T/8P part-III*

FINAL OPERATIONS REPORT

AUSTRALIA MARINE SIESMIC SURVEY

T 70A

WEST TASMANIA

FOR

ESSO STANDARD OIL (AUSTRALIA) LIMITED

BY

WESTERN GEOPHYSICAL COMPANY OF AMERICA

PARTY 80

JANUARY - FEBRUARY, 1970

086002

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I. SUMMARY

A continuous reflection seismic survey using the AQUAPULSE® system was conducted offshore West and South Tasmania, Australia, by Western Geophysical Company of America for Esso Standard Oil (Australia) Limited. Operations commenced on January 28, 1970 and were completed on February 10, 1970. Refer to Plate I for location of survey area.

II. GENERAL INFORMATION

A. Contractors

The survey was conducted by Western Geophysical Company of America, 8100 Westpark Drive, Houston, Texas, and 514 Miller Street, Cammeray, New South Wales, Australia. Positioning control was provided by Offshore Navigation, Incorporated, 5728 Jefferson Highway, New Orleans, Louisiana, and 202 Roma Arcade, 413-417 New South Head Road, Double Bay, New South Wales, Australia.

B. Base of Operations

Headquarters were set up in Hobart, Tasmania. Good port facilities and a daily air service for supplies were available. Radio communications were established with the survey vessel "Marchart 3" from Hobart.

C. Weather

Good weather and calm seas were experienced throughout most of the survey. Only one day was lost when recording had to be suspended due to excessive cable noise.

D. Surveying Technique

The Shoran XR Extended Range system was employed for positioning control. The mobile equipment used included a track plotter, digital print-out system and dual directional antennae. Five Shoran base station sites were used to cover the survey area. These were located at Southdown, Mt. Owen, Mt. Osmond, Mt. Counsel and Bare Hill. A complete description of the Shoran system and the fixed base station sites is included in a separate report to be submitted by Offshore Navigation Incorporated.

E. Chronology

January 23, 1970:	Survey vessel M/V "Marchart 3" departed for prospect from Hobart.
January 24, 1970:	Boat in survey area. Digital problems with A/D Converter. Running to Stanley to work on instruments and await spares.

January 25 - 27, 1970:	Boat docked at Stanley.
January 28, 1970:	Departed Stanley - commenced recording on Line 7.
January 29, 1970:	Completed Lines 7, 28, 13. Recording on Line 32.
January 30, 1970:	Completed Lines 32, 30, 26, 24, 22, 5.
January 31, 1970:	Completed Lines 3, 9, 36. Recording on Line 11.
February 1, 1970:	Completed Lines 11, 15, 13. Recording on Line 34.
February 2, 1970:	Completed Line 34. Called at Strahan to take on supplies.
February 3, 1970:	Recorded on Lines 17 and 38.
February 4, 1970:	Completed Lines 38, 17. Bad weather - ran to Hobart for shelter.
February 5, 1970:	Departed Hobart. Working on cable.
February 6, 1970:	Repairing dead groups in cable.
February 7, 1970:	Repairing cable, docked at Hobart.
February 8, 1970:	Departed Hobart for survey area.
February 9, 1970:	Commenced recording. Completed Line 19.
February 10, 1970:	Recorded Line 40 complete. End of survey.

III. RECORDING OPERATIONS

A. Survey Vessel

M.V. "Marchart 3" - 101 foot, steel hull, twin-screw vessel of Australian registry, powered by two Caterpillar D343, 365 h.p. marine diesel engines, capable of 11 knots cruising speed. Equipped with a Decca 202 Radar, Elac fathometer and Mariner ship-to-shore radio.

B. Instrumentation

Digital Recorder - SDS 1010, 30 channel, 9 track, IBM compatible ½ inch E.P.R.Co. format, binary gain controlled amplifiers.

On-board Display - Raytheon Precision Depth Recorder, driven by output of trace 22, through a playback amplifier.

Magnetometer - Ship board, Varian Proton Marine Model V4937.

Fathometer - Elac Model DENEB, 2200 fathom range.

Sonar Forward Scanner - Honeywell Model S-1600-A3.

Tape Transport - Potter dual tape deck.

Sample Rate - 2 milliseconds.

Monitor Records - Read-after-write wiggle trace recorded on direct write paper every 30 files.

C. Detector Cable

The cable used was a 5290 foot, neutrally-buoyant, oil-filled streamer equipped with four depth detectors, four water break detectors and twenty-four seismic detector groups. Each seismic detector group was 230 feet long and consisted of 32 crystal geophones in a tapered noise cancelling array. The buoyancy of the cable was adjusted so that it ran at an average depth of 45 feet. Refer to Plate II for a detailed diagram of the streamer cable, AQUAPULSE® gun array and navigation antennae - gun array - cable relationship.

D. Recording Technique

With the AQUAPULSE® system, four Model "B" guns, in a rectangular array were towed at a subsea depth of 20-25 feet. A gun pulse monitoring system was provided by the use of 4 MP8B Geospace geophones. The gas, air pressures and fill-time were as specified by ESSO; oxygen 60lb.sq.in., air 45lb.sq.in., propane 16-18lb.sq.in., fill-time 1.3 seconds. Under continuous tow operations the metered oxygen, air and propane mixture was fired electrically at intervals such that a minimum of three pulses per 230 feet, or 68.87 pulses per mile were recorded. Shot point locations were preplotted with a 460 feet interval.

IV. DATA PRESENTATION

A. Field

A variable density section was made by recording the output of group 22 on the Raytheon Precision Depth Recorder. Wiggle trace, read-after-write monitors were produced by a Dri-Write camera every 5 shot points. This monitor displayed data from the 24 seismic data channels, time break and individual gun pulse signatures.

B. Processing

The digital tapes were air expressed to Geophysical Services International in Sydney for processing.

C. Post Plotting

The post plotting was carried out by Engineering Computer Services Limited, of 48 Chandos Street, St. Leonards, Sydney. Maps were produced using the Gerber 522 plotting system on the Australian Map Grid (based on U.T.M. Projection) at a scale of 1:100,000.

V. KEY FIELD PARTY PERSONNEL

A. Esso Standard Oil (Australia) Limited

Name	Position
A. Martens	Client Representative
W.R. Stone	Client Representative

B. Western Geophysical Company of America

Name	Position
V. Smith	Supervisor
A. Mahoney	Operations Manager
R. Stansbury	Co-ordinator
J. Goodin	Assistant Co-ordinator
A. Shirley	Instrument Supervisor
J. Hammond	Gun Captain

C. Offshore Navigation, Incorporated

Name	Position
I. Easterbrook	Party Chief
G. Owen	Mobile Operator
D. Woody	Mobile Operator

VI. STATISTICAL SUMMARY

Cable length - 5290 feet.

Line length measured by computing the number of Shoran intervals on line and adding half an interval on the last Shoran position.

One interval equals .0871 of a mile.

Centre of AQUAPULSE® gun array to centre of group 24 - 819 feet

Record length - 5 seconds.

Line	S.P. - S.P.	Chargeable Shot Point Intervals	Statute Miles
3	2822 - 2942	120½	10.495
5	2704 - 2821	117½	10.234
7	1 - 893		
	888A - 893A		
	894 - 1254	1253½	109.180
9	2943 - 3386	443½	38.629
11	3498 - 3830		
	3825A - 3830A		
	3831 - 3941	443½	38.629
13	1542 - 1716		
	1708A - 1713A		
	4385 - 4509	296½	25.825
15	3942 - 4384	442½	38.542
17	4686 - 5166		
	5161A - 5166A		
	5393 - 5680	768½	66.936
19	5681 - 6148	467½	40.719
22	2608 - 2703	95½	8.318
24	2324 - 2607	283½	24.693
26	2095 - 2322	227½	19.815
28	1255 - 1366		
	1266A - 1255A		
	1367 - 1541	286½	24.954
30	1893 - 2094	201½	17.551
32	1717 - 1892	175½	15.286
34	4510 - 4684	175½	15.200
36	3387 - 3497	110½	9.625
38	5167 - 5325		
	5299A - 5325A		
	5326 - 5392	225½	19.641

Line	S.P.-S.P.	Chargeable Shot Point Intervals	Statute Miles
40	6149 - 6510	361½	31.487
	TOTALS:	6496½	565.76

Full Magnetometer coverage was obtained over the same Lines of survey.

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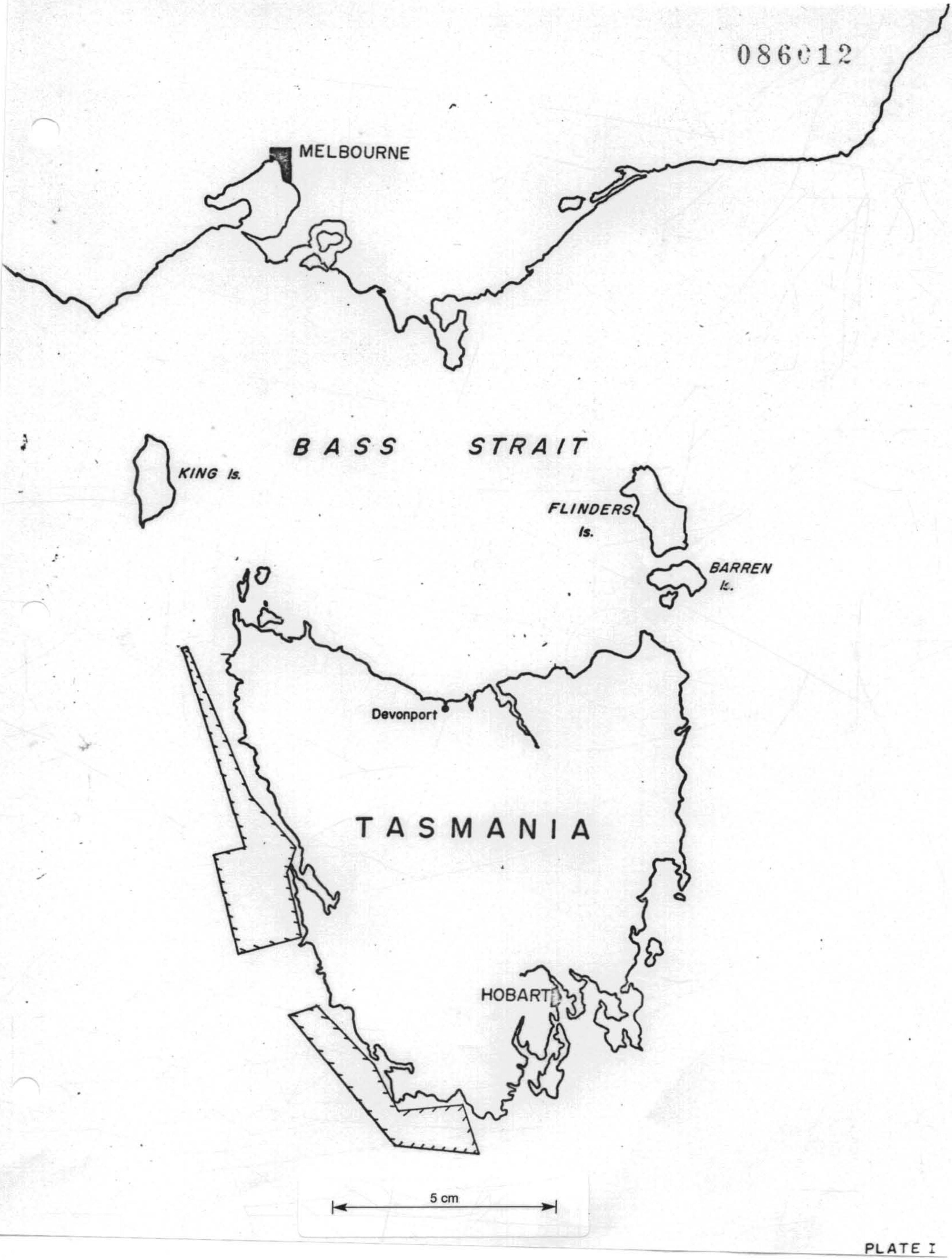
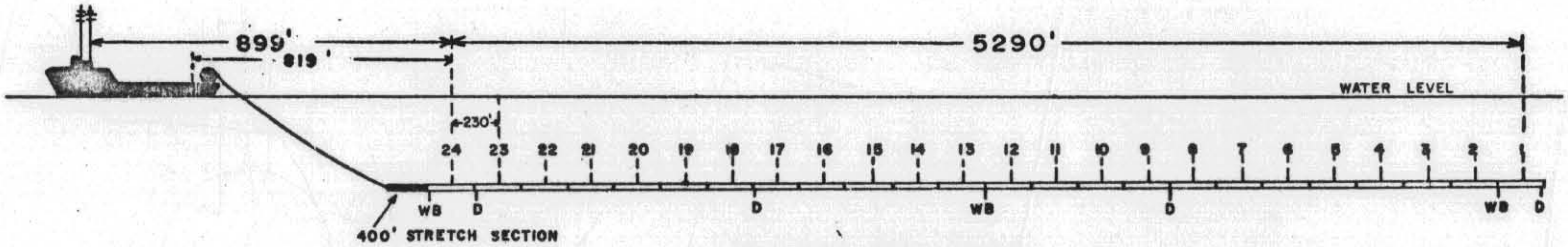
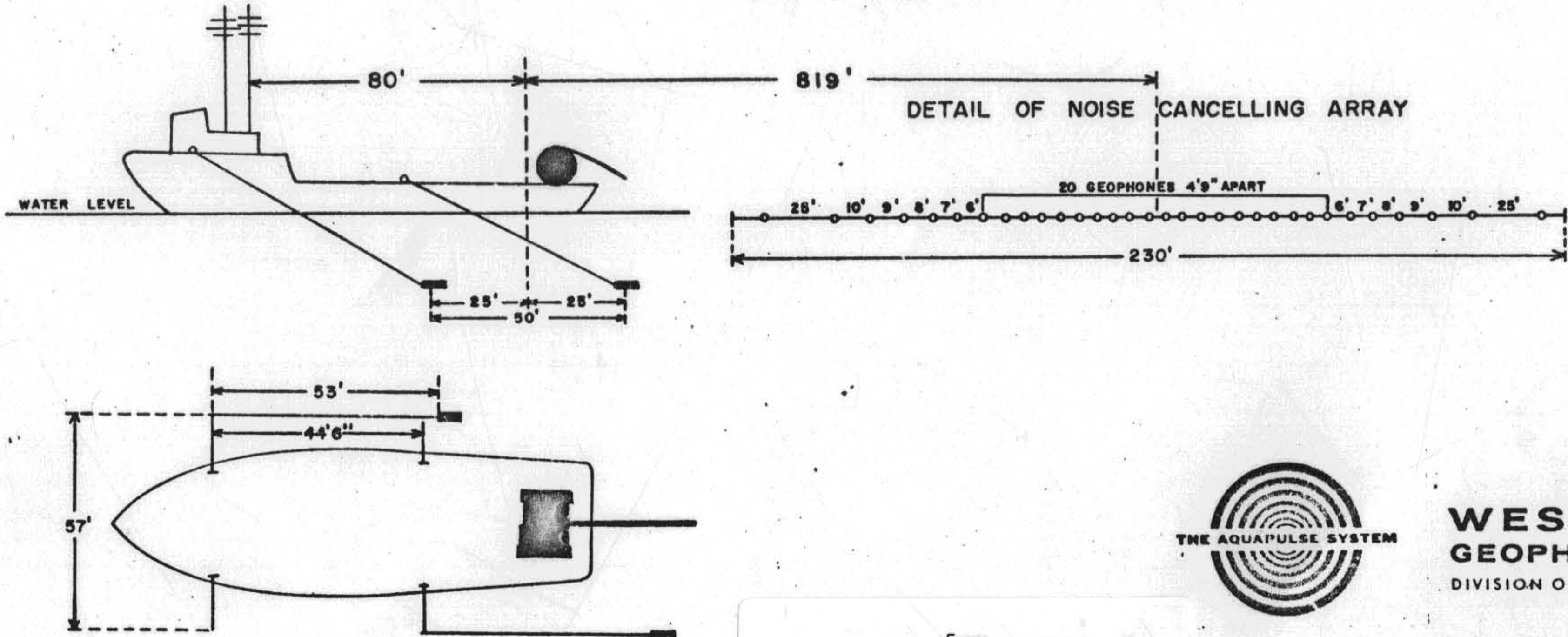


PLATE I

ESSO STANDARD OIL (AUST.) LTD.
SEISMIC SURVEY
1970

DIAGRAM OF 5290 Ft. STREAMER CABLE





THE AQUAPULSE SYSTEM

WESTERN GEOPHYSICAL
DIVISION OF LITTON INDUSTRIES

PLATE II

APPENDIX 1

GENERAL DESCRIPTION and SPECIFICATIONS

DFR-300 BINARY GAIN SEISMIC SYSTEM (HIGH GAIN)

1. General Information

1.0 Function

1.0.0 The DFR-300 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 read-after-write mode concurrently with the digital recording, output from the amplifiers can be monitored directly, 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 sections as follows:

1. Input and Test Panel
2. Binary-Gain Input Amplifiers
3. Master Control Panel
4. Magnetic Tape Unit
5. Playback Amplifiers
6. Camera
7. Power Converter

1.2 Input and Test Panel

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

1.3 Binary-Gain Amplifiers

1.3.1 For each amplifier there is provided a hum balance circuit, adjustable high-cut, low-cut, and alias filters, and preamplifier-gain and D.C. offset trim pots.

1.3.2 Amplifier gain is adjusted automatically in 6 db steps; the system always attempts to maintain the signal level between one-fourth and one-half of full scale. To prevent signal clipping and distortion, it is urgent to reduce gain if the signal bursts out above half scale so downward gain-ranging may take place on every alternate scan. At a 1 ms sample rate, the attack rate is 3000 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-quarter 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 provided to delay the gain increase until all samples fall below the trigger level. This operation is accomplished by examining all samples of a given channel for a time period which is set by a 3-position release-rate switch, having the positions, fast, medium, and slow (30, 40, 60 ms, nominal or 200, 150, 100 db/second). The release rate is an expression of the speed, in decibels per second, at which an amplifier is capable of increasing gain to follow a declining seismic signal. As soon as all samples are below the lower set point for an examination period, the gain is increased by 6 db at the next scan. Thus, with a 30 ms examination period, the gain could be increased 6 db every 30 ms or at a rate of 200 db/sec. Provision of three release rates permits the operator to select the one best suited to the data being received.

1.3.3 Each amplifier unit includes one preamplifier and two paralleled post-amplifiers. The preamplifier has a gain of 40 for systems 105 and all systems with serial number 108 and later. The output of the post-amplifiers is applied to the system multiplexer and also to the analog camera when switched to the noise monitor mode. Of the two post-amplifiers, post-amplifier 1 has selectable gains of 1 and 256; post-amplifier 2 has selectable gains of 16 and 4096. The choice of one of the two gains and one of the two post-amplifiers is a function of the gain-control unit selecting the particular amplifier. In the noise monitor mode, the amplifier gain is forced to $\times$163,840.

1.4 Logic Control Chassis

1.4.1 The Logic Control chassis contains the master control panel multiplexer, buffer amplifier, gain control unit, A/D and D/A converters, and control logic. Early gain controls for the amplifiers are mounted on the master control panel. The tape drive is included in this chassis unless a 10" tape drive is specified, in which case the tape is mounted in a third rack. An optional dual drive is available for continuous operations.

1.4.2 The analog outputs of the amplifier units are time-multiplexed by the amplifier multiplexer, whence each analog signal is fed to the buffer amplifier. The buffer amplifier serves both as an impedance matcher between the multiplexer and the A/D converter and as an element of the binary gain amplification scheme. Binary signals from the control unit select any one of four buffer-amplifier gains of 1, 2, 4, or 8. The selected buffer-amplifier gain, combined with one of the four gains in the post-amplifiers, result in 15 binary gain steps from 1 to 32,768.

1.4.3 The Gain Control Unit originates a 4-bit gain code to select the gain of one of the two post amplifiers and to control the gain of the buffer amplifier. In general, when the analog value being digitized falls below one-quarter scale, the gain control unit increases the gain code by 1. When the value exceeds one-half scale, the gain control unit decrements the gain code by 1. These values are acquired by decoding the digital outputs of the A/D converter.

1.4.4 The Input Control Unit controls flow of data from the A/D converter, gain control unit, file counter, time counter and other sources to the input bus. This unit sequences and formats the data words into two 8-bit bytes, generates the parity bit, and writes the data on tape via the tape write unit.

1.4.5 The A/D converter is a 14-bit-plus-sign binary converter with complement output for negative numbers. It is controlled by a single start line originating in the input control unit. A trigger pulse on this line for each seismic channel starts the entire conversion sequence. The bit circuits continuously track the analog signal; then, after a particular analog signal has settled, the start signal initiates the sequential clamping of the bit circuits. In this way the precise digital value is achieved very rapidly by successive approximation. The digital output levels are applied to the input bus and are also used to control the gain control units.

1.4.6 The D/A converter accepts the magnitude bits furnished by the A/D converter as well as the 4-bit gain code from the gain control unit. It uses both of these--as mantissa and exponent--in a floating point representation to generate an analog signal with three significant features: (1) The analog output contains the full dynamic range of the system in a form capable of representation on a recording oscillograph. (2) The gain steps that would ordinarily be visible when the system moves from one gain code to another are removed. (3) The average value of the analog signal is normalized by digital and analog AGC, around a manually set playback level, so that rapid changes such as burst-outs are readily visible. The final result is a camera record on which both the average signal value and the reflections are clearly visible for the entire length of the file. On high-gain models, the gain change blips can be displayed at the operator's option.

1.5 Magnetic Tape Unit

1.5.1 The Magnetic Tape Unit is a field tape transport accommodating 9-track tape, ½-inch wide, on 8-½ or 10 inch reels. Direction of tape motion, startup and shutdown are controlled by the system control unit on the basis of the mode selected; tape speed depends upon the sampling rate selected.

1.5.2 A beginning-of-tape sensor determines when first recording may commence, and the end-of-tape sensor warns of the approach of the tape end. If the EOT marker is sensed while a file is being recorded, recording will continue past the EOT mark until the file is completed but no further recording can be done on that reel. It should be noted that this capability is possible because the EOT marker is located 65 feet from the actual end of tape. The tape transport is interlocked with a number of system and transport conditions so that it can operate only when all conditions are ready.

1.5.3 Use of the seismic recording system may involve interlaced recording or playback operations; therefore, a special type of file protection system is provided. This over-write protection uses the electronic detection of data on the tape to inhibit writing. An advance-to-end-of-data control allows the system operator to automatically reposition the tape at the end of the previously recorded data. As a result, it is possible to record a file, replay it or another file, and go ahead with more recording with no chance of inadvertently over-writing data.

1.5.4 In addition to the electronic data-detector-write-inhibitor, conventional write-ring protection is provided. This feature assures the operator that previously recorded data cannot possibly be damaged. If desired, the erase head and electronic file protector can be disabled when recording in the continuous forward mode and, in this case, file protection is available only via the write-ring file protect.

1.5.5 The write logic generates IBM-compatible odd vertical parity which is recorded on tape along with the data. Parity errors are displayed by means of indicator-lights; whenever an excess of parity errors occurs, an audible and visible alarm is activated. The usual EOF characters are generated automatically after the recording has been completed; a manual EOF switch is also available.

1.5.6 A special switch is provided to write a block of all 1's. This block, of indefinite length, is used to check skew.

1.6 Playback Amplifiers

1.6.1 Camera displays can be made in playback mode, either read-after-write during a recording or read only at a later time, or in noise monitor mode.

1.6.2 When the noise-monitor mode is entered, signals are taken from the output of post-amplifier 2 and are fed to the camera. In this mode, the gain is forced to ×163,840.

1.6.3 In the direct playback mode only the mantissa is displayed with no reference to the gain code. In this mode the transients due to gain changes are readily visible.

1.6.4 Playback AGC capability is partly analog and partly digital. The digital part removes the transients due to gain changes by bit-shifting and applies gain control to all channels so that the maximum average signal is at a preset level. Differences of amplitude level between channels are then removed by analog AGC applied to individual channels. Burstouts are preserved in their true relationship to the signal envelope level at the point where they occurred. The rate at which the average envelope level is followed in the reconstruction of the signal is adjusted by a three-position AGC rate switch. In addition to the AGC rate, the level at which the average envelope is controlled can also be adjusted. If, for example, the level is reduced, a relatively large burstout capability is provided. To prevent the AGC action from forcing the amplifier to maximum gain when no data signal is present, the AGC preset control is provided to limit the amount of gain control before trip.

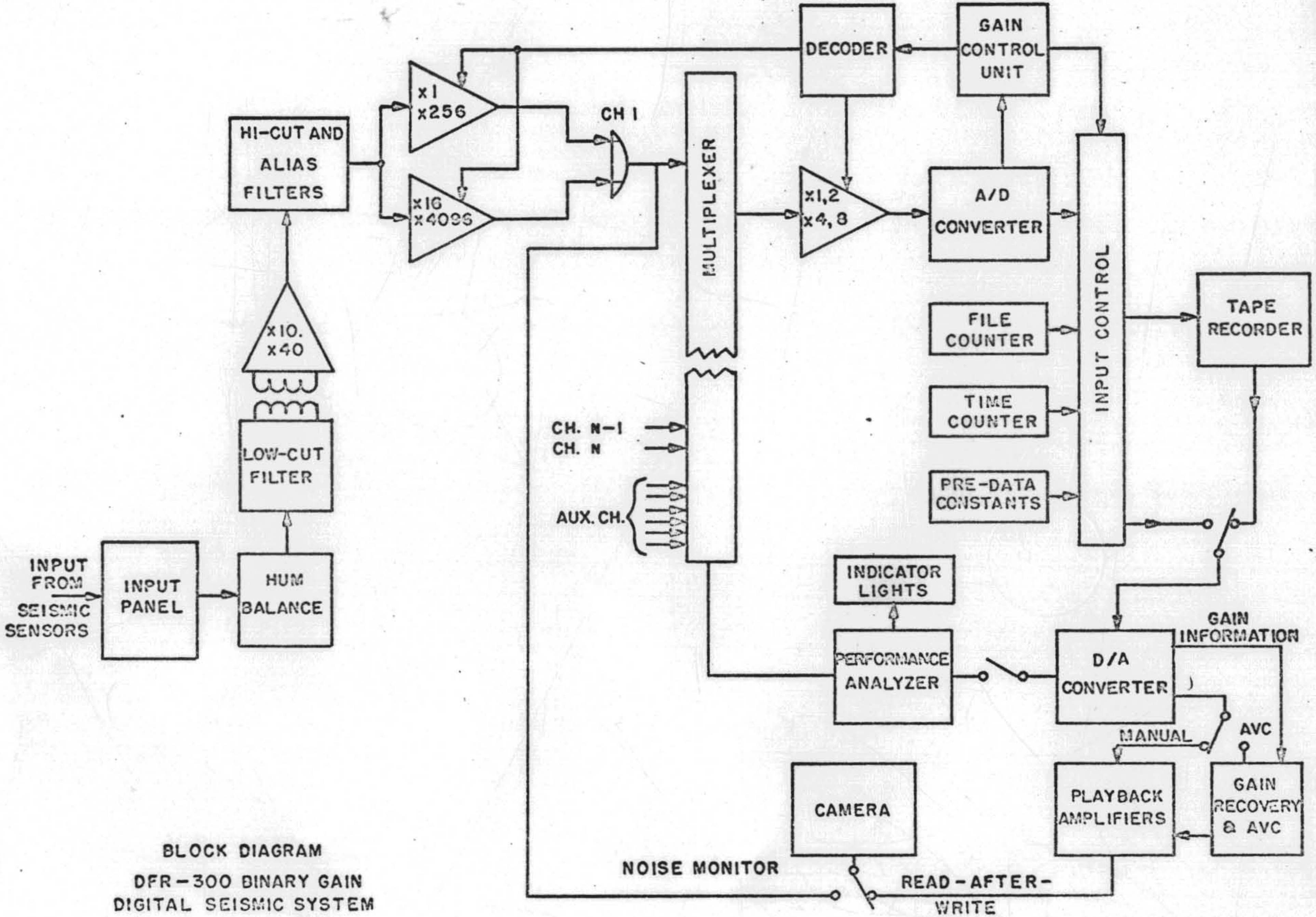
1.6.5 Fixed-gain playbacks can be made by locking out the AGC action so that the effective gain is set by the preset switch. It should be noted that if the Preset gain, as set for playback, is greater than the Early gain, as set for record, all signals will be automatically bit-shifted by the amount of the difference, but if the settings are the same, no bit-shifting will occur. For certain test purposes it is desirable to make specified bit-shifts without regard to the early gain setting used at recording time. To accomplish this end, Unit 105, 108 and later models have been equipped with a special function switch providing the option of normal AGC preset, or the capability of shifting the data bits, on playback, by specified fixed amounts regardless of the Early gain setting used during recording.

1.6.6 On playback, the data can be filtered at the option of the operator. Three-position, high- and low-cut filters are provided, with provision to switch the filters out if desired.

1.6.7 Many units have a time accumulator. To monitor its functioning, the least significant bits of the time word are selected and displayed on trace 25 of the camera recording. The signal will appear as a saw-tooth wave with a period of 2048 ms. The time-word display appears on an auxiliary trace.

1.6.8 In addition to the time accumulator display, the time break event is shown as follows. At the beginning of the recording, a DC offset is applied to trace 25. At the moment that the time

Figure 1



BLOCK DIAGRAM
DFR-300 BINARY GAIN
DIGITAL SEISMIC SYSTEM

WESTERN GEOPHYSICAL

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break is sensed, the offset is removed and the trace returns to normal in the form of a step function. The amplitude of the time-break signal must exceed 1/4 scale for this feature to function.

1.7 Camera

1.7.1 A multi-trace, direct-writing camera is a permanent part of the system. Ordinarily, camera input is fed from the read-after-write heads on the magnetic tape recorder unless the system is in the noise monitor or tape bypass mode. Camera start may be set to coincide with either the recording or playback cycles. For test purposes, the tape can be bypassed so that incoming signals can be played directly into the camera.

1.8 Power Converter Unit

1.8.1 The Power Converter Unit converts 12-volt battery power to thirteen, DC output voltages to operate the units of the 1010 system. Five shielded outputs are used where the maintenance of analog accuracy is critically important. Seven regulated voltages are used principally for digital purposes. An unregulated voltage is used for indicators and relays, and the battery voltage is used directly for motors and heaters.

1.9 Block Diagram

1.9.1 A simplified block diagram is illustrated in Figure 1.

2. Specifications

2.1 System

Number of inputs	24 data channels plus 6 auxiliary channels
Sample rate	1, 2, or 4 ms per scan, switch-selectable
Sample rate accuracy	0.01%
System resolution (A-D)	15 bits including sign
System resolution (D-A)	10 bits including sign manually left shiftable to 84 db
Data code	15 bits in 2 bytes, 1's complement
Redundancy check	Odd vertical parity
Search capability	Forward and reverse for three-digit file identification
Playback AGC control	3 positions: fast, medium, slow
Voltage required	12 v DC

2.2 Amplifier

Maximum input signal	250 mv zero to peak
Input impedance	500 ohms nominal
Minimum gain	32 db
Noise	Less than 0.2 μvp RTI r.m.s.
Cross talk	Greater than 66 db down from full scale
Harmonic distortion	0.1% from 10 Hz to 250 Hz
Automatic gain range, binary gain amplifiers	90 db
Attack rate (@ 1 ms sample rate)	3000 db/sec.
Release rate	200, 150, 100 db/sec. (30, 40, 60 ms delay, nominal)

2.3 Multiplexer, A/D converter

Input	±10 v from seismic amplifier
Number of inputs	30
Noise	±0.6 mv peak referred to ±10 v peak at input to A-D
Coding error	±½ least significant bit
Nagative numbers	1's complement
Linearity	Better than 0.01%
Slope error	Better than 0.01%
Zero error	Better than 0.01%
Conversion time	12 μs

2.4 D/A Converter

Code input	Binary, 1's complement
Number of bits	10 bits, including sign
Accuracy	±0.2%

2.5 Magnetic Tape Unit

Speeds	20, 40, 80 ips
Speed tolerance	±2% long term
Direction	bi-directional
Tape width	½" (0.498 ±0.002)
Recording	IBM compatible
Packing density	800 bpi
Tracks	9
Track spacing	ASI standard
Tape sensing	Photo-reflective IBM compatible; both BOT and EOT

Read direction	3 speeds forward, 1 speed reverse
File protection	Electronic and/or write-ring file protection
Erase head	
Reels	8½" or 10" compatible with IBM hubs and snap-off locks

2.6 Filter Amplitude Response Curves

2.6.1 Refer to Figures 2 and 3.

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AMPLITUDE RESPONSE

SDS BINARY GAIN AMPLIFIER

SERIES DFR-300

LOW CUT FILTERS

AMPLIFIER ONLY

HIGH CUT FILTERS-OUT

ALIAS FILTER -2MS

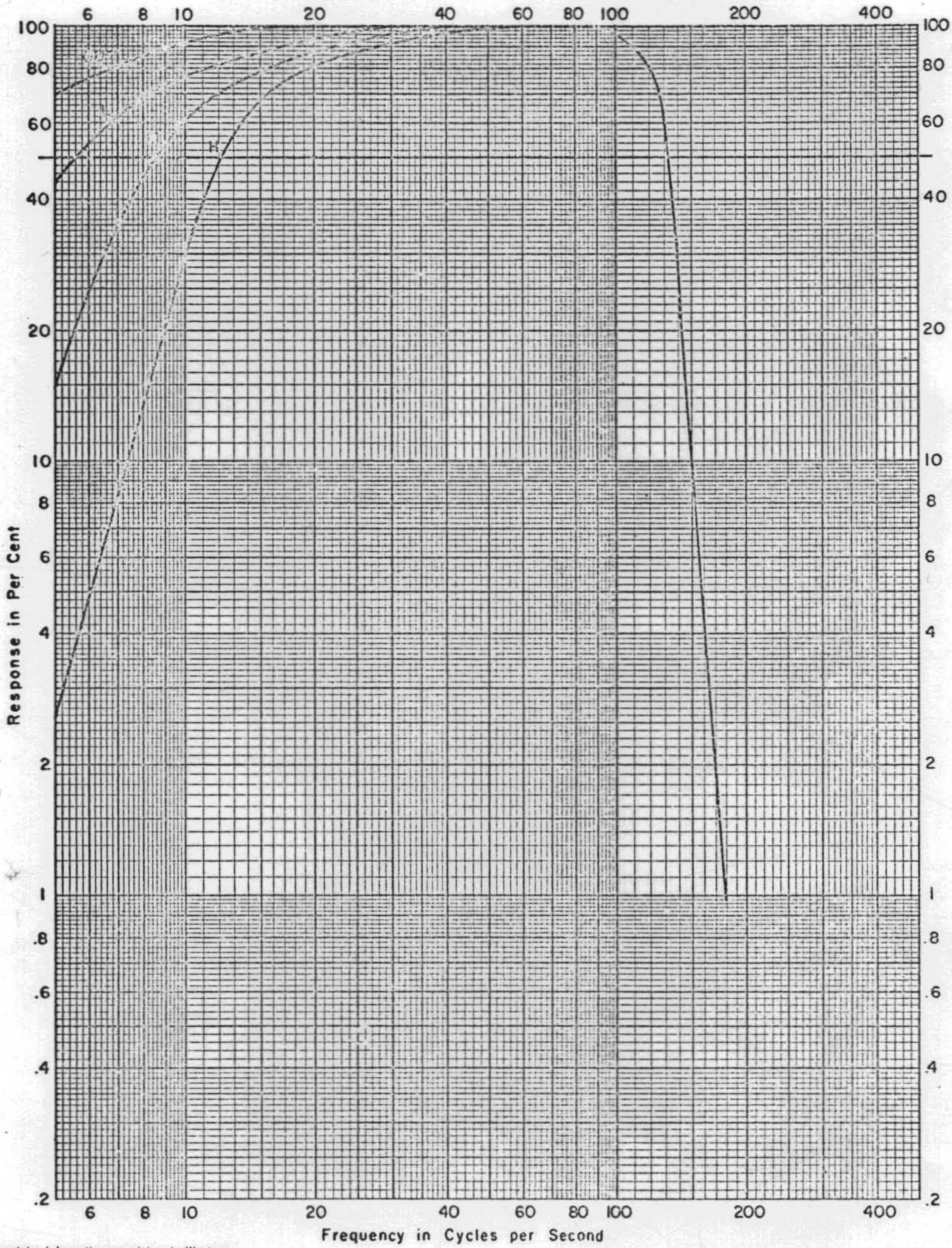

FIGURE 2.

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AMPLITUDE RESPONSE

SDS BINARY GAIN AMPLIFIER
SERIES DFR-300
HIGH CUT FILTERS

AMPLIFIER ONLY
LOW CUT FILTER-OUT
ALIAS FILTER - 2MS

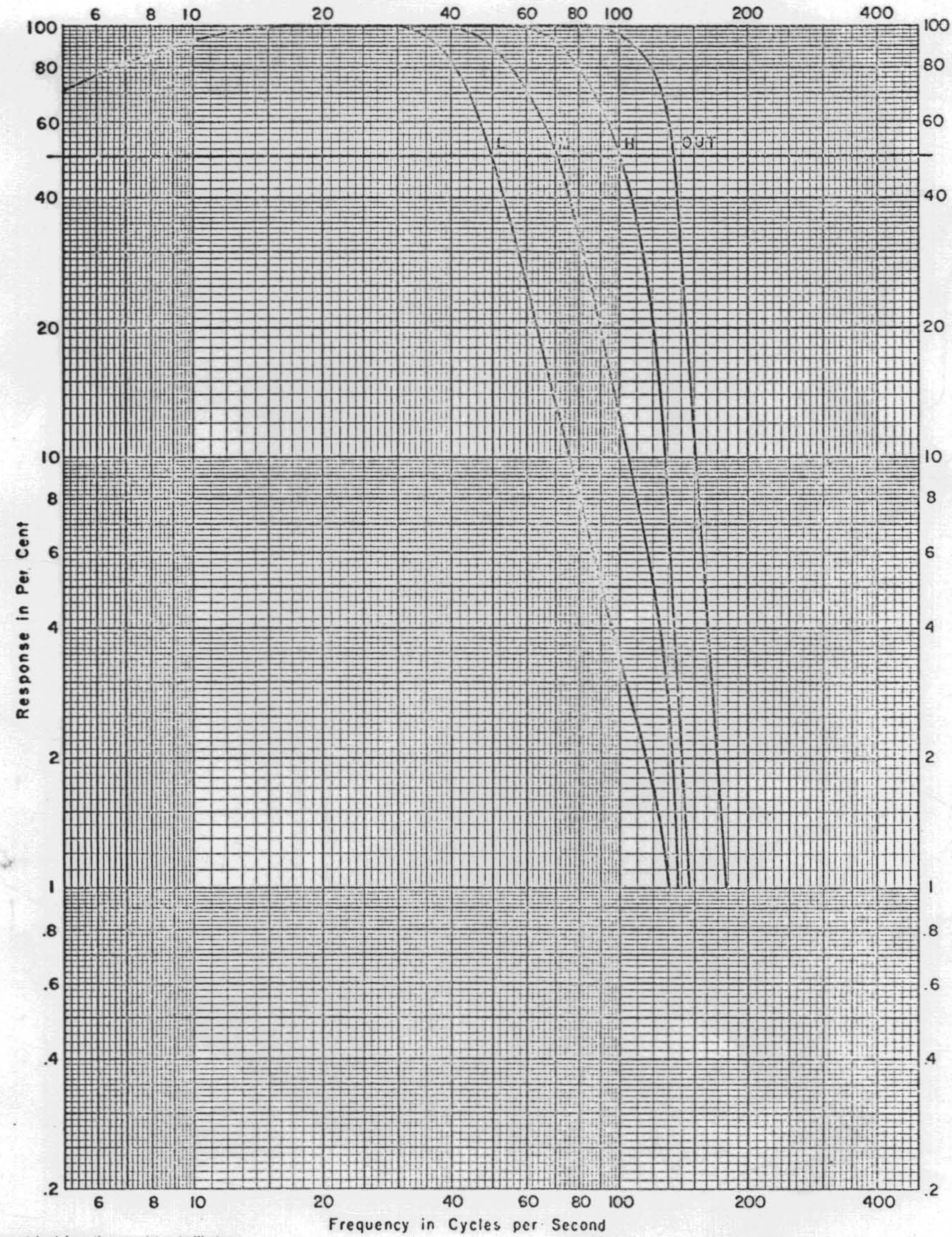

FIGURE 3.

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9-TRACK DIGITAL RECORDING FORMAT

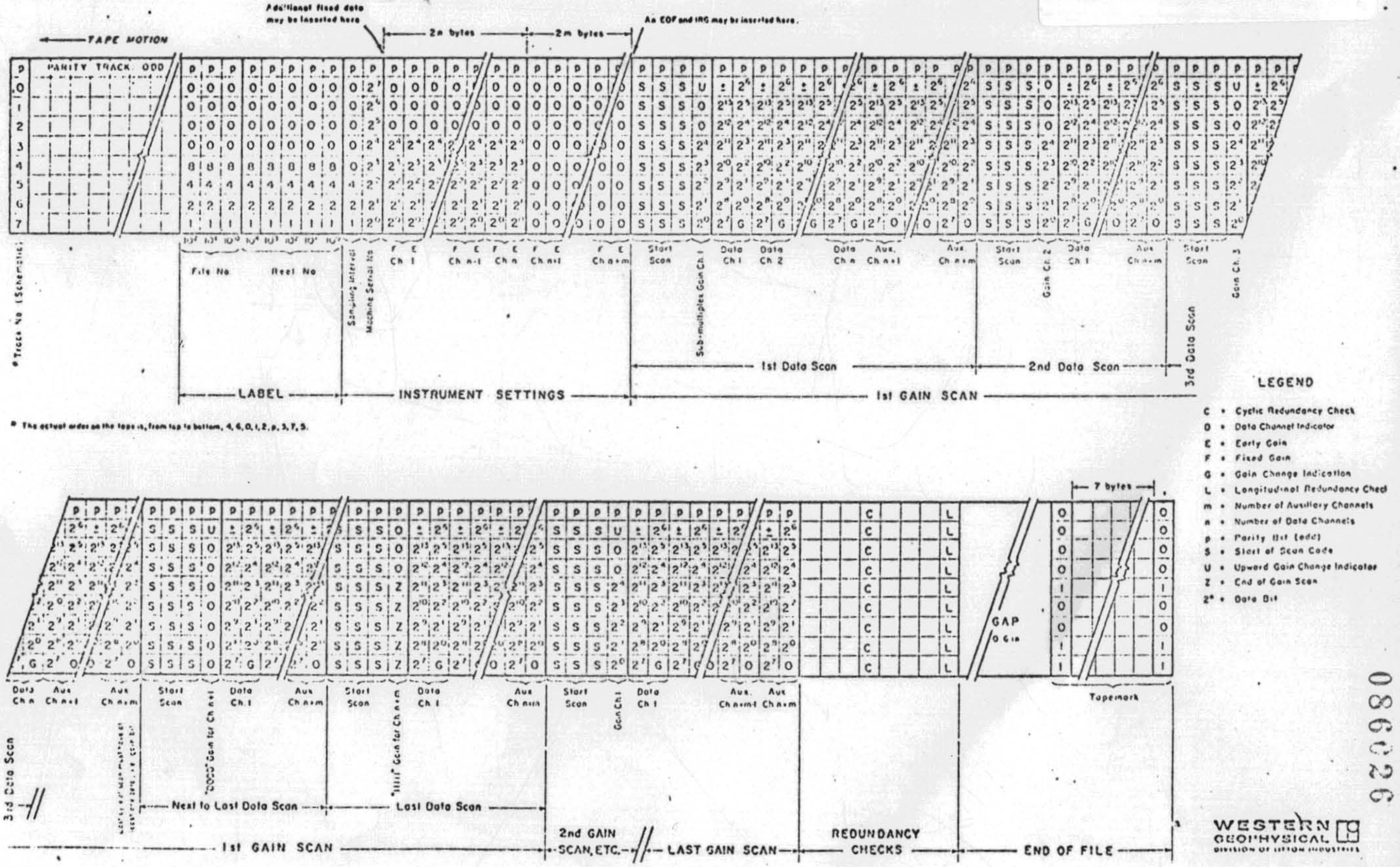

FIGURE 4

920080