cable noise and the shooting boat released the charge which was suspended 3-5 feet below the surface, depending on charge size. The charge was then detonated electronically by the recording boat. Shot spacing was 600 meters providing subsurface coverage of 100%. As operations were in relatively shallow water, shooting was suspended at times waiting for favourable tides.

E. Surveying.

The TORAN system, supplied by Compagnie Generale de Geophysique was employed.

III. DATA PROCESSING

A. Field.

Dynamically corrected, variable area 70mm film sections were made when using the 5344' and 1600 meter cables. Monitor records were taken direct from the read-after-write feature of the Redcor 210.

B. Processing.

All digital tapes were processed by Western's Shreveport, U.S.A. Digital Center.

C. Final Interpretation.

All final interpretations were made by the client.

IV. BASE MAPS

Shotpoint location maps were provided by Compagnie Generale de Geophysique.

V. KEY FIELD PERSONNEL

A. Australian Aquitaine Petroleum Pty. Ltd.

NAME	POSITION
R. Amberg.	
Y. Godechot.	Client Representative
B. Mollah.	Client Representative

B. Western Geophysical Company of America.

NAME	POSITION
V. Smith	Supervisor
B. Powell	Operations Manager
A. Mahoney	Assistant Operations Manager
A. McEachern	Co-ordinator
G. Hancock	Digital Operator
J. Sutherland	Shooter
R. Adams	Shooter

C. TORAN (Compagnie Generale de Geophysique).

For Personnel see TORAN final report.

VI. STATISTICAL SUMMARY

O.P. 2 and O.P. 83

A. AUGUST 1967.

7644' Streamer Cable.
200 meter shot spacing (600% Coverage).

LINE	SHOTPOINTS	PROFILES	
BO7	1 - 92	92	
BO5	93 - 114	22	
	112R - 175	64	3 repeat shots
BO3	176 - 242	67	
BO1	243 - 305	63	
BO4	306 - 348	43	
	346R - 394	49	3 repeat shots
BO2	395 - 411	17	

	409R - 484	76	3 repeat shots
H5	485 - 986	502	
		995	

Total kilometers shot	199.00
Missed kilometers	2.60
Repeat kilometers	1.80
Net	194.60

B. SEPTEMBER 1967.

5344' Streamer Cable.
833 meter shot spacing (100% coverage).

LINE	SHOTPOINTS	PROFILES	
H3	987-992, 992R - 1015	30	1 repeat shot
	1013R - 1066	54	3 repeat shots
H2	1067 - 1125	59	
	1125R - 1176	52	1 repeat shot
H1	1177 - 1189	13	
	1188R - 1228	41	2 repeat shots
	1227R - 1265	39	2 repeat shots
H4	1266 - 1341	76	
	1341R - 1474	134	1 repeat shot
	1474R - 1501	28	1 repeat shot
H4/15	1502 - 1525	24	
H15	1526 - 1600	75	
	1600R - 1661-1696	37	1 repeat shot
H11	1601 - 1620	20	
H13	1621 - 1660	40	
H17	1697 - 1718	22	
H19	1719 - 1740	22	
H16	1741 - 1780	40	
H12	1781 - 1798	18	
	1798R - 1823	26	1 repeat shot
H21	1824 - 1836, 1 dummy shot	14	
	2331 - 2360	30	
H24	1837 - 1869	33	
H29	1870 - 1880	11	
H25	1881 - 1904	24	
KI-3	1905 - 1924	20	

KI-5	1925 - 1947	23	
KI-7	1948 - 1955	8	
KI-2	1957 - 1962	6	
H7	2432 - 2452	21	
	2452R - 2544	92	1 skipped, 1 repeat shot
H6	2361 - 2431	71	
		1203	

Total kilometers shot	1002.500
Repeat kilometers (14 shots)	11.667
Net	990.833

5344' Streamer Cable.
137 meter shot spacing (600% coverage).

LINE	SHOTPOINTS	PROFILES
H22	1963 - 2330	368

Total kilometers shot 51.111

1200 meter floating cable.
600 meter shot spacing (100% coverage).

LINE	SHOTPOINTS	PROFILES	
H6/27	2599 - 2607	9	
H27	2608 - 2662	55	
	2662R - 2691	30	1 repeat shot
H25	2692 - 2790	99	
H22	2791 - 2813	23	
H29	2814 - 2894	81	
H8	2895 - 2916	22	
H31B	2917 - 2961	45	
H18	2962 - 2996	35	
H23	2997 - 3039	43	
H10	3040 - 3062	23	
H10	3063 - 3084	22	
H33	3085 - 3093	9	
H14	3094 - 3151	58	

H21	2545 - 2567	23	
	3152 - 3176	25	
	3176R - 3205	30	1 repeat shot
H6	2568 - 2598	31	
H20	3206 - 3250	45	
H31A	3251 - 3276	26	
H24	3277 - 3287	11	
		745	

Total kilometers shot	447.00
Repeat kilometers (2 shots)	1.20
Net	445.80

C. <u>OCTOBER 1967</u>.

1200 meter floating cable.
600 meter shot spacing (100% coverage).

LINE	SHOTPOINTS	PROFILES	
KI-1	3288 - 3321	34	
KI-3	3322 - 3353	32	
KI-6	3354 - 3376	23	
KI-2	3377 - 3425	49	
KI-7	3426 - 3462	37	
KI-6	3463 - 3474	12	
KI-7	3475 - 3492	18	
KI-4	3493 - 3510	18	
KI-5	3511-3537, 3537R, 3538R - 3558	50	2 repeat shots
KI-8A	3559 - 3579	21	
KI-8A	3580 - 3606	27	
KI-8B	3607 - 3614	8	
H32	3615 - 3630	16	
H45	3631 - 3645	15	
H43	3646 - 3664	19	
H28	3665 - 3683	19	
H47	3684 - 3694	11	
H34	3695 - 3713	19	
H30	3714 - 3734	21	
H41	3735 - 3749	15	
H39	3750 - 3765	16	
H37	3766 - 3779	14	
H35	3780 - 3789	10	
H26	3790 - 3808	19	
		523	

Total kilometers shot	313.80
Repeat kilometers (2 shots)	1.20
Net	312.60

Grand Totals :

August	194.600
September	1487.744
October	312.600
	1994.944

EXPLOSIVES:

August	50,850 lbs
September	105,700 lbs
October	23,250 lbs
	179,800 lbs

CAPS:

August	1013
September	2323
October	529
	3865

D. SUMMARY REFLECTION SHOOTING.

Average explosives per profile	46.89 lbs
Average explosives per kilometer	89.32 lbs
Recording days	34
Daylight travelling days	0
Non-recording days	13
Days at sea	38
Days lost due to weather	2
Average recording time per day at sea $\frac{251{:}08}{38}$ (first shot to last shot)	6.6 hours
Average kilometers per day at sea (net total km/38)	52.46 km
Average recording time per recording day	7.4 hours

GENERAL DESCRIPTION AND SPECIFICATIONS

DFR-200 BINARY GAIN SEISMIC SYSTEM

1. General Information

1.0 Function

1.0.0 The DFR-200 Binary Gain Seismic System accepts data directly from the seismic sensors, conditions the data, and causes the conditioned data to be recorded on digital tape. At the option of the operator, either an analog oscillograph monitor record can be recorded in the noise monitor mode concurrently with the digital recording, or else selected files can be played back at some later time.

1.0.1 The basic 9-track format is described in Savit "A proposed standard format for nine-track digital tape", published in Geophysics, v. 31, n. 4, 1966.

1.1 Physical Description

1.1.1 The recording system consists of seven modules as follows:

1. Input and Test panel
2. Binary-Gain Amplifiers
3. Digital Processor Unit
4. Magnetic Tape Unit
5. Operators Control Console
6. Camera
7. Power Converter

1.2 Input and Test Panel

1.2.1 Included with the input and test panel are bridling switches, cable leakage and continuity tester, precision low distortion oscillator and attenuator, and group selector switch. Test panels include means to terminate the amplifier inputs with a 500 Ω load. This feature is used in certain test procedures.

1.3 Binary-Gain Amplifiers

1.3.1 For each amplifier there is provided fixed and early gain controls, adjustable high-cut, low-cut, and alias filters, hum balancers, and a three-position release-rate switch.

1.3.2 Amplifier gain is adjusted automatically in 6-db steps; the system attempts to maintain the signal level between one fourth and one half of full scale. Gain control for the variable-gain amplifier is accomplished by means of a 4-bit binary counter capable of counting in either direction.

This counter is decoded to provide 12 gain positions which control the particular gain setting of the amplifier. When the detector element indicates that a gain change is necessary, the binary counter on the amplifier is incremented in either a positive or negative direction depending upon whether the change shall be an increase or decrease in gain. The output of the variable gain amplifier serves as the direct input to the digital system and is also utilized as a input to the gain control element.

1.3.3 Deleted

1.3.4 To prevent signal clipping and distortion it is urgent to reduce gain if the signal bursts out above half scale. Downward gain-ranging may take place on every scan except an integral multiple of the 30th scan. The 30th scan and each multiple thereof is reserved for upward gain changes. Thus, at a 2 ms. sample rate the attack rate would be 2900 db/sec. On the other hand, in the case of a varying data signal which is crossing zero many times per second, it is apparent that some of the sample values of the signal would fall below the one-eighth scale set point which triggers the gain increase, yet the signal peaks would be above the trigger level, and the existing gain level should be continued. A means is needed to delay the gain increase until all samples fall below the trigger level. On the first scan of a thirty-scan sequence, the A/D converter output for each channel is tested. If the sample value is less than 1/8 full scale at this time, a second test is enabled in scan two. Provided the sample value remains below 1/8 of full scale for all of the succeeding scans including scan 29, the amplifier increments its gain at the end of conversion command on scan 29 and the gain change is effective for scan 30.

1.3.5 If the first arrivals fail to trigger a gain increase in the early part of the record, the gain-ranging capability is triggered after a preset time interval.

1.4 Digital Processor Unit

1.4.1 The Digital Processor Unit is the central control unit. It contains the A/D and D/A converters, multiplexer, record and play-back control logic, and the general system timing functions. The digital processor communicates with and controls all other subsystems, including fire command, digital recorder start-stop, and camera start.

1.4.2 Accepting 15-bit binary words from the A/D converter, the record-mode formatting and playback control logic formats the words into two 8-bit bytes, generates the parity bit, and writes the information on magnetic tape. In addition, it records header information and amplifier gain settings. As it proceeds to create the format, this section controls gain changing in the seismic amplifier unit and receives gain data from it.

1.4.3 In the Playback Mode, after file search is performed, either forward or reverse, data is read back from the MTU and reconstructed into analog form. In conjunction with the seismic amplifier unit, the recorded data is read out in constant-envelope analog form.

1.4.4 For playback, the least significant bits in the data register can be shifted manually 2, 4, 6 or 8 places to the left so that low-level signals can be recorded on an analog camera recording.

1.4.5 During the record operation, a read-after-write playback is made in which the data is played back to the camera in uncorrected format. In both Record and Playback mode, a parity check is performed and the number of errors displayed by means of readout lights on the control panel. A parity error count in excess of 14, actuates the parity warning indicator light. For test purposes, the magnetic tape unit can be bypassed so that seismic data can be played directly to the camera.

1.5 Magnetic Tape Unit

1.5.1 The Magnetic Tape unit contains the tape-control electronics, tape data logic, and the mechanical tape transport. This unit will read and write 9-track IBM 2400 format tapes. One tape-recording speed is available but other tape speeds are available by mechanically changing the drive pulleys. Selection of tape speed depends upon sampling rate. A special switch is provided for writing all 1's on the tape for the purpose of checking skew. Dual tape decks are available on special order for use in continuous operations.

1.6 Operators Control Console

1.6.1 Operator controls and indicator-light displays are panel-mounted at the tops of the seismic amplifier rack and the digital processor rack. From this point the operator can control functioning of the entire system including tape and camera start, fire command, read-after-write or playback functions, sampling rate, reel and file numbering, and file searching. A saturation-indicator audibly and visibly warns the operator that the signal level is approaching saturation and that signal clipping may be impending. The same indicator is used for the parity error warning system.

1.7 Camera

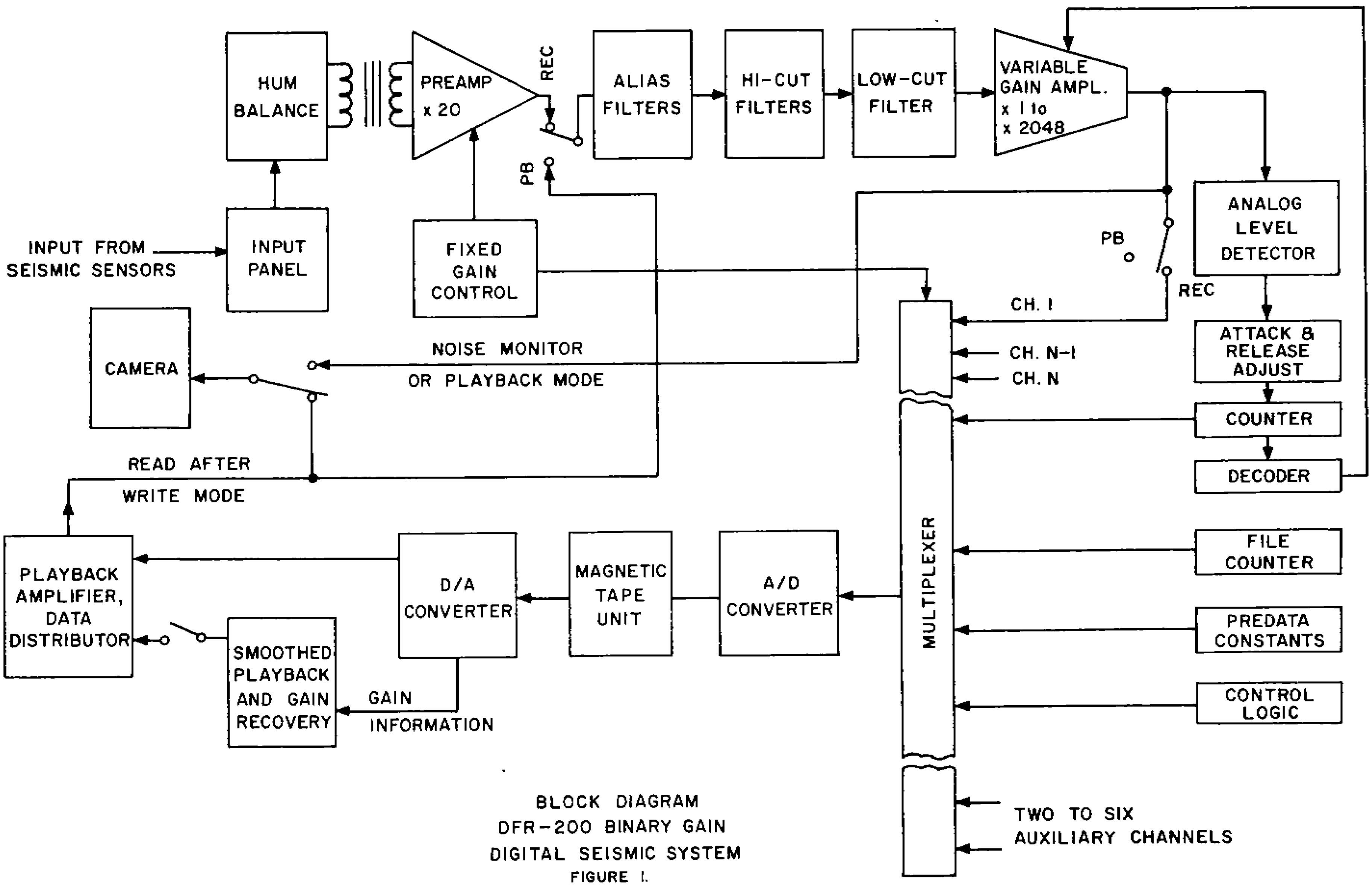
1.7.1 A multi-trace, direct-writing camera is a permanent part of the system. Camera input is fed from the read heads on the magnetic tape recorder on playback or from the output of the amplifier in the noise monitor mode. Camera start is automatic and is synchronized with the tape-recorder operation. Any selected file can be played back in the smoothed mode (gain-change pips are suppressed). For test purposes, the tape can be bypassed so that incoming signals can be played directly into the camera.

1.8 Power Supply

1.8.1 The power supply may be remotely located with respect to the remainder of the equipment. Both 110v AC and 12v DC are required to drive the power supply.

1.9 Block Diagram

1.9.1 A simplified block diagram is illustrated in Figure 1.



BLOCK DIAGRAM
DFR-200 BINARY GAIN
DIGITAL SEISMIC SYSTEM
FIGURE 1.

2. Specifications

2.1 System Specifications

Number of inputs	24 data channels plus 6 auxiliary channels
Input impedance	500 ohms
Minimum gain	26 db
Maximum gain	116 db
Automatic gain range, binary gain amplifiers	72 db
Attack rate (@ 2 ms sample rate)	2900 db/sec
Release rate (@ 2 ms sample rate)	100 db/sec
Cross talk	Greater than 66 db down from full scale
Harmonic distortion	0.1% from 10 Hz to 250 Hz
Sample rate accuracy	0.01%
Sample aperture time	0.1 μsec
System resolution (A-D)	15 bits including sign
System resolution (D-A)	10 bits including sign, manually left shiftable by 2, 4, 6, or 8 bits
Data code	15 bits in 2 bytes, 1's complement
Noise	Less than 0.5 μv RTI
Redundancy check	Odd vertical parity
Computer codes	Longitudinal redundancy character (LRC) Cyclic redundancy character (CRC)
Search capability	Forward and reverse for three-digit file identification
Sample rate	1, 2, or 4 ms per scan

Voltage required	110v AC, 1φ, 60 Hz 12v DC
Operating temperature range	$0^{o}C$ to $50^{o}C$
Non-operational temperature	$-50^{o}C$ to $+82^{o}C$
Humidity	0% to 100% relative

2.2 Multiplexer, A/D converter, Sample-and-Hold

Input	$\pm$ 10v from seismic amplifier
Number of inputs	30
Noise	$\pm$ 0.6 mv peak referred to $\pm$ 10v peak at input to A-D
Accuracy	$\pm$ .05%
Linearity	Better than .02%
Sample and Hold aperture	0.1 μsec
Sampling settling time	.1 μsec to within 2mv of final value

2.3 D/A Converter

Code input	Binary, 1's complement
Number of bits	10 bits, including sign
Output amplitude	$\pm$ 10v peak maximum
Gain stability	$\pm$ .02% per millisecond
Accuracy	$\pm$ .1%
Output impedance	.01 ohm at DC

2.4 Magnetic Tape Unit

Speeds	Single speed for any given pulley configuration
Speed Tolerance	$\pm$ 2%
Direction	Bidirectional

Start/Stop Time	100 ms at 120 ips
Tape Width	½" (0.498 $\pm$ .002)
Recording	IBM compatible
Packing Density	800 BPI
Tracks	9
Track Spacing	ASI standard
Tape Sensing	Photo-reflective, IBM compatible; both BOT and EOT
Read-after-Write	Read head .3"
Read Direction	1 speed forward, 1 speed reverse
Reels	10½" compatible with IBM hubs and snap-off locks. Write-ring file protect

2.5 Filter Amplitude Response Curves

2.5.1 Refer to Figures 2 through 5.

AMPLITUDE RESPONSE

REDCOR BINARY GAIN AMPLIFIER
SERIES DFR-200
AMPLIFIER ONLY

LOW CUT FILTER - I SECTION
HIGH CUT FILTER - OUT
ALIAS FILTER - 2 MS

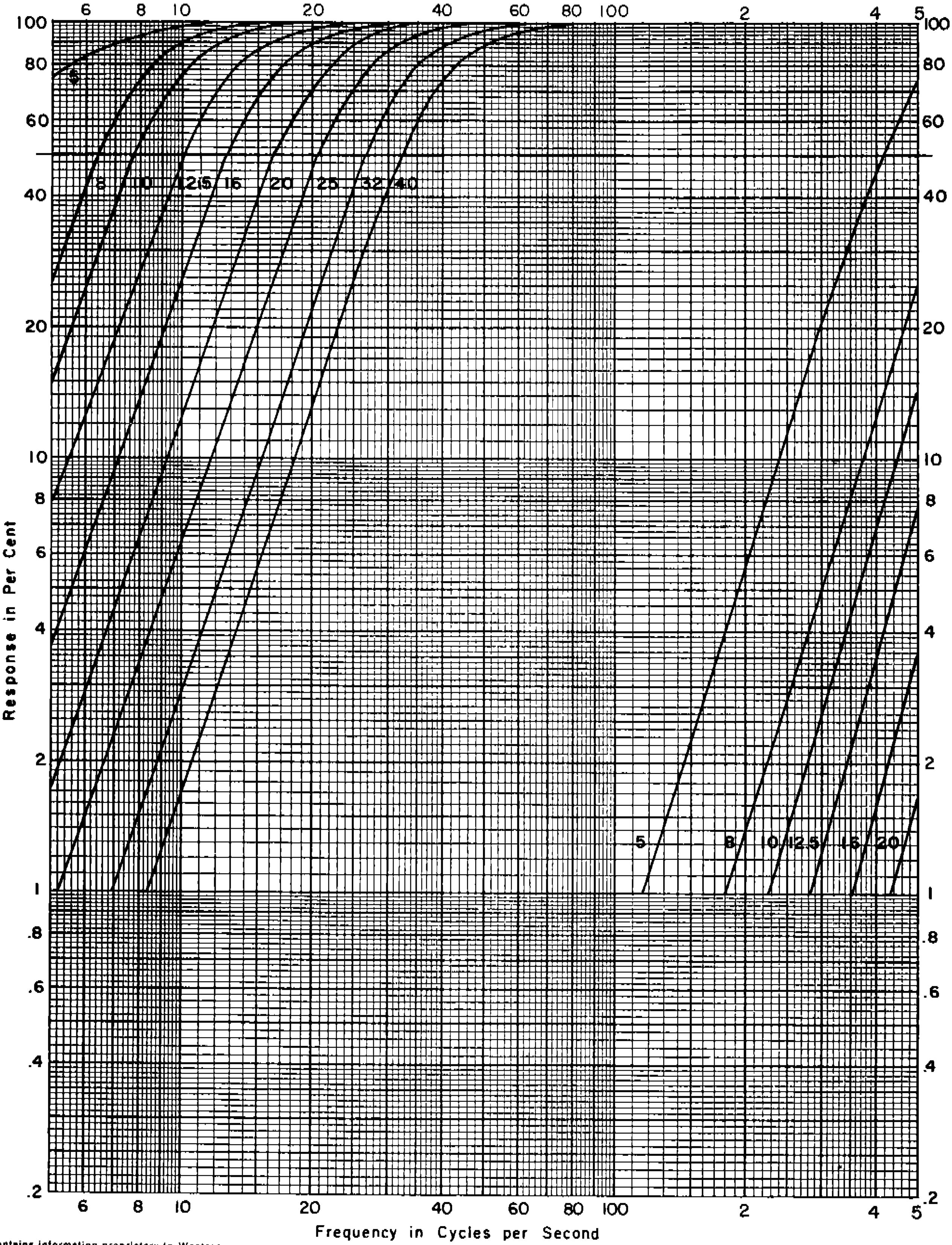


FIGURE 2.

WESTERN GEOPHYSICAL

AMPLITUDE RESPONSE

REDCOR BINARY GAIN AMPLIFIER
SERIES DFR-200
AMPLIFIER ONLY

LOW CUT FILTER - 2 SECTION
HIGH CUT FILTER - OUT
ALIAS FILTER — 2MS

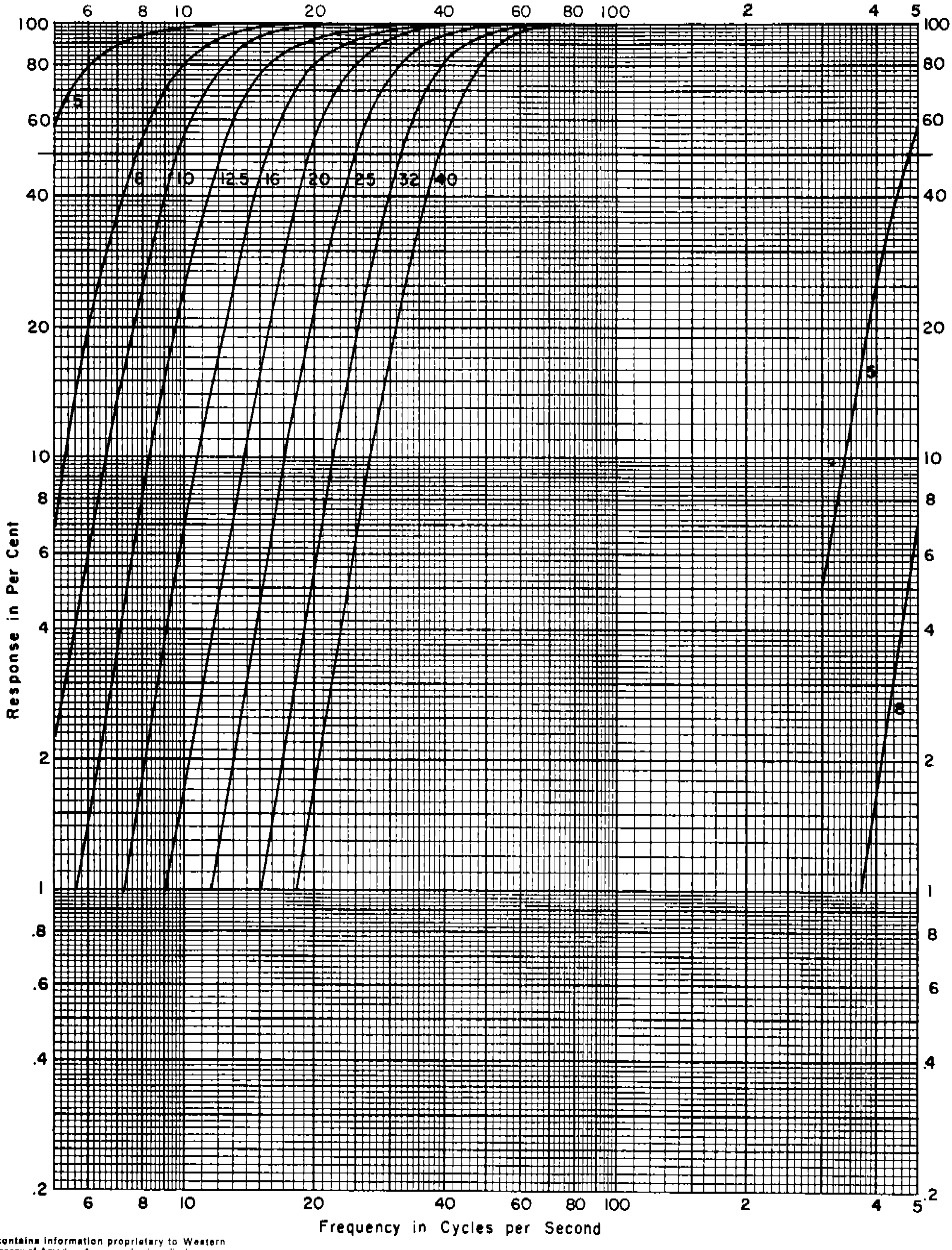


FIGURE 3.

WESTERN GEOPHYSICAL

AMPLITUDE RESPONSE

REDCOR BINARY GAIN AMPLIFIER
SERIES DFR-200
AMPLIFIER ONLY

LOW CUT FILTER-OUT
HIGH CUT FILTER-1 SECTION
ALIAS FILTER-2 MS

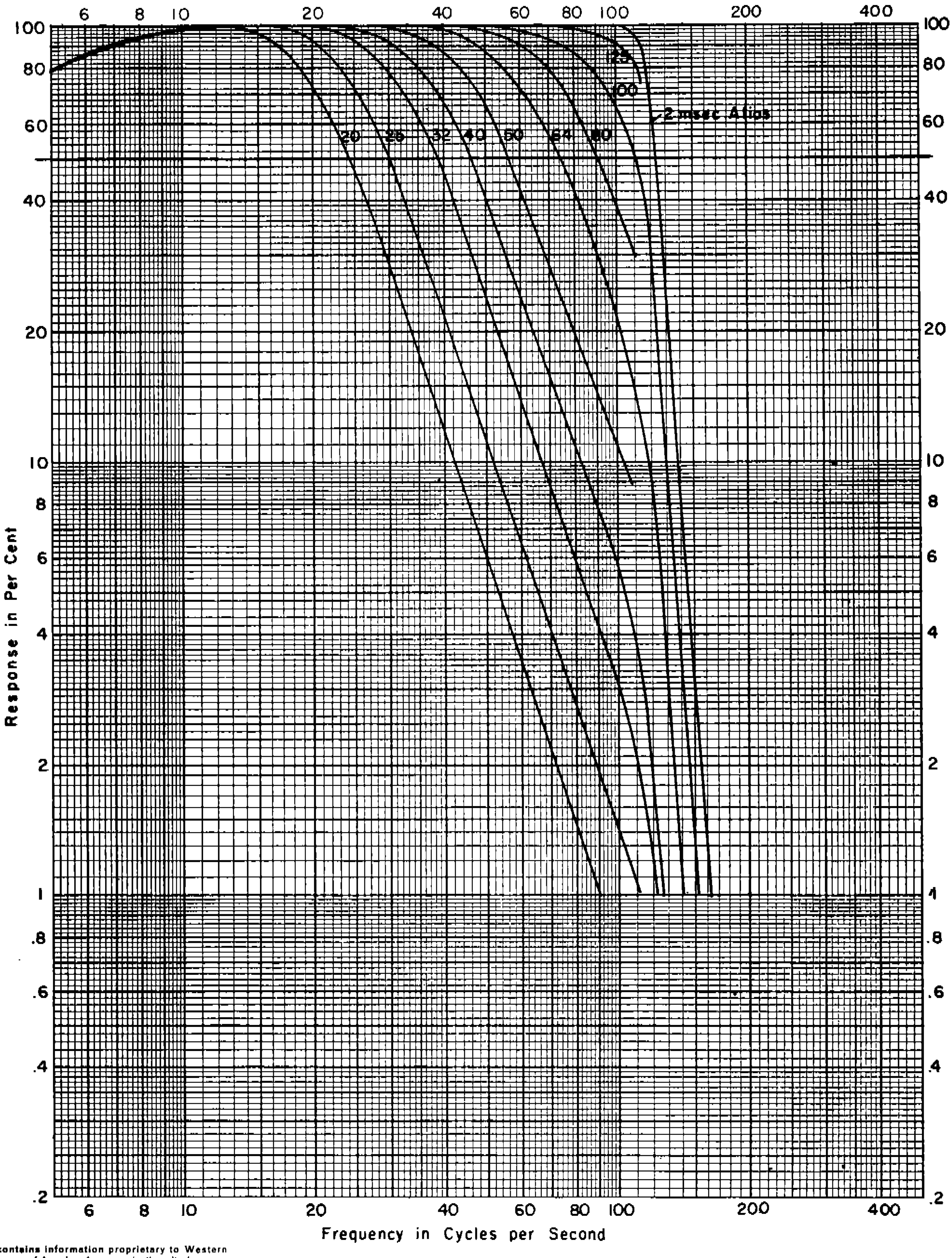


FIGURE 4.

WESTERN GEOPHYSICAL

AMPLITUDE RESPONSE

REDCOR BINARY GAIN AMPLIFIER

SERIES DFR-200

AMPLIFIER ONLY

LOW CUT FILTER-OUT

HIGH CUT FILTER-2 SECTION

ALIAS FILTER-2MS

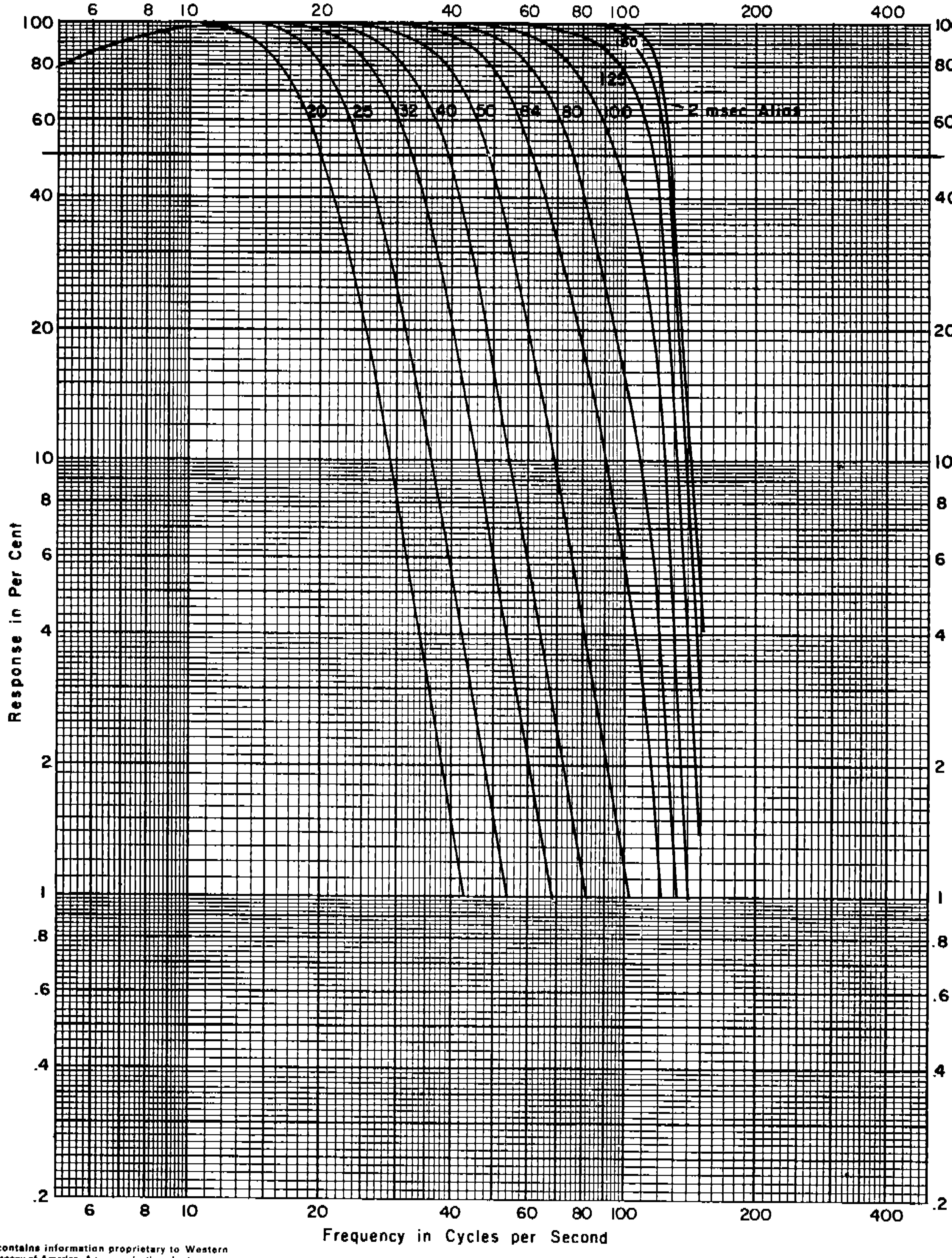


FIGURE 5.

WESTERN GEOPHYSICAL

AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

O.P. 2 & O.P. 83

HYLAND MARINE SEISMIC SURVEY - 1967

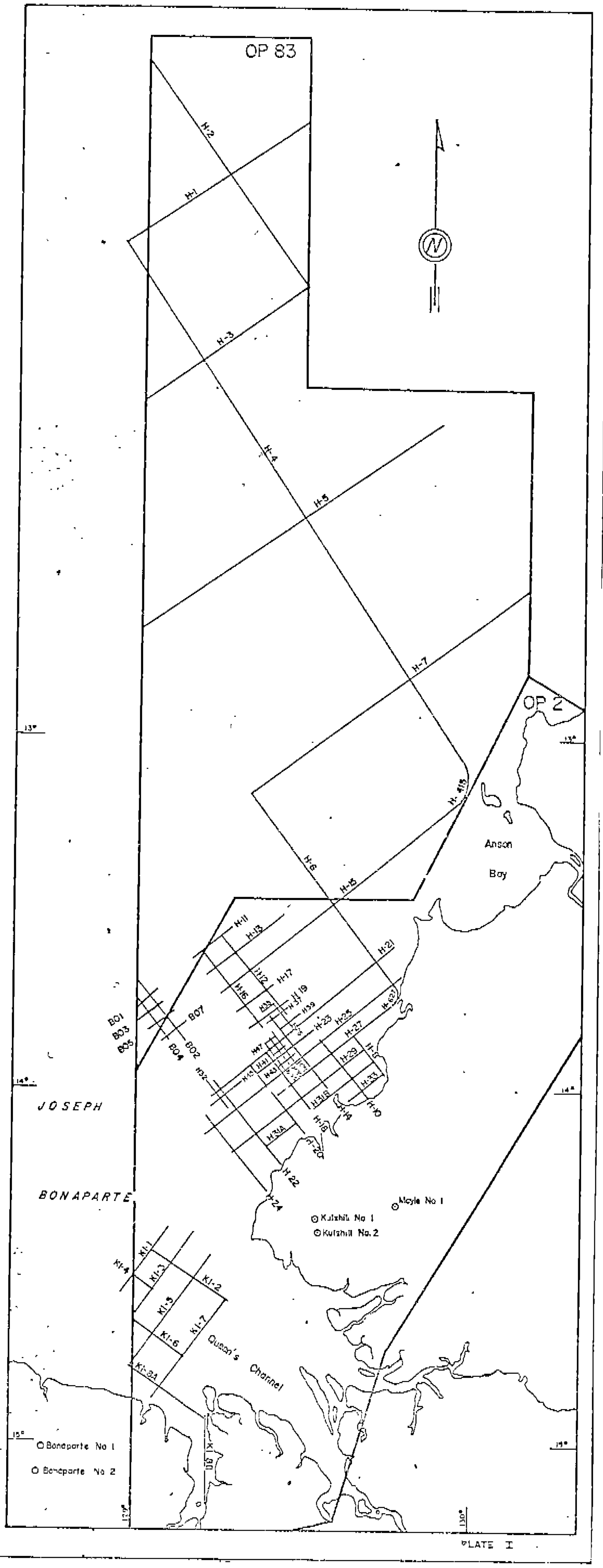
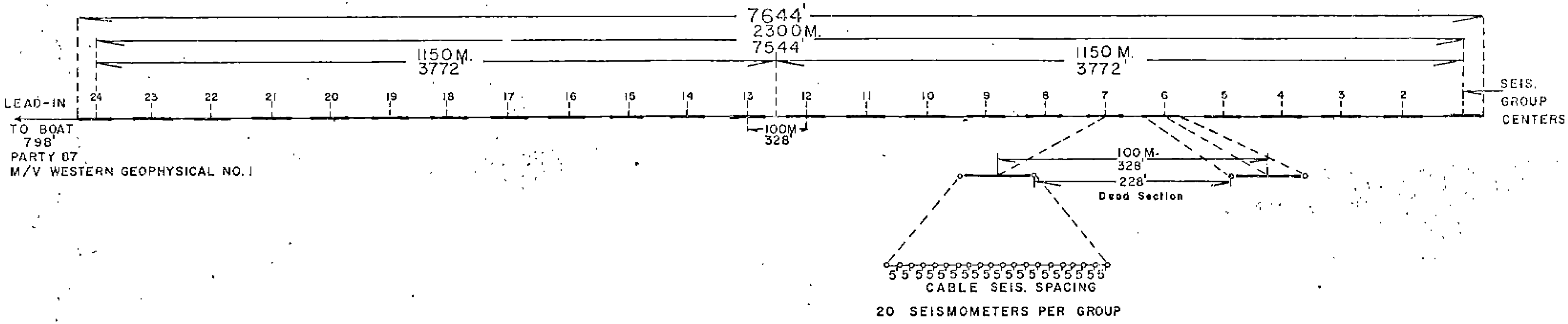


PLATE I

A.A.P.
HYLAND SEISMIC SURVEY
1967
DIAGRAM OF 2300M. SINGLE PURPOSE DEEP RUNNING CABLE



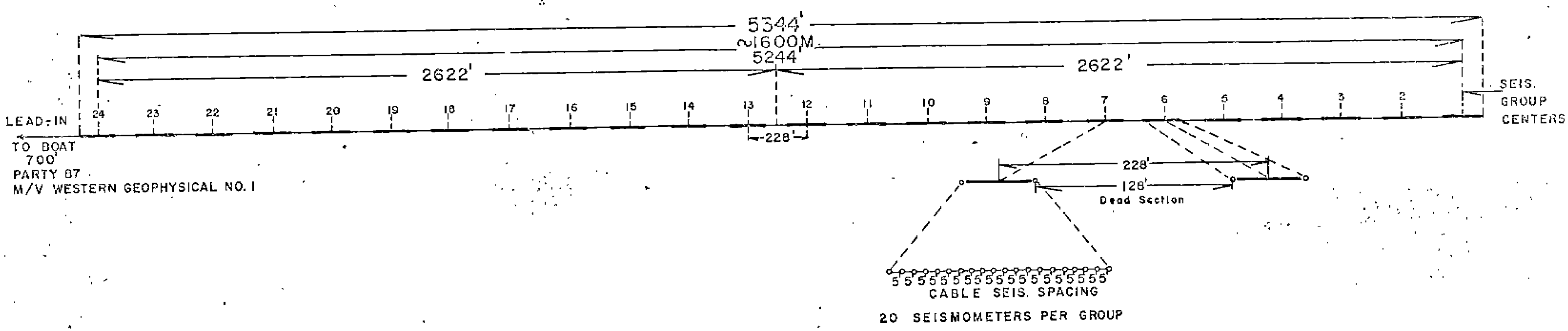
DRY-LAND DIMENSIONS DISPLAYED

WESTERN GEOPHYSICAL
DIVISION OF LITTON INDUSTRIES

SPREAD DIAGRAM

PLATE II

A.A.P.
HYLAND SEISMIC SURVEY
1967
DIAGRAM OF ~1600M. SINGLE PURPOSE DEEP RUNNING CABLE



DRY-LAND DIMENSIONS DISPLAYED

WESTERN GEOPHYSICAL
DIVISION OF LITTON INDUSTRIES

SPREAD DIAGRAM

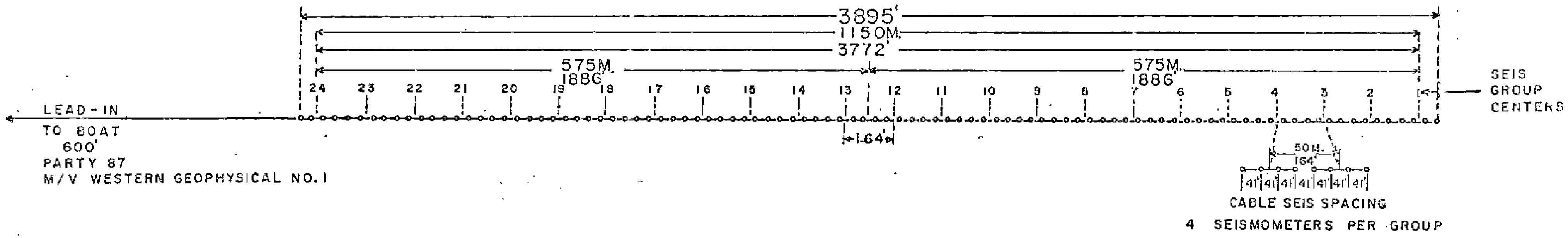
PLATE III

A. A. P.

HYLAND SEISMIC SURVEY

1967

DIAGRAM OF ~1200M. SINGLE PURPOSE FLOATING CABLE



DRY-LAND DIMENSIONS DISPLAYED

WESTERN
GEOPHYSICAL
DIVISION OF LITTON INDUSTRIES

SPREAD DIAGRAM

PLATE IV

REPORT ON DIGITAL PROCESSING OF SEISMIC DATA FROM THE HYLAND MARINE SEISMIC SURVEY, 1967

FOR

AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

BY

WESTERN GEOPHYSICAL COMPANY

AT

SHREVEPORT DIGITAL PROCESSING CENTER

SEPTEMBER, OCTOBER, AND NOVEMBER, 1967

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I. INTRODUCTION

The Hyland Marine Seismic Survey was recorded in the waters off the northwest coast of Australia during the months of August, September, and October, 1967, for the account of Australian Aquitaine Petroleum Pty. Ltd. by Party 87 of Western Geophysical Company of America. The conventional two-boat, dynamite method was used in shooting, and data were recorded with the digital binary gain system.

A total of 74 lines of various lengths, with a total of 3808 shot points, were surveyed. Relevant field information is tabulated below:

Cable	No. of Lines	No. of Shotpoints	Subsurface Coverage
2300-meter, deep-running	7	986	600%
1600-meter, deep-running	1	368	600%
	24	1190	100%
1200-meter, floating	42	1264	100%

Processing requested for the six-fold stacked lines was to include editing, dynamic and static corrections, stacking, deconvolution after stacking, and the use of an analog filter in playback to section form. Processing to be used on the 100 percent lines was editing, deconvolution, dynamic and static corrections, and the use of an analog filter in playback.

In this report it is planned to describe first the major, or "mainstream" processing operations, then the auxiliary or control operations, and finally to list in proper sequence the major and the auxiliary processes used to produce and present, in section form, the six-fold stacked and deconvolved data and the single-fold deconvolved data.

II. MAJOR PROCESSES

A. EDIT

Editing of data recorded with binary gain actually entails two distinct processes. First, the data are de-multiplexed, that is, rearranged from time-sequential (Redcor) format to trace-sequential (Disk) format. Then, trace by trace, using gain inverse to that applied in recording, the data are restored to original geophone amplitude; a gain curve based principally on indicated natural decay rate and desired output amplitude is computer-fitted and applied to these data, resulting in uniformly balanced traces, ready for further processing. The data remains in "Disk" format throughout all subsequent processing until it is restored to "Redcor" format for play-back in final section form.

B. DECONVOLUTION

In this process, the regularly repetitive events present on each trace, such as ringing and multiple reflections, are removed. The process works on the principle of subjecting each trace to a digital filter operator chosen by the computer through the use of parameters indicated by the autocorrelograms (produced in an auxiliary operation), and designed to pass one set of the offending repetitive events while rejecting the other elements of the trace. The resulting "predicted" trace, after a suitable shift with respect to the parent trace, so as to prevent the primary event from being operated on and to bring the filtered undesired events into phase with the parent trace, is subtracted from the latter, thus cancelling out the offending repetitive elements. This procedure is repeated, or iterated, as necessary, using a different operator for each type of repetitive pseudo-event.

C. NMO (DYNAMIC AND STATIC CORRECTIONS AND MUTING)

Dynamic corrections are used to remove the excess travel-time of a true event due to the horizontal distance of the seismometer from the energy source. These corrections are critical for stacking and to achieve good continuity of reflection horizons on 100 percent sections. They are computed by the machine from the velocity and spread information furnished to it.

Static corrections for varying water depths are calculated by replacing water velocity with the appropriate formation velocity. They are necessary to reduce the data to sea-level datum plane.

In muting, early noise due to direct arrivals through the water and to refracted arrivals is zeroed out on those traces beyond the ones essential for at least 100 percent coverage in the shallowest portion of the section. Muting is used only when the data is to be stacked, and is necessary to prevent the early noise from interfering with the stacking of shallow reflection data.

D. STACKING

In this process, the traces which form a common depth point family are summed, averaged, and subjected to a gain and trace balancing routine to produce uniformly balanced stacked traces.

E. REFORMAT

This is the final purely digital operation in any sequence of digital processing. The data are not modified in any way, but are simply rearranged from trace-sequential (Disk) format to time-sequential (Redcor) format. This prepares the data for playback in section form.

F. PLAYBACK (With or without Analog Filter)

This is the conversion of digital data to visible traces on a section. There are several modes of presentation: Squiggle Line, Variable Area, Variable Density, and combinations of Squiggle Line and Variable Area or Variable Density. Horizontal and vertical scales may be varied, as well as type of timing lines.

III. AUXILIARY PROCESSES AND CONTROLS

A. EDIT CONTROL

Before editing all the field data of any line, only the first 3 profiles from selected field reels are edited and played back. The playbacks are inspected to check quality of data, proper choice of editing parameters, and to check other data, such as first arrival times and spreads, which will affect parameters used in subsequent processing. Complete editing of field data is carried out after any adjustments of parameters that may have been indicated by edit control.

B. AUTOCORRELOGRAMS

These are machine-plotted from computer-calculated autocorrelations of the traces of profiles from selected locations throughout the area. The autocorrelograms show the elements of the trace which are repetitive at regular intervals, i.e., ringing and multiples, and are used in choosing the parameters for the deconvolution process. Autocorrelograms are also made from the same profiles after deconvolution. The extent to which the regularly repetitive elements have been eliminated is an indication of the effectiveness of the deconvolution process.

C. VELOCITY CONTROL

This is the most critical of the auxiliary control operations, particularly for stacked data. Its purpose is to determine the velocity that will give the proper dynamic corrections (NMO), before stacking, to assure optimum enhancement of true reflection data and attenuation of multiples. For 100 percent data, proper choice of velocity is perhaps less critical, but is necessary to assure good continuity of true reflection events.

Velocity control requires the production of deconvolved, 100 percent monitor sections, dynamically corrected with a preliminary trial velocity, before the production of final sections, whether these are 100 percent or stacked. The trial velocities may be based on well data, on previous experience in the area, on expanded velocity profiles, or, in critical cases, on special computer-run velocity analyses. The velocity analyst examines the monitor sections for excess or insufficient dynamic correction, and adjusts the velocity as necessary. New monitor sections are then produced and examined. The process is repeated until satisfactory dynamic corrections are obtained.

Velocity control also includes examination of the stacked sections to see that the best enhancement of valid reflections and attenuation of multiples was obtained.

The number of trial velocity runs required depends upon the degree of lateral variation found in the velocities characteristic of the area. As work on an area progresses, the velocity analyst constructs a velocity gradient map which helps him in choosing trial velocities.

D. FILTER ANALYSIS

This is not a digital operation, but is necessary whether the filtering requested is digital and time-variant or analog and constant. Selected portions of lines typical of the area are played back in from 4 to 6 different analog filters, as well as unfiltered. Comparison of the effects of the various filters leads to the selection of the band-pass filters, whether digital or analog, which result in maximum enhancement of the data.

E. FINAL INSPECTION

Final sections are closely inspected before transmitting to the client to assure that they are free of inadvertent errors or flaws of any kind and that they are representative of the highest professional standards.

IV. PROCESSING SEQUENCE - 600 PERCENT, DECONVOLVED AFTER STACK, ANALOG FILTERED SECTIONS

1. Edit Control (III A)
2. Edit (II A)
3. Velocity Control (III C)
   a. Autocorrelograms (III B)
   b. Deconvolution (II B)
   c. NMO (II C) (100% monitors, Dynamic Corrections only)
   d. Reformat (II E)
   e. Playback (II F) (with Analog Filter)
4. NMO (II C) (Dynamic and Static Corrections and Mute)
5. Stack (II D)
6. Autocorrelograms (III B)
7. Deconvolution (II B)
8. Autocorrelograms (III B)
9. Reformat (II E)
10. Filter Analysis (III D)
11. Playback (II F) (with Analog Filter)
12. Final Inspection (III E).

V. PROCESSING SEQUENCE - 100 PERCENT DECONVOLVED, ANALOG FILTERED SECTIONS

1. Edit Control (III A)
2. Edit (II A)
3. Autocorrelograms (III B)
4. Deconvolution (II B)
5. Autocorrelograms (III B)
6. Velocity Control
   a. NMO (II E) (Dynamic Corrections Only)
   b. Reformat (II E)
   c. Playback (II F) (with Analog Filter)

7. NMO (II C) (Dynamic and Static Corrections, but no Mute)
8. Reformat (II E)
9. Filter Analysis (III D)
10. Playback (II F) (Some of these lines without filter)
11. Final Inspection (III F)

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