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TECHNICAL REPORT NO. 65-128

OPERATION OF TWO OBSERVATORIES

Quarterly Report No. 2, Project VT/5054

1 August through 31 October 1965

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GEOTECH

THE GEOTECHNICAL CORPORATION

3401 SHILOH ROAD

GARLAND, TEXAS

TECHNICAL REPORT NO. 65-128

OPERATION OF TWO OBSERVATORIES

Quarterly Report No. 2, Project VT/5054
1 August through 31 October 19[illegible]

Sponsored by

Advanced Research Projects Agency
Nuclear Test Detection Office
ARPA Order No. 624

TELEDYNE INDUSTRIES
GEOTECH DIVISION
3401 Shiloh Road
Garland, Texas

IDENTIFICATION

AFTAC Project No:	VELA T/5054
Project Title:	Operation of Two Observatories
ARPA Order No:	624
ARPA Program Code No:	5810
Name of Contractor:	The Geotechnical Corporation
Date of Contract:	1 July 1963
Amount of Contract:	$1,677,304
Contract Number:	AF 33(657)-12373
Contract Expiration Date:	30 April 1966
Program Manager:	B. B. Leichliter, BR 8-8102

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ABSTRACT

This report describes the operation of the Blue Mountains Seismological Observatory and Uinta Basin Seismological Observatory during the period of 1 August through 31 October 1965. Modifications and additions to the observatory instrumentation are described and tests to improve the operation of the observatories are reported.

Also discussed is the progress of special investigations designed to evaluate and improve the detection capacity of the observatories.

OPERATION OF TWO OBSERVATORIES

1. INTRODUCTION

1.1 AUTHORITY

The research described in this report was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, and was monitored by the Air Force Technical Applications Center under Contract AF 33(657)-12373. The Statement of Work for this contract is shown in appendix 1.

1.2 HISTORY

The two seismological observatories operated under Project VT/5054 were constructed under Contract AF 33(657)-7185. Site selection and noise surveys for each observatory were accomplished by The Geotechnical Corporation; the final decision on the observatory locations was made by AFTAC. Texas Instruments Incorporated (TI) was responsible for the construction of all physical facilities.

Contract AF 33(600)-43486, issued to TI, contained the authority for equipping and operating the observatories. The instrumentation was supplied by Geotech and was installed under the direction of Geotech personnel under subcontract to TI. The observatories began operation on the following dates:

Blue Mountains Seismological Observatory (BMSO)	13 August 1962
Uinta Basin Seismological Observatory (UBSO)	26 November 1962

2. OPERATION OF BMSO AND UBSO

2.1 GENERAL

Data are recorded at each of the observatories on a 24-hour basis The observatories are normally manned 8 to 10 hours a day, 5 days a week. On weekends and holidays, they are manned by a skeleton crew 8 hours a day; however, additional personnel are on call in case of an emergency.

The Commander of Mountain Home Air Force Base, Idaho, was notified of the forthcoming transfer of BMSO to the USC&GS; the real property is under the control of that base. No reply has been received in regard to the real property.

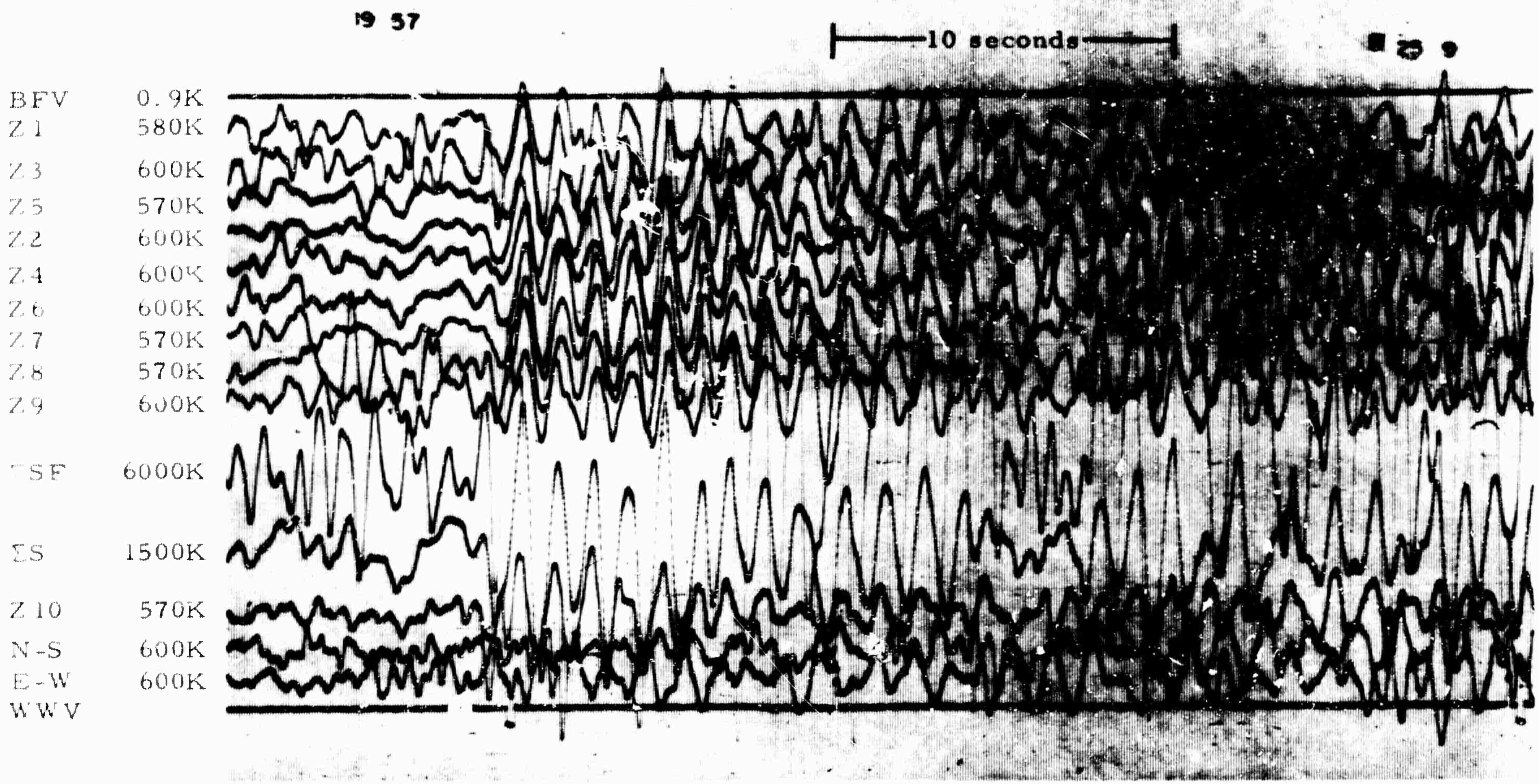
BMSO inventory information was sent to Mr. Brazee of the USC&GS at his request during September.

The annual lease payment for the BMSO site was made to the landowner, Mr. Robert J. Steward. This payment covers the interval 16 October 1965 to 16 October 1966.

The UBSO access road was accepted into the Uinta county road system during this reporting period. This will provide an opportunity for future assistance in repair and maintenance of the road. Recent conditions had made the road almost impassable during wet weather. The entire 5 miles of road surface has either received unprocessed natural asphalt (1.9 miles), new gravel surface (1.8 miles), or grading and clearing of drainage ditches.

Both BMSO and UBSO recorded the signal from CHASE IV. Figures 1 and 2 show the P-wave arrival at UBSO on the surface and shallow-buried array records. Note the difference in the background noise. The wind was from the NE at a speed of about 30 mph.

An underground nuclear explosion, Project "LONG SHOT", was detonated on 29 October at Amchitka Island, Alaska. Project "LONG SHOT" information was reported to AFTAC from the observatories and, as requested, all 16 mm film, magnetic tape records and observatory logs were air mailed, special delivery to SDL.



UBSO
16 Sept 65
Run 259
DG5000

Figure 1. Surface array recording of the P wave from CHASE IV. Wind from NE at 30 mph (X10 enlargement of 16 mm film)

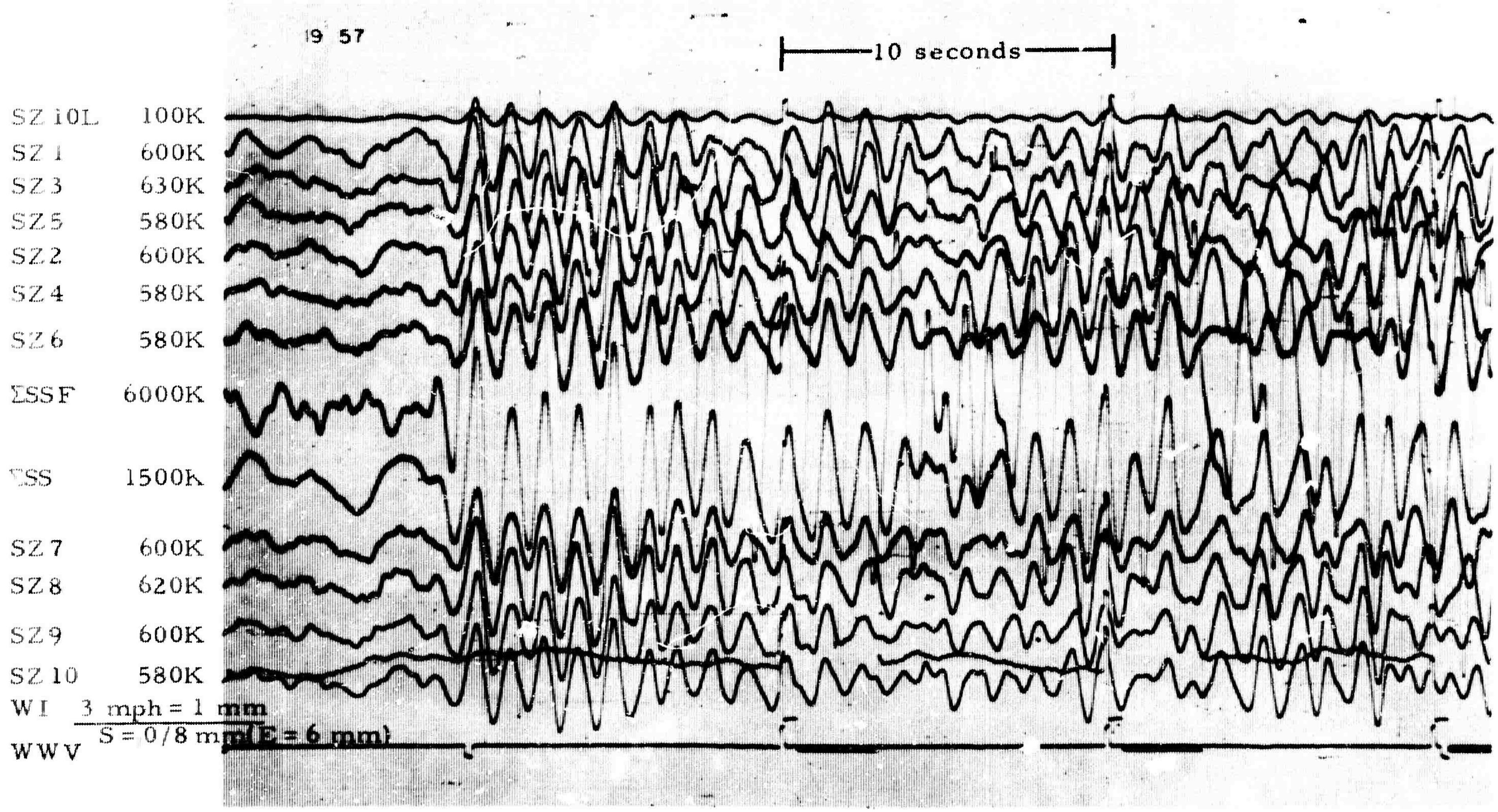


Figure 2. Shallow buried array recording of the P wave from CHASE IV. Wind from NE at 30 mph (X10 enlargement of 16 mm film)

UBSO
16 Sept 65
Run 259
DG5016

2.2 STANDARD SEISMOGRAPH OPERATING PROCEDURES

The operating parameters and the tolerances for these parameters are shown in table 1. These parameters are checked and reset, as necessary, when the frequency response of a seismograph is found to be out of tolerance. The calibration norms and their respective tolerances are shown in table 2. The characteristics of the response at which the BMSO and UBSO seismographs are normally operated are shown in figure 3.

When the August frequency response check was made at UBSO, all responses except that of shallow-buried array element SZ2 were within tolerances, and no adjustments were required.

During the September frequency response checks at UBSO, a seismometer damping change was required for SZ 10; this is the first such change to be made in the shallow-buried array seismometers since they were installed.

2.3 OUTAGES CAUSED BY ELECTRICAL STORMS

2.3.1 Electrical Storms and Damage to Instrumentation at BMSO

Table 3 shows a summary of electrical storm damage at BMSO during this reporting period.

2.3.2 Electrical Storms and Damage to Instrumentation at UBSO

No electrical storms occurred at UBSO during this reporting period.

2.4 DATA CHANNEL ASSIGNMENTS AND STANDARD OPERATING MAGNIFICATION OF SEISMOGRAPHS

In compliance with AFTAC specifications, each data format recorded at each observatory is assigned a data group number. When a data format is changed, a new data group number is assigned to the new format and reported to the Project Officer. All of the data formats and their group numbers, recorded during the reporting period at BMSO, are listed in table 4; data formats and data group numbers recorded at UBSO during this reporting period are listed in table 5.

Table 1. Operating parameters and tolerances of seismographs at BMSO and UBSO

Seismograph		Seismometer		Operating parameters and tolerances					Filter settings	
System	Comp	Type	Model	T_s	λ_s	T_g	λ_g	σ^2	Bandpass at 3 dB cutoff (sec)	Cut off rate at SP side (dB/oct)
SP	Z and H	Johnson-Matheson	7515 6480	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.03	0.1-100	12
SP	SZ	Geotech	18300	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.053	0.1-100	12
SP	Z	UA Benioff	1051	1.0 ±5%	1.0	0.083 ±5%	≈1.4	1.0	-	-
IB	Z	Melton	10012	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.018	0.05-100	12
IB	H	Geotech	8700B	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.001	0.05-100	12
BB	Z	Geotech	7505	12.5 ±5%	0.485 ±5%	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
BB	H	Geotech	8700A	12.5 ±5%	0.485	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
LP	Z	Geotech	7505A	20.0 ±5%	0.74 ±5%	110 ±10%	1.0 ±10%	0.175*	25-1000	12
LP	H	Geotech	8700A	20.0 ±5%	0.74 ±5%	110 ±10%	1.0 ±10%	0.175*	25-1000	12

KEY

SP	Short period	T_s	Seismometer free period (sec)
IB	Intermediate band	T_g	Galvanometer free period (sec)
BB	Broad band	λ_s	Seismometer damping constant
LP	Long period	λ_g	Galvanometer damping constant
UA	Unamplified (i.e., earth powered)	σ^2	Coupling coefficient
*	Changed at BMSO in September to 0.07		

Table 2. Calibration norms and operating tolerances for frequency response of the standard seismographs at BMSO and UBSO

SP Johnson-Matheson Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.2	5.0	0.0113	10
0.4	2.5	0.0950	7.5
0.8	1.25	0.685	5
1.0	1.0	1.0	-
1.5	0.67	1.52	5
2.0	0.5	1.90	5
3.0	0.33	2.12	7.5
4.0	0.25	1.87	12
6.0	0.167	1.15	20
8.0	0.125		
10.0	0.100		

LP Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.01	100	0.246	20
0.0125	80	0.377	20
0.0167	60	0.589	15
0.02	50	0.745	15
0.025	40	0.899	10
0.033	30	1.06	5
0.04	25	1.0	-
0.05	20	0.822	5
0.0667	15	0.506	10
0.10	10	0.173	20
0.143	7	b	a

IB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.1	10.0	0.0090	25
0.2	5.0	0.068	20
0.3	3.3	0.25	15
0.4	2.5	0.46	10
0.5	2.0	0.64	5
0.7	1.43	0.86	5
1.0	1.0	1.0	-
1.5	0.67	1.04	5
2.0	0.5	1.0	10
3.0	0.33	0.89	15
5.0	0.2	0.66	20

BB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.04	25.0	0.104	20
0.06	16.7	0.350	20
0.08	12.5	0.775	15
0.1	10.0	0.950	10
0.2	5.0	1.0	5
0.4	2.5	1.0	5
0.8	1.25	1.0	-
1.6	0.625	1.0	5
3.2	0.312	1.0	10
6.4	0.156	0.980	15

KEY

R. M. Relative magnification
A. T. Amplitude tolerance
a Tolerance not established in the period
b Measurements not reliable due to interference from microseismic background noise

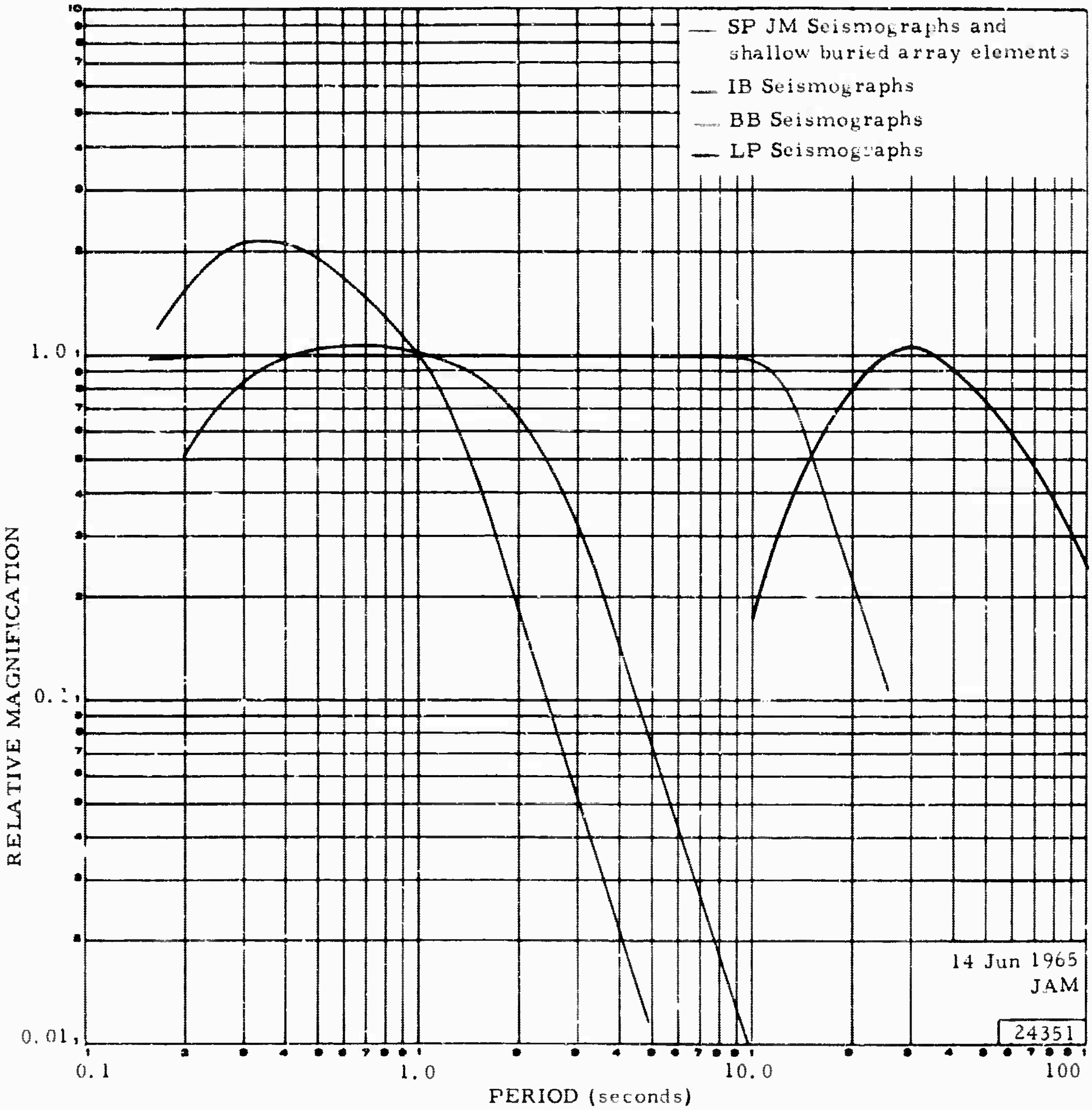


Figure 3. Normalized response characteristics of the routine seismographs at BMSO and UBSO during the reporting period

Table 3. Summary of electrical storms and component damage at BMSO 1 August thru 31 October 1965

Date of storm	Component damaged: Seismometer	Galvanometer	Fuse	Carbon blocks	Calibration line
2 August		Z6			
3 August			Z-1 Z-2 Z-4 Z-6 Z-9 N-S BBN ML	Z5	LF
24 August			Z-4 Z-1 Z-9		
25 August			Z-7 Z-10		

Table 4. Data channel assignments and normal operating magnifications of seismographs at BMSO

DEVELOCORDERS

Fast speed, 30 mm/minute

Primary data: Channel	Data group 4004 1 Aug to 31 Oct	Mag	Secondary data: Channel	Data group 4009 1 Aug to 20 Oct	Mag	Channel	Data group 4010 21 Oct to 31 Oct	Mag
1	V	25K	1	V	1K	1	V	1K
2	Z1	750K	2	Z3	1500K	2	Z3	1500K
3	Z4	750K	3	Z3L	70K	3	Z3L	70K
4	Z7	750K	4	NSL	70K	4	NSL	70K
5	Z2	750K	5	ESL	70K	5	ESL	70K
6	Z5	750K	6	ΣQ	1000K	6	ZHF5H	10,000K
7	Z6	750K	7	ΣA	1000K	7	ZHF5L	1000K
8	Z8	750K	8	ΣB	1000K	8	ZHF6H	9000K
9	Z9	750K	9	ΣC	1000K	9	ZHF6L	1000K
10	Z10	750K	10	MS	—	10	MS	-
11	ΣSF	5000K	11	WI	—	11	WI	-
12	ΣS	2000K	12	ΣS	4000K	12	ΣS	4000K
13	Z3	750K	13	ZIB	60K	13	ZIB	60K
14	NSP	750K	14	NIB	60K	14	NIB	60K
15	ESP	750K	15	EIB	60K	15	EIB	60K
16	WWV	—	16	WWV	—	16	WWV	-

Slow speed, 3 mm/minute

Channel	Data group 4005 1 Aug to 31 Oct	Mag
1	WI	—
2	MS	—
3	ZLL	1K
4	NLL	1K
5	ELL	1K
6	ZLP	60K
7	NLP	10K
8	ELP	10K
9	ML	—
10	ZBB	5K
11	NBB	5K
12	EBB	5K
13	Z8	800K
14	Test	—
15	Test	—
16	WWV	—

MAGNETIC-TAPE RECORDERS

Primary data: Channel	Data group 4007 1 Aug to 31 Oct	Secondary data: Channel	Data group 4001 1 Aug to 21 Oct	Channel	Data group 4011 22 Oct to 31 Oct
1	TCMDG	1	TCMDG	1	TCMDG
2	Z1	2	ZLP	2	ZLP
3	Z2	3	NLP	3	NLP
4	Z3	4	ELP	4	ELP
5	Z4	5	NSP	5	NSP
6	Z5	6	ESP	6	ESP
7	Comp	7	Comp	7	Comp
8	Z6	8	ZIB	8	ZIB
9	Z7	9	NIB	9	NIB
10	Z8	10	EIB	10	EIB
11	Z9	11	ZBB	11	ZHF5H
12	Z10	12	NBB	12	ZHF5L
13	ΣSF	13	EBB	13	ZHF5LL
14	WWV	14	WWV	14	WWV

KEY

Z	Amplified vertical short-period seismograph from a site identified by a suffix number
Z3L	Amplified vertical short-period low-gain seismograph - number denotes seismometer site
ZIB	Vertical intermediate-band seismometer
ZLL	Vertical long-period low-gain seismograph
ZLP	Vertical long-period seismograph
ZBB	Vertical broad-band seismograph
V	Unamplified vertical short-period seismograph
ΣSF	ΣS filtered
ΣS	Summation of Z1 through Z10
ΣQ	Summation of Z4, Z5, & Z8
ΣA	Summation of Z1, Z3, & Z5
ΣB	Summation of Z2, Z4, & Z6
ΣC	Summation of Z7, Z8, Z9, & Z10
NSP	Amplified north-south short-period seismograph
NSL	North-south short-period low-gain seismograph
NIB	North-south intermediate-band seismograph
NLL	North-south long-period low-gain seismograph
NLP	North-south long-period seismograph
NBB	North-south broad-band seismograph
ESP	Amplified east-west seismograph
ESL	East-west short-period low-gain seismograph
EIB	East-west intermediate-band seismograph
ELL	East-west long-period low-gain seismograph
ELP	East-west long-period seismograph
EBB	East-west broad-band seismograph
MS	Microbarograph - short-period
WI	Anemometer - wind speed & direction
ML	Microbargraph - long-period
WWV	Radio time - (WWV, STS, and voice on tape)
Comp	Compensation
TCMDG	Time code management data group
Mag	Magnification (see note)
HF	High-frequency response JM vertical seismograph
H	High gain
L	Low-gain level 1 for tape recorder
LL	Low-gain level 2 for tape recorder
Note:	Magnification of: Short-period measured at 1 cps; Intermediate-band measured at 1 cps; Broad-band measured at 0.8 cps; Long-period measured at 0.04 cps

Table 5. Data channel assignments and normal operating magnifications at UBSO

DEVELOCORDERS

Fast speed, 30 mm/minute								Slow speed, 3 mm/minute			Shallow-buried array		
SP Primary			SP Secondary										
Channel	Data group 5000 1 Aug to 31 Oct	Mag	Channel	Data group 5020 1 Aug to 15 Oct	Mag	Data group 5026 14 Oct to 31 Oct	Mag	Channel	Data group 5004 1 Aug to 31 Oct	Mag	Channel	Data group 5016 1 Aug to 31 Oct	Mag
1	V	16K	1	V	1K	V	1K	1	WI	—	1	SZ10L	100K
2	Z1	600K	2	NEP	1.4K	Z1	600K	2	MS	—	2	SZ1	600K
3	Z3	600K	3	EEP	1.9K	ZHF5	20000K	3	ZLL	2K	3	SZ3	600K
4	Z5	600K	4	ΣQ	1000K	ZHF5L	2000K	4	NLL	2K	4	SZ5	600K
5	Z2	600K	5	Z1	600K	ZHF6	20000K	5	ELL	2K	5	SZ2	600K
6	Z4	600K	6	SH1	2000K	ZHF6L	2000K	6	ZLP	45K	6	SZ4	600K
7	Z6	600K	7	SH1L	600K	ΣSF	3000K	7	NLP	25K	7	SZ6	600K
8	Z7	600K	8	ΣSF	3000K	SHHF5	6000K	8	ELP	25K	8	Test	—
9	Z8	600K	9	DH1	2000K	SHHF5L	9000K	9	Test	—	9	ΣSSF	6000K
10	Z9	600K	10	DH1L	600K	SHHF6	40000K	10	ML	—	10	ΣSS	1500K
11	ΣSF	6000K	11	ZIB	50K	SHHF6L	6000K	11	ZBB	2.5K	11	SZ7	600K
12	ΣS	1500K	12	NIB	50K	DHHF	40000K	12	NBB	2.5K	12	SZ8	600K
13	Z10	600K	13	EIB	50K	DHHFL	4000K	13	EBB	2.5K	13	SZ9	600K
14	NSP	600K	14	MS	—	Test	-	14	SZ	350K	14	SZ10	600K
15	ESP	600K	15	WI	—	WI	-	15	Test	—	15	WI	—
16	WWV	—	16	WWV	—	WWV	-	16	WWV	—	16	WWV	—

MAGNETIC-TAPE RECORDERS

Channel	No. 1 Data group 5007 1 Aug to 31 Oct	Channel	No. 2 Data group 5011 1 Aug to 13 Oct	Channel	No. 2 Data group 5015 14 Oct to 31 Oct	Channel	No. 3 Data group 5013 1 Aug to 31 Oct
1	TCMDG	1	TCMDG	1	TCMDG	1	TCMDG
2	Z1	2	ZLP	2	ZLP	2	SZ1
3	Z2	3	NLP	3	DHHF	3	SZ2
4	Z3	4	ELP	4	DHHFL	4	SZ3
5	Z4	5	NSP	5	NSP	5	SZ4
6	Z5	6	ESP	6	ESP	6	SZ5
7	Comp	7	Comp	7	Comp	7	Comp
8	Z6	8	ZIB	8	ZHF5	8	SZ6
9	Z7	9	Test	9	ZHF5L	9	SZ7
10	Z8	10	Z1	10	ZHF5LL	10	SZ8
11	Z9	11	ZBB	11	SHHF5	11	SZ9
12	Z10	12	DH1	12	SHHF5L	12	SZ10
13	ΣSF	13	SH1	13	SHHF5LL	13	ΣSSF
14	WWV	14	WWV	14	WWV	14	WWV

KEY

Z	Amplified vertical short-period seismograph from a site identified by a suffix number
ZIB	Vertical intermediate-band seismograph
ZLL	Vertical long-period low-gain seismograph
ZLP	Vertical long-period seismograph
ZBB	Vertical broad-band seismograph
V	Unamplified vertical short-period seismograph
ΣSF	ΣS filtered
ΣQ	Summation of Z4, Z5, & Z8
ΣS	Summation of Z1 through Z10
ΣSSF	ΣSS filtered
ΣSS	Summation of SZ1 through SZ10
NSP	Amplified north-south short-period seismograph
NIB	North-south intermediate-band seismograph
NEP	Unamplified north short-period seismograph
NLL	North-south long-period low-gain seismograph
NLP	North-south long-period seismograph
NBB	North-south broad-band seismograph
ESP	Amplified east-west seismograph
EIB	East-west intermediate-band seismograph
EEP	Unamplified east short-period seismograph
ELL	East-west long-period low-gain seismograph
ELP	East-west long-period seismograph
EBB	East-west broad-band seismograph
SH	Seismometer in 500 ft hole
	Number with SH or DH indicates 1st or 2nd seismometer in hole
DH	Seismometer in 10,000 ft hole
SZ10L	Amplified vertical short-period low-gain seismometer in a hole
SZ	Amplified vertical short-period seismometer in a hole at a depth of 200 ft
WWV	Radio time- (WWV, STS, and voice on tape)
MS	Microbarograph - short-period
ML	Microbarograph - long-period
WI	Anemometer - wind speed & direction
Test	Test instrumentation
Comp	Compensation
Mag	Magnification (see note)
TCMDG	Time code management data group
HF	High-frequency response JM vertical seismograph
L	Low-gain level 1 for tape recorder
LL	Low-gain level 2 for tape recorder
Note.	Magnification of: Short-period measured at 1 cps; Intermediate-band measured at 1 cps; Broad-band measured at 0.8 cps; Long-period measured at 0.04 cps

2.5 EQUIPMENT MALFUNCTIONS

Component failure information is routinely punched onto IBM cards. A computer program, Program MISERABLE, has been written to tabulate some of these data. A printout of the tabulated data for BMSO and UBSO for the reporting period is shown in tables 6 and 7. The interpretation of the codes used is given in appendix 2 of this report.

2.6 CALIBRATION OF TEST EQUIPMENT

Routine calibration of test equipment was accomplished at each observatory during the reporting period by use of a 1-percent standard meter. This meter is sent to the Garland laboratory for a calibration check every 3 months. A dual equipment calibration record/log for each item of test equipment has been kept up to date by the observatories and the Garland laboratory during the reporting period.

2.7 SHIPMENT OF DATA TO THE SEISMIC DATA LABORATORY (SDL)

BMSO and UBSO magnetic-tape seismograms from 1 June through 31 September were shipped to SDL. Magnetic-tape seismograms are shipped to SDL with the regular Long-Range Seismic Measurements Program (LRSM) data shipment about 15 days after the end of the month during which they were recorded.

All 16-millimeter film seismograms recorded at BMSO and UBSO through 31 August were sent to SDL. The primary and secondary short-period and the long-period 16-millimeter film seismograms and their corresponding operating logs were shipped to SDL as soon as the data for the monthly five-station earthquake bulletin were compiled.

2.8 SECURITY INSPECTION

Mr. L. T. Wallenborn, Seattle, Washington, Security Inspector for BMSO, telephoned on 30 August and received needed information on security instead of making a personal inspection.

Table 6. Component failure report for BMSO

Specific function	Model No.	Sub assembly	No. serviced	Repair time	Time inop	Prevent.	Catas.	Component	No.
PTA	(4300)		4	3.2	3.7	3	1	V103	1
								V102	1
								V101	1
								GALVO	1
FC	(1151A)		1	.1	.1	0	1	DSXXX	1
PS	(4304)		5	.7	1.4	3	2	V201	5
MOC	(10380)		3	.4	17.0	0	3	V403	1
								V402	1
								V401	1
TR	(7360)	OSC	17	5.3	6.0	4	13	V103	2
								V102	7
								V101	8
		PS	3	.7	.8	1	2	V102	1
								V101	1
								V103	1
C	(9212)		1	.1	6.0	1	0	Y-1	1
PA	(9231)		1	.5	.5	0	1	Q1	1
VR	(760R)		6	8.0	456.0	0	6	Q81	1
								Q56	1
								Q36	1
								Q30	1
								CR79	1
								Q82	1

Table 7. Component failure report for UBSO

Specific function	Model No.	Sub assembly	No. serviced	Repair time	Time inop	Prevent.	Catas.	Component	No.
DEV	(400[illegible])		5	.8	.9	2	3	DS601	1
								DS602	1
								B301	1
								DS301	2
HE	(2484)		2	.4	6.0	0	2	STYLUS	2
RPC	(11901)		1	.1	14.0	0	1	DS1	1
TR	(7360)	DISC	1	.5	.5	0	1	DSXXX	1
		OSC	1	.4	4.0	1	0	V101	1
PS	(4304)		3	.3	.3	1	2	V201	2
								V203	1
PTA	(4300)		1	.1	.1	0	1	V101	1
FC	(1151A)	PCB	2	1.0	1.0	0	2	Q103	1
								Q328	1
PA	(9231)		4	.4	.4	0	4	Q1	1
								Q2	1
								Q3	1
								Q4	1

2.9 QUALITY CONTROL

Film quality control checks were routinely made on the primary short-period, secondary short-period, and long-period data recorded at BMSO and UBSO during this reporting period.

Magnetic-tape quality control checks were routinely made on the data from the two tape recorders at BMSO and the three tape recorders at UBSO.

3. EVALUATE DATA AND PROVIDE MOST EFFECTIVE OBSERVATORY POSSIBLE

3.1 MODIFICATIONS AND ADDITIONS TO INSTRUMENTATION AT BMSO AND UBSO

3.1.1 Power System Modification

During the last week of August and the third week of September, modifications were made to the power system at UBSO and at BMSO, respectively. These modifications include the installation of an additional relay rack and ventilating blower and the installation of the new Dual Dc Regulator, Model 21427, to replace the Dc Regulator, Model 11219, previously used.

The relay rack provides additional space for instrumentation in the console, allowing some of the instrumentation to be relocated for more reliable operation. Specifically, the Beckman AC voltage regulator, which had been inadequately ventilated, was placed in a location where adequate ventilation is supplied. We anticipate that this will improve the performance of the Beckman regulator.

The dc regulator is used to maintain the voltage level of the dc power below the upper input limits of timing system components, power amplifiers, etc. The new regulator is much more efficient and is expected to be more reliable than the old regulator. The added efficiency is acquired because the new unit is a "chopper type" regulator while the old unit was a "voltage divider type" regulator.

Both regulators caused added compensated and uncompensated noise at BMSO and at UBSO. Added output capacitance was applied to the UBSO unit resulting in a normal magnetic-tape recorder noise level. The UBSO unit was then left in operation with the external capacitors pending a permanent correction for the problem. The BMSO unit has been removed from operation and returned to our Garland laboratory for investigation. The old regulator has been temporarily returned to operation.

3.1.2 Lightning Protector Modification at BMSO and UBSO

The present observatory lightning protector equipment, composed of fuses and carbon blocks, is being replaced with the three-electrode, gas-filled, Associated Electrical Industries, LTD. (AEI) Protector. Two types of AEI Protectors are being used. Type 16B (300-500 volt, yellow) is used in 110 Vac power circuits, i.e., mass position actuator, vault power, and seismometer heaters. Type 16A (150-300 volt, black) is used for all other circuits.

3.1.3 Installation of High-Frequency Seismograph Systems

In order to determine if high-frequency energy in the 3 to 10 cps range can be detected from signal sources at teleseismic distances, two high-frequency vertical seismographs, ZHF5 and ZHF6, were placed in operation at BMSO and UBSO on 20 and 21 October, respectively. Figure 4 is a block diagram of the ZHF5 and ZHF6 high-frequency response seismograph systems. Shaping of the responses was obtained by a modification to the PTA and the addition of a filter amplifier. The modification included replacement of the 3 cps galvanometer normally used with a 10 cps galvanometer and exchange of the Model 6824-1 filter for a Model 6824-7 filter. Figures 5 through 10 show the computed frequency responses of the ZHF5 and ZHF6 high-frequency seismograph systems. The standard short-period seismographs are routinely calibrated at 1 cps, and the high-frequency short-period systems are calibrated at 6 cps.

An equivalent high-frequency seismograph system was installed in the shallow-buried array on 26 October and in the deep-hole system on 27 October. The deep-hole system uses a Krohn-Hite filter for response shaping.

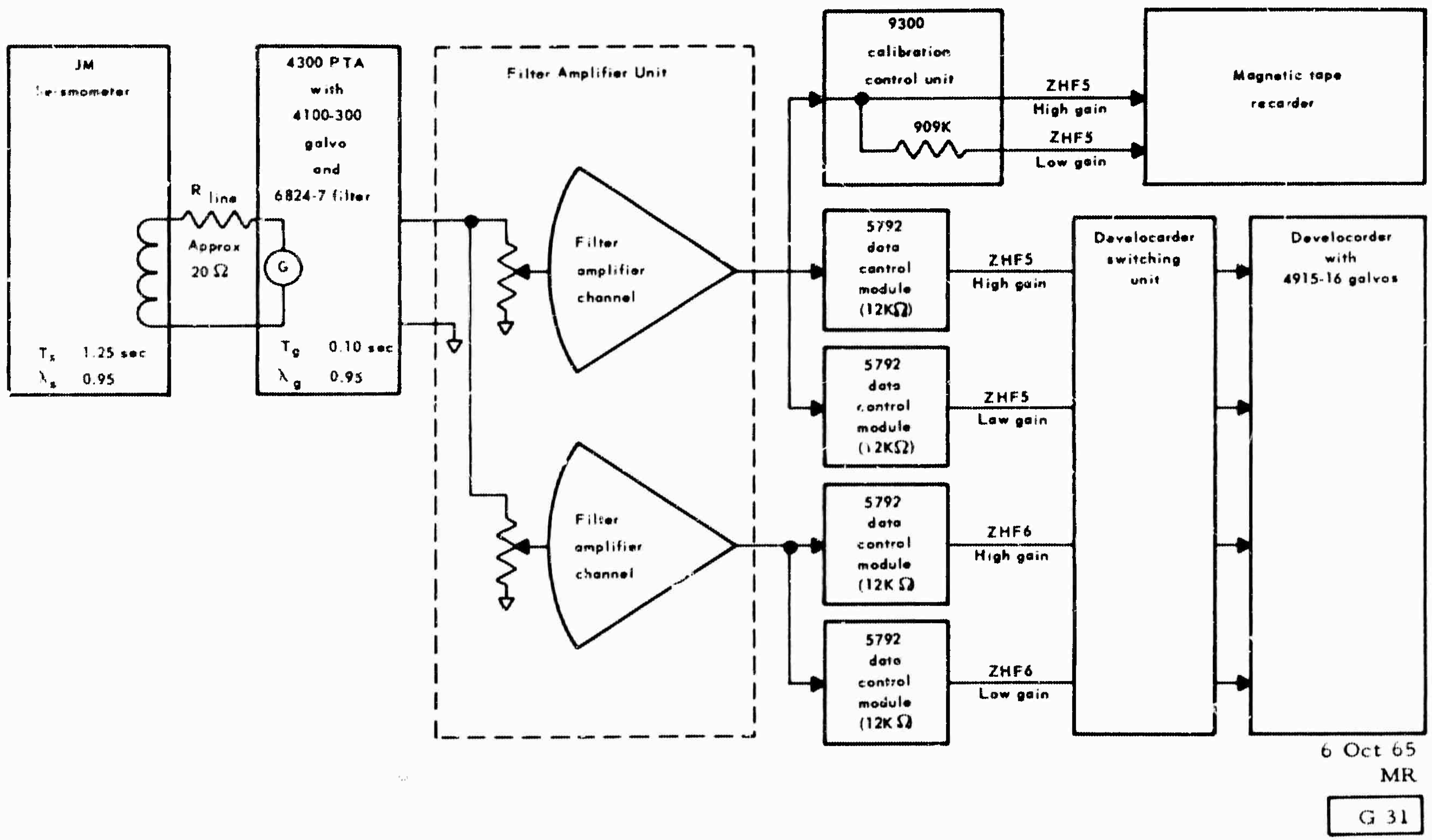


Figure 4. Block diagram for the ZHF5 and ZHF6 high-frequency seismograph systems

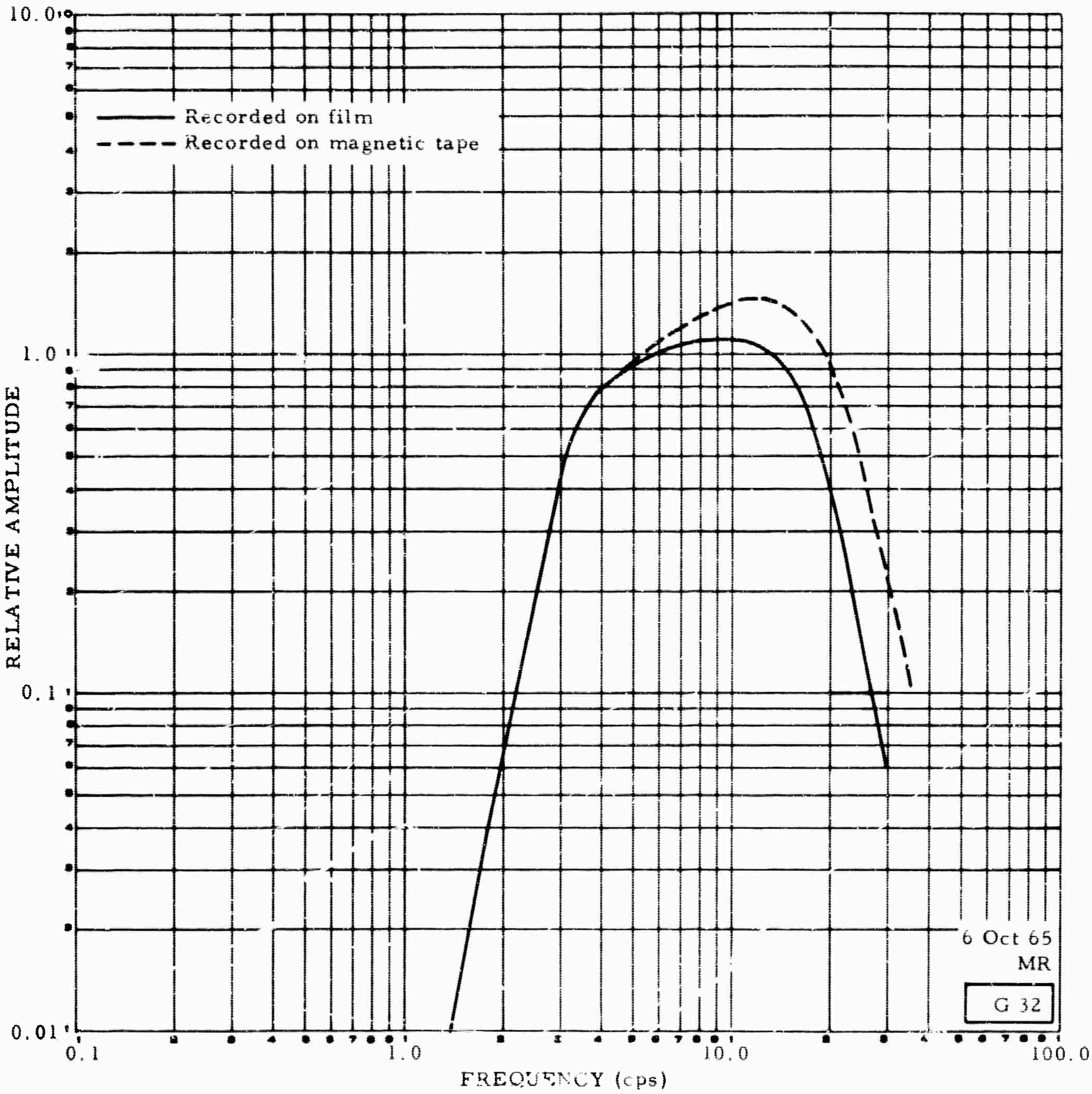


Figure 5. Frequency responses for the ZHF5 seismograph system with constant displacement input

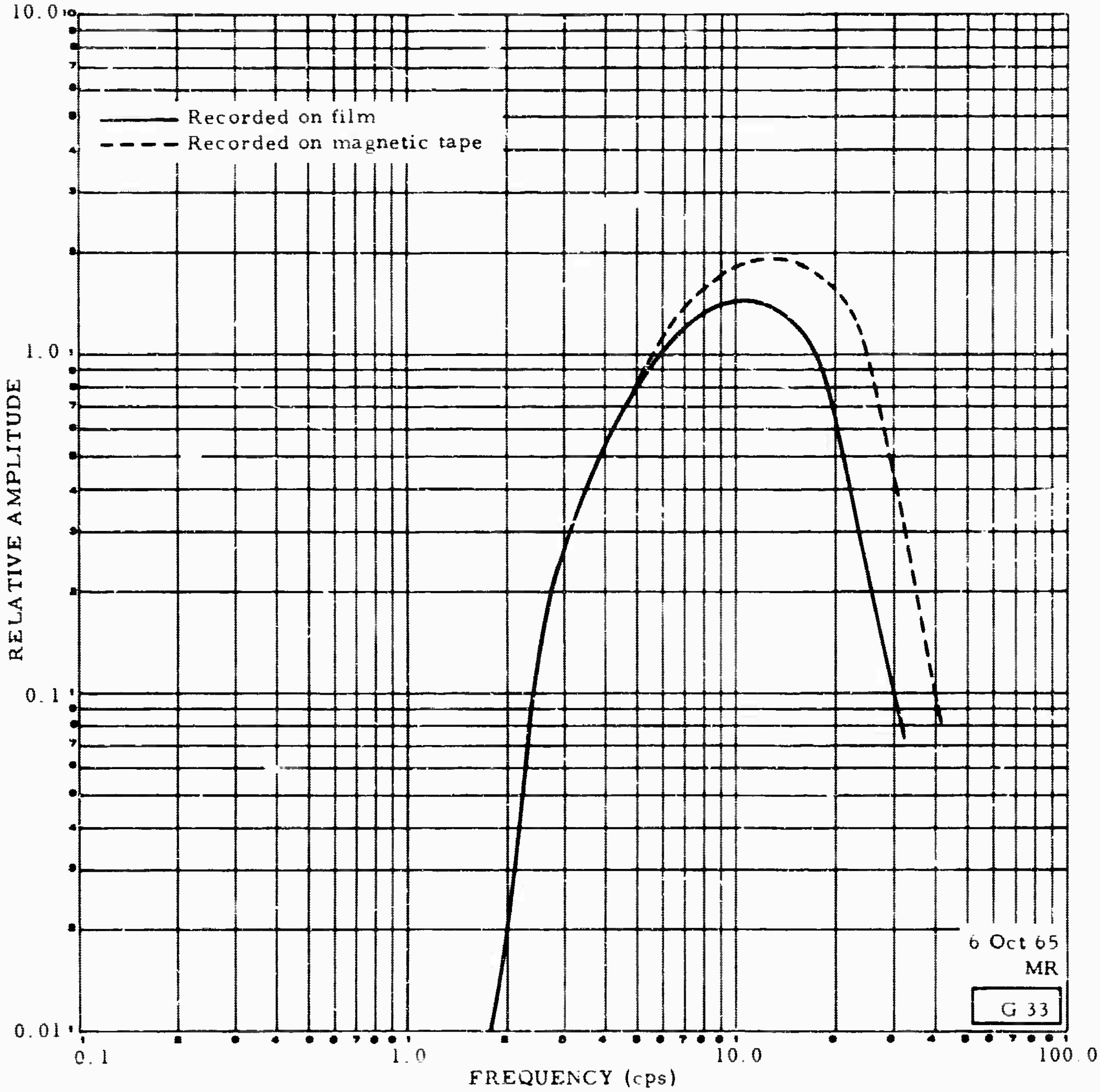


Figure 6. Frequency responses for the ZHF6 seismograph system with constant displacement input

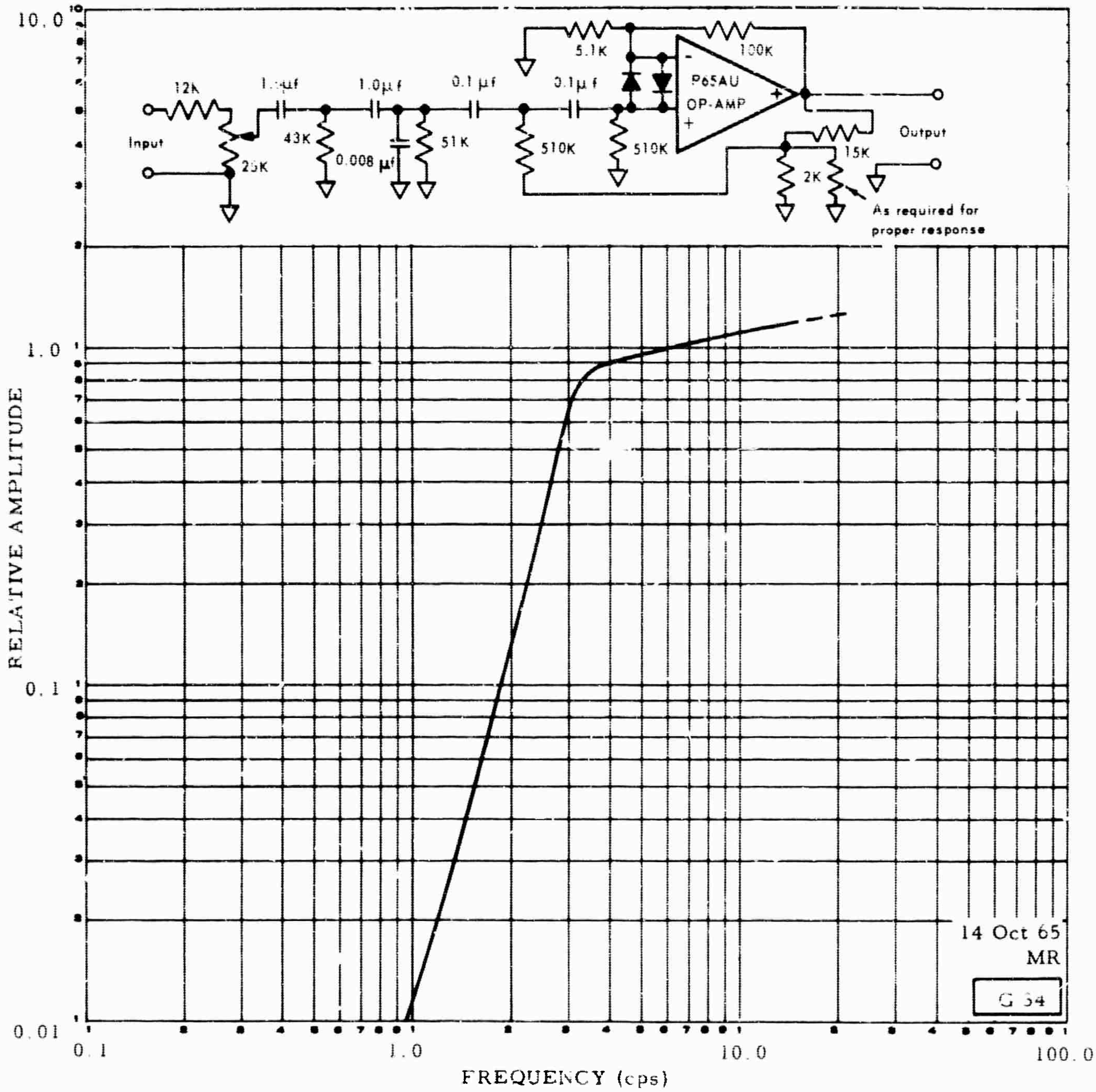


Figure 7. Frequency response and simplified circuit diagram for the filter amplifier for the ZHF5 high-frequency seismographs. The maximum gain of this channel is approximately 10 at 6 cps

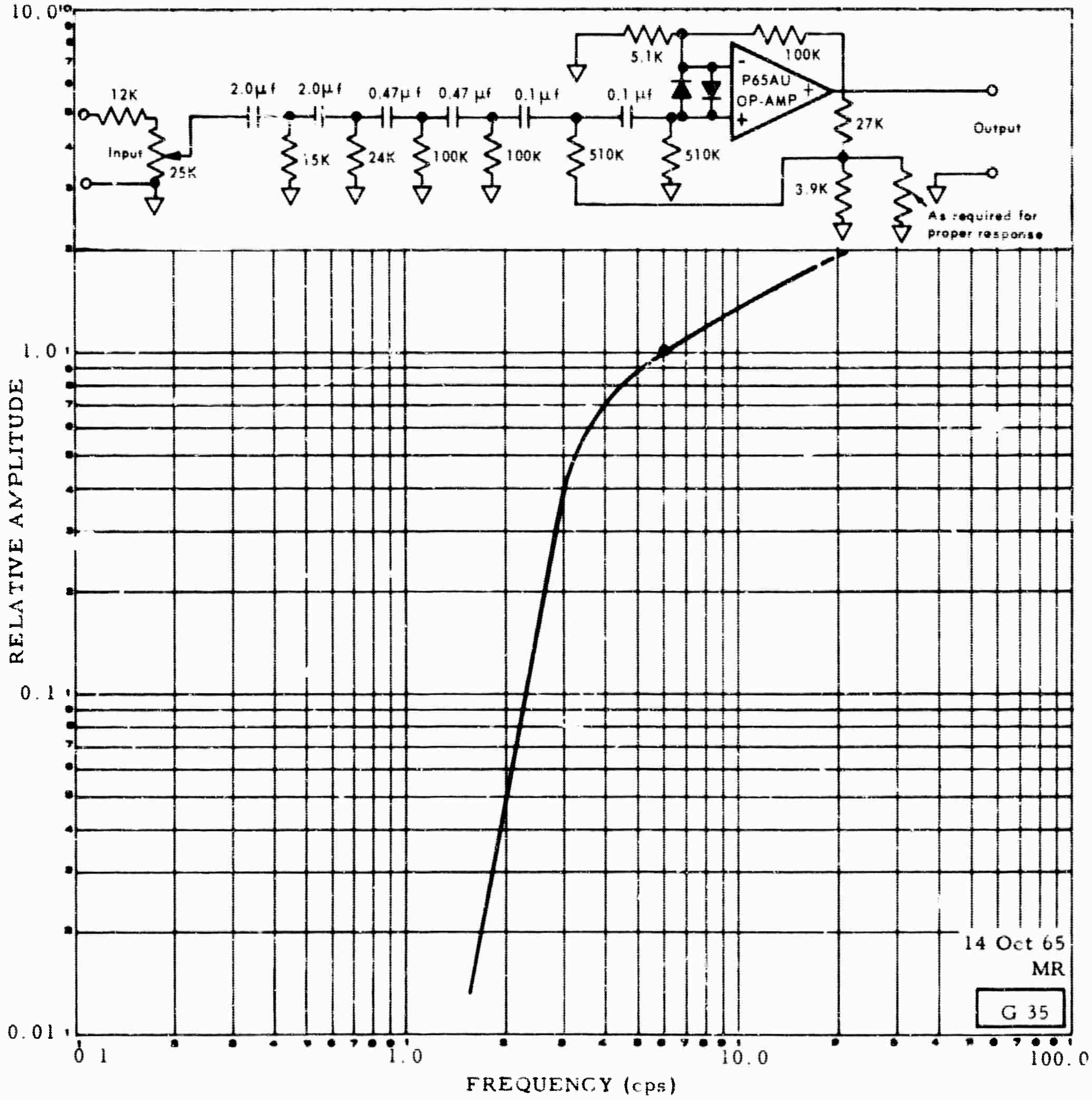


Figure 8. Frequency response and simplified circuit diagram for the filter amplifier for the ZHF6 high-frequency seismographs. The maximum gain of this channel is approximately 6 at 6 cps

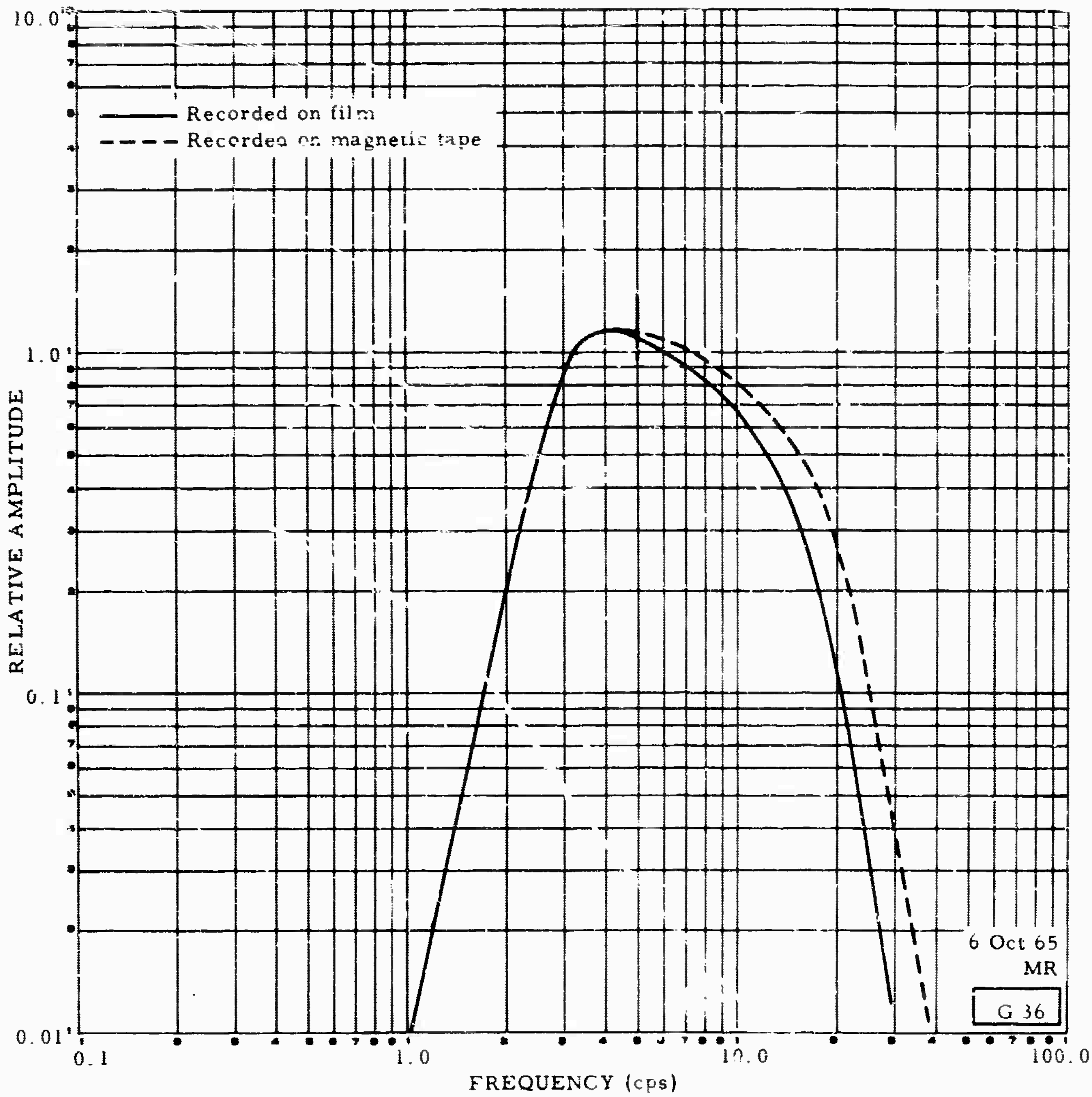


Figure 9. Frequency responses for the ZHF5 seismograph system with constant velocity input

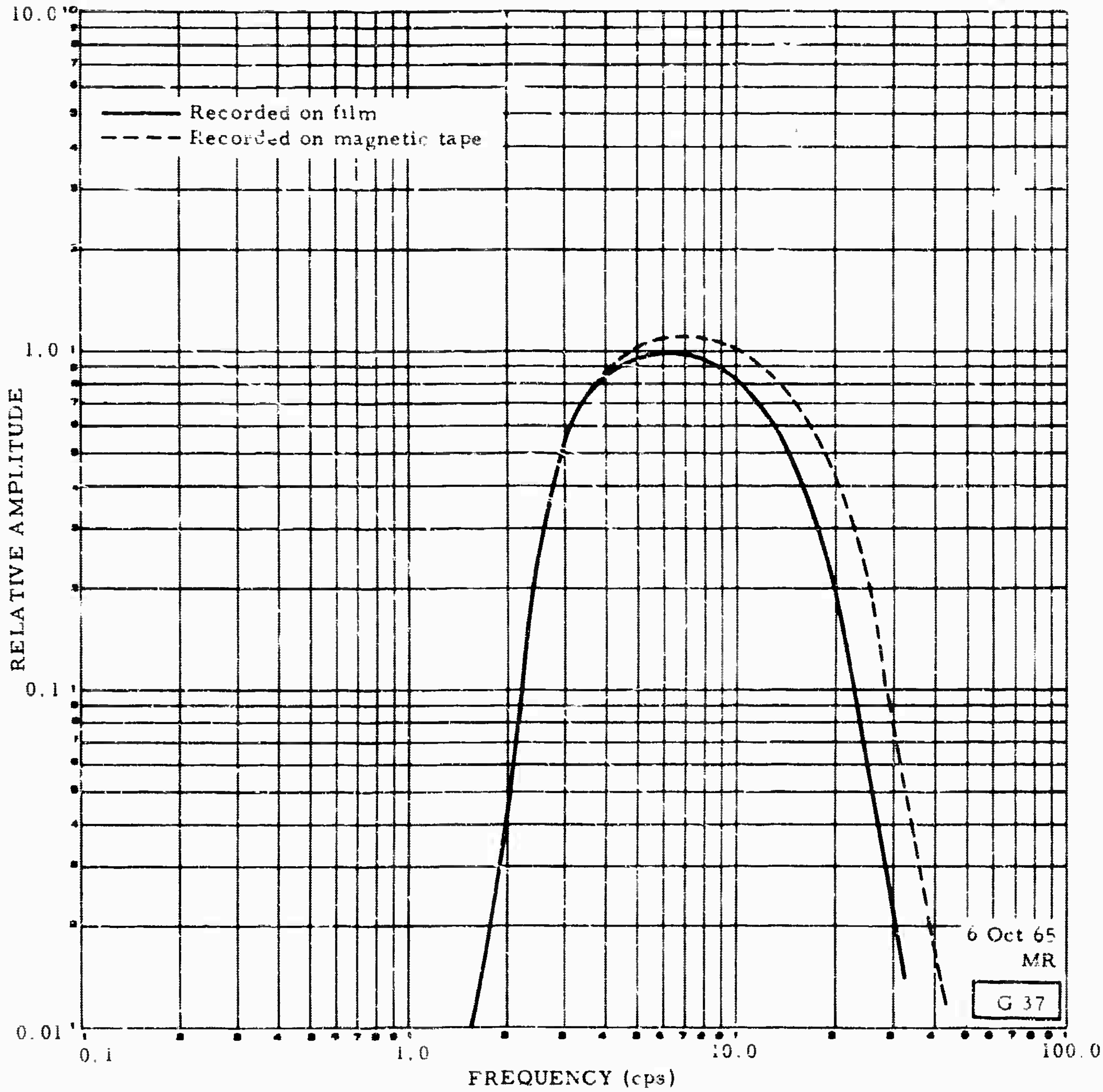


Figure 10. Frequency responses for the ZHF6 seismograph system with constant velocity input

3.1.4 Addition of PTA Test Set

A PTA Test Set, Model 23930, was supplied to BMSO and UBSO during August and September, respectively. This device saves operator time in allowing simultaneous monitoring of the PTA input and output balance and is very useful in signal tracing.

3.1.5 Installation of the Microbarograph Calibrator, Model 19403

Installation of the Microbarograph Calibrator, Model 19403, was started at BMSO and UBSO during the last week of the reporting period. The calibrator output is 19 microbars at a period of 5 seconds and 68 microbars at a period of 120 seconds. Routine calibrations will be conducted on a weekly basis.

3.1.6 Helicorder Modification

Modification of the Helicorder amplifiers and styli was completed during August. This modification improved the frequency response of the Helicorder system.

3.2 LONG-PERIOD SEISMOGRAPH MODIFICATION AT BMSO

During September the modification of the long-period seismographs at BMSO was completed. The modifications to each of the seismographs include:

a. Installation of a remote period actuator so that the natural period of the seismometer can be adjusted without entering and disturbing the vault;

b. Installation of convection shields over the seismometer to provide better protection from air convections and temperature changes;

c. Conversion of the basic seismograph to a direct-coupled system. To accomplish this the PTA attenuator was set to zero dB, the circuit damping resistance was reduced to properly damp the galvanometer, and the magnetic flux of the seismometer magnet was reduced by shunting to get the proper seismometer damping. This conversion will increase the output level and the signal-to-electrical noise ratio for the seismograph. Because the magnetic flux can no longer be used to adjust the calibrator motor constant, this adjustment must be accomplished through the use of resistive networks in the calibration system.

As an experiment, the insulating material for the long-period north-south vault was placed in fabric bags instead of plastic bags.

3.3 DEVELOCORDER MODIFICATIONS AT UBSO

All UBSO Develocorders are now completely modified with the installation of new transport, processing, and pump units.

Installation of peristaltic pumps in the Develocorders was completed during August.

All operating date-timers (Model 4800), except those for the Develocorders used with the MAP units, have been converted to the Model 4800A configuration. This modification will greatly reduce the maintenance time required in replacing the old flash-tube assemblies. The new bulb-type light source provides a clearer printing of the date-time information.

The rotary processing assemblies for all of the UBSO Develocorders were converted to a new type (Recording Unit Kit, Model 16041). The new processor has no moving parts and provides a thicker meniscus for more reliable fluid application to the film. The new type processor was included in the Develocorder for the shallow-buried array when it was initially installed.

3.4 DEEP-HOLE MEASUREMENTS OF CASING DEVIATION FROM VERTICAL AT UBSO

On 28 August, the deep-hole seismometer was removed from the hole at UBSO to allow measurement of the verticality of the inside casing. Measurements were made at 1000-foot intervals. This work was accomplished under another Geotech contract in preparation for installation of a vertical array.

3.5 VERTICAL ARRAY INSTALLATION AT UBSO

A vertical array was installed in the 10,000-foot hole at UBSO during September. An LRSM van was used for recording and control. A 15-inch snow hampered the installation of this equipment; however, outputs from this array were being recorded through the MAP system at the end of September.

The gain trims for the vertical array inputs were adjusted to provide input levels comparable to the shallow-buried array. The 50 mμ calibration level normally used exceeded the linear range of the system; therefore, a 30 mμ calibration level was used. Operation of the array was suspended on 22 October, and the van was moved on 23 October.

3.6 MODIFICATION TO THE HONEYWELL VOLTAGE-CONTROLLED OSCILLATORS AT UBSO

The purpose of the modification is to increase linearity of voltage-controlled oscillators. Two modified oscillators have been installed; however, sufficient data have not been collected from which definite conclusions can be reached. An additional oscillator has been sent to the Garland laboratory for modification. This oscillator will be field tested at BMSO.

4. TRANSMIT DAILY MESSAGES TO THE USC&GS

Arrival time, period, and amplitude measurements recorded at each observatory are reported daily to the Director of the USC&GS in Washington, D.C. A list of the number of events of all types reported to the USC&GS by BMSO and UBSO from 1 January through 31 October 1965 is included in table 8.

5. PUBLISH MONTHLY EARTHQUAKE BULLETIN

Data from BMSO and UBSO were combined with data from CPSO, TFSO, and WMSO and published in a multistation earthquake bulletin. The bulletins for February, March, April, and May 1965 were published during this reporting period. Data for June and July have been keypunched, transcribed onto magnetic tape, and sent to SDL for processing. Processing of the August data is about 98 per cent complete. Keypunching of the September data is about 50 per cent complete.

Table 8. Locals (L), near regionals (N), regionals (R), and teleseisms (T) reported to the USC&GS by BMSO and UBSO from 1 January through 31 October 1965

January 1965

	L	N	R	T	Per[a]
BMSO	74	49	7	484	51.2
UBSO	21	280	25	738	67.8
USC&GS signals located		358			

February 1965

	L	N	R	T	Per[a]
BMSO	108	24	4	1057	60.1
UBSO	34	244	37	3015	90.5
USC&GS signals located			1030		

March 1965

	L	N	R	T	Per[a]
BMSO	111	31	8	1153	63.0
UBSO	55	332	18	1503	85.9
USC&GS signals located			679		

April 1965

	L	N	R	T	Per[a]
BMSO	64	60	10	840	65.4
UBSO	51	318	24	1132	82.6
USC&GS signals located		524			

May 1965

	L	N	R	T	Per[a]
BMSO	70	69	4	433	60.3
UBSO	13	307	18	861	70.3
USC&GS signals located			418		

June 1965

	L	N	R	T	Per[a]
BMSO	65	68	15	602	59.1
UBSO	10	301	31	1145	74.8
USC&GS signals located			469		

July 1965

	L	N	R	T	Per[a]
BMSO	93	97	15	670	67.2
UBSO	24	388	47	883	77.4
USC&GS signals located		469			

August 1965

	L	N	R	T	Per[a]
BMSO	90	196	12	813	b
UBSO	29	632	39	1026	b
USC&GS signals located			b		

September 1965

	L	N	R	T	Per[a]
BMSO	100	153	28	627	b
UBSO	67	614	50	908	b
USC&GS signals located			b		

October 1965

	L	N	R	T	Per[a]
BMSO	117	113	13	556	b
UBSO	56	628	36	990	b
USC&GS signals located		b			

[a] Percentage of those events located by the USC&GS that were reported by the indicated observatory (based on USC&GS "Earthquake Data Report").

[b] Not available

TI placed their portable digital recorder into operation at UBSO on 24 September and recorded the outputs of the vertical array, the shallow-buried array, and the MAP systems through 14 October.

6. PROVIDE OBSERVATORY FACILITIES TO OTHER ORGANIZATIONS

6.1 GENERAL

The reporting of earthquakes that occur within the continental limits of the United States to Stanford Research Institute (SRI) by collect telephone call was discontinued by BMSO and UBSO at the request of SRI.

Data have been furnished to the USC&GS by all observatories on several occasions when the USC&GS requested information about specific arrivals. This is in addition to the routine daily report to the USC&GS.

6.2 VISITORS

Mr. Hans Schmidt of Boeing, Seattle, Washington, visited BMSO on 4 August to determine if information could be given on the detection of rockets fired from Seattle to White Sands Proving Grounds in New Mexico.

Professor Joseph Berg, Oregon State University; Mr. Wagner, Oregon Department of Geology; and Messrs. Bailey and Mickey of USC&GS visited BMSO on 16 September in conjunction with the transfer of the observatory to USC&GS on 1 January 1966.

Mr. Robert A. Eppley, USC&GS, Washington visited BMSO on 4 October in conjunction with the transfer of the observatory to USC&GS on 1 January 1966 Colonel H. S. Reinhart and Major J. G. Allison, AFTAC, visited UBSO 13 October to inspect the vertical array operation and to have a tour of the observatory.

Mr. Best, Baker County Engineer, visited BMSO on 21 October in regard to graveling 0.5 mile of access road.

Captain Fred Munzlinger, Project Officer, visited the Garland laboratory 25-27 October for a review of the status of the project. Mr. Brad Leichliter accompanied him on a visit to UBSO 28 and 29 October to check the progress of the work at UBSO. Mr. Leichliter departed UBSO on 30 October.

7. INSTRUMENT EVALUATION

7.1 MULTIPLE ARRAY PROCESSOR (MAP) INSTALLATION AT UBSO

During the last week in August, Texas Instrument's representatives installed two multiple array processors (MAP) at UBSO and furnished some preliminary training in their operation. MAP No. 1 is a 10-channel unit and MAP No. 2 is a 19-channel unit. During the final stages of installation and training, Major Walter Davis, TI's Project Officer, and Messrs. Holle and Seymour of the Garland laboratory visited the observatory to review the operation of the MAP systems.

Figure 11 shows the 6 consoles associated with MAP, and figure 12 shows their location with respect to other consoles in the observatory. A cursory evaluation of the first MAP data from the surface array indicates that more direction information on signals is available; however, the noise background during daylight hours prevents good resolution of direction at the present time. Figures 13 and 14 show the MAP 1 response to the daylight noise background compared to the surface array. Some additional filtering may be helpful and plans are underway to obtain adequate filters for use in conjunction with the beam-steering feature.

Figure 15 and figure 16 show a comparison of the MAP 1 and surface array response to a typical low-level teleseismic signal. Figure 17 and figure 18 give a comparison of the MAP 1 and surface array responses to an acoustic signal.

A single frequency, relative amplitude output response for MAP 1 was completed 30 September. All channels appear to be operating as originally programmed; however, the program was not designed to attenuate the cultural noise observed during the daylight hours. TI is studying the problem and redesigning the multiple channel filter (MCF) program to attenuate this noise. A similar check for MAP 2 is in progress; MCF 11 and MCF 12 are functioning as programmed.

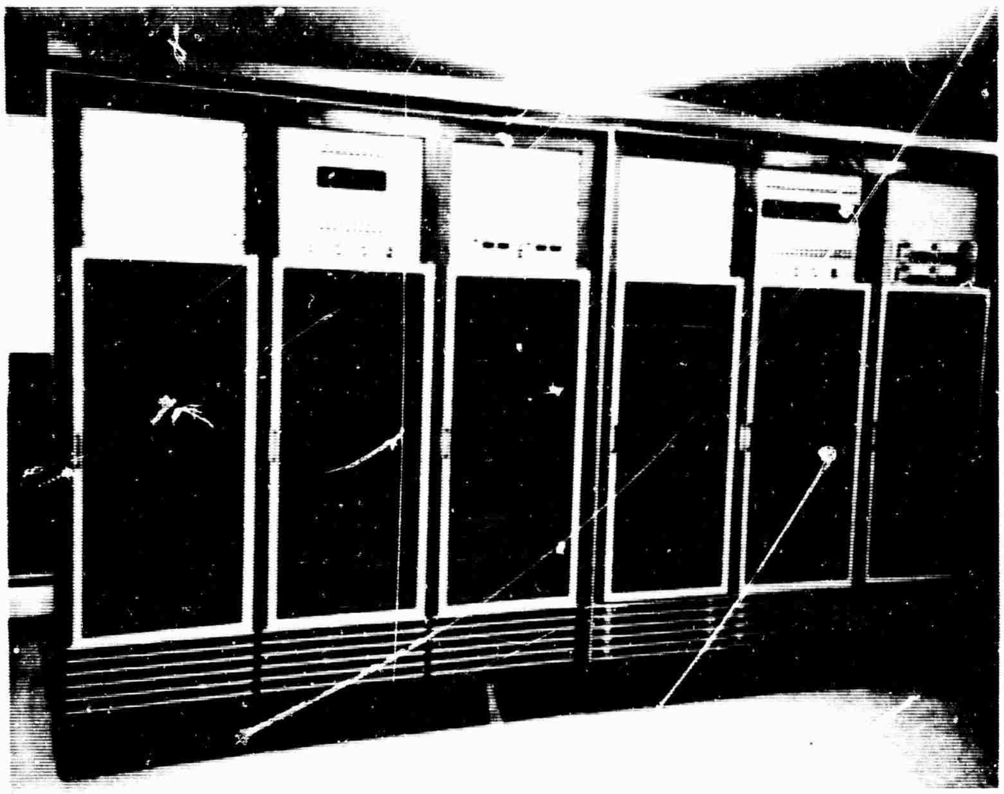


Figure 11. Consoles for the two MAP systems at UBSO

Figure 12. Location of MAP consoles in respect to other consoles at UBSO

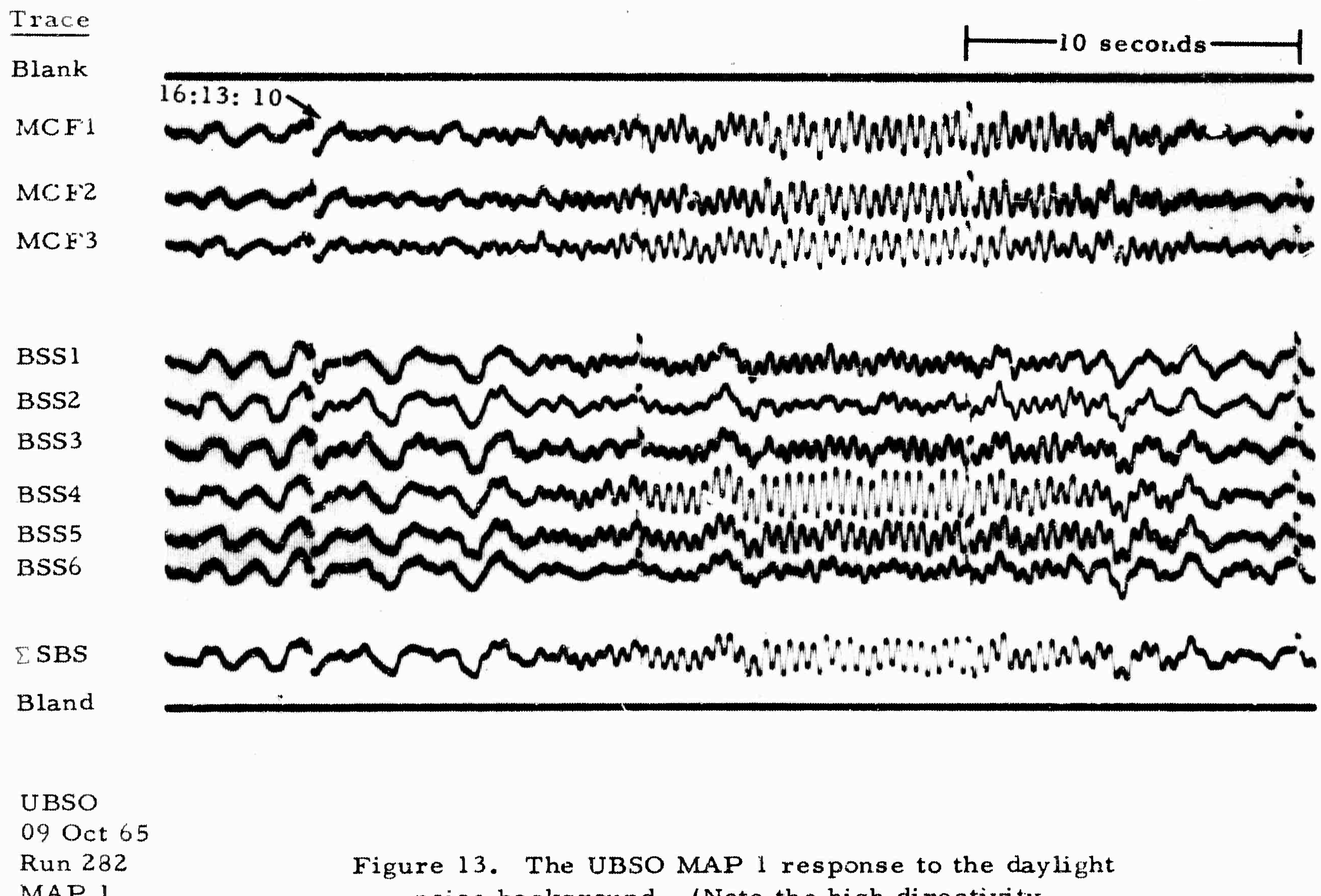
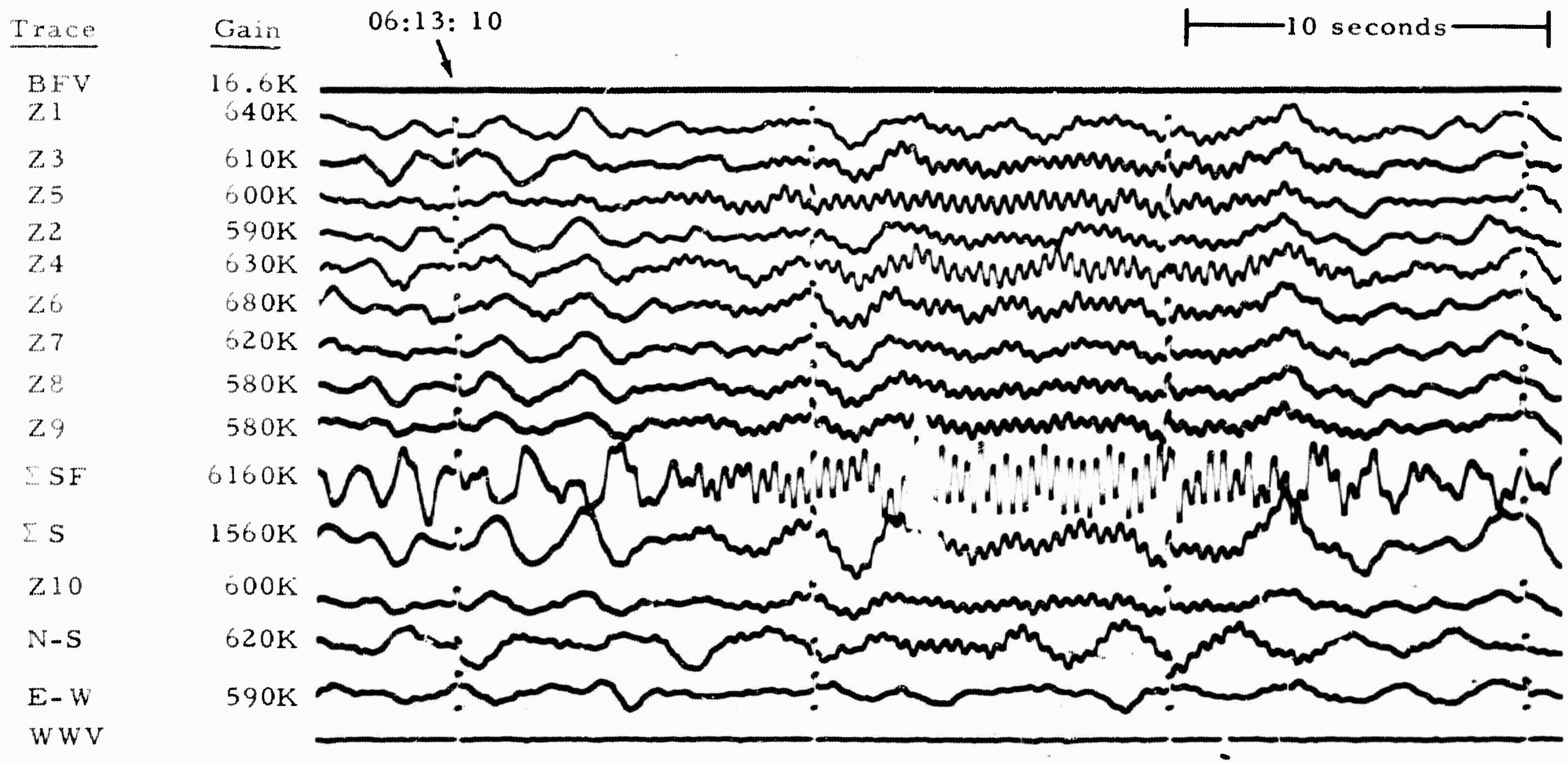


Figure 13. The UBSO MAP 1 response to the daylight noise background. (Note the high directivity of beam-steering channel 4)



UBSO
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Figure 14. The UBSO surface array response to the daylight noise background

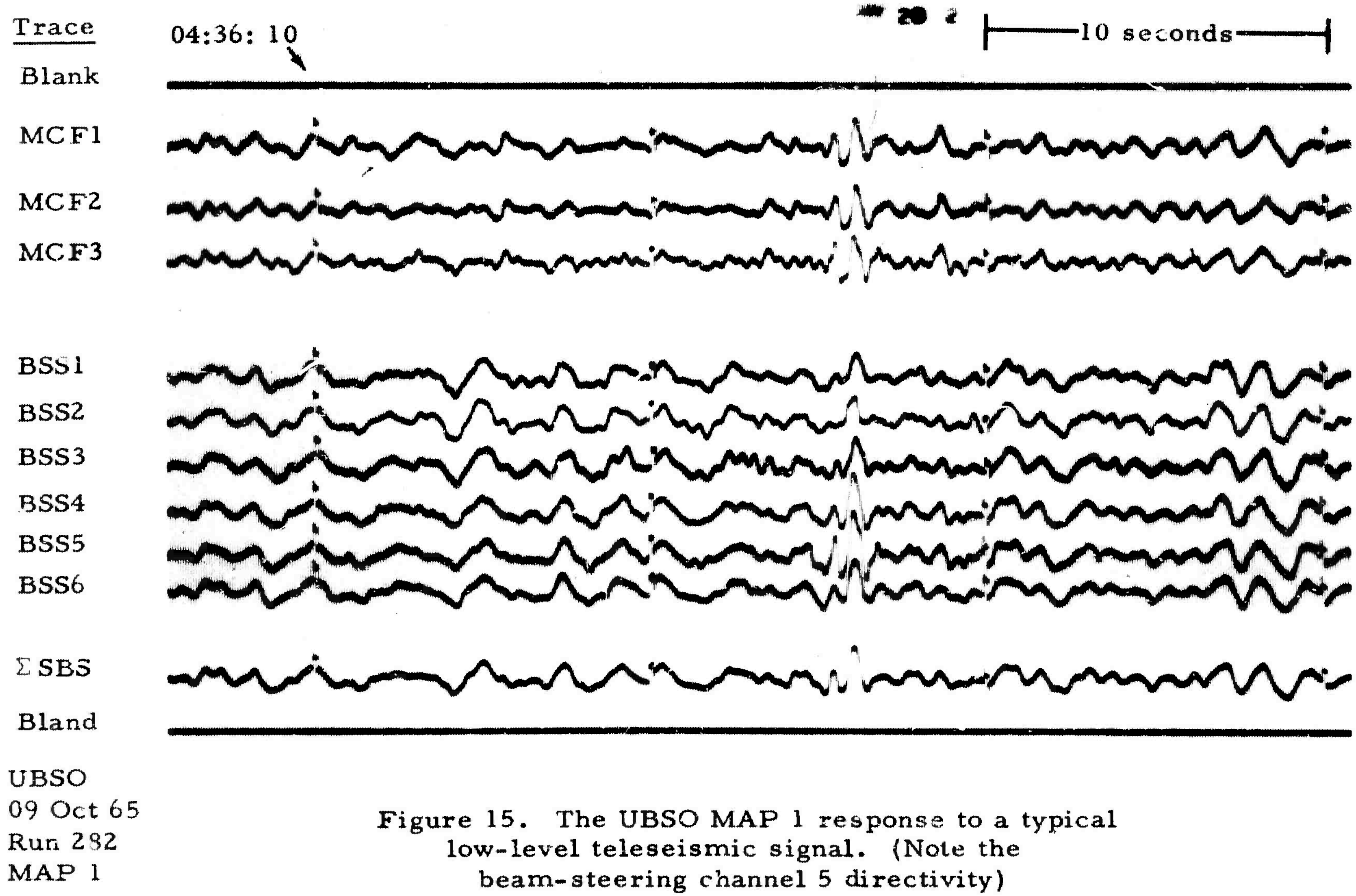

Figure 15. The UBSO MAP 1 response to a typical low-level teleseismic signal. (Note the beam-steering channel 5 directivity)

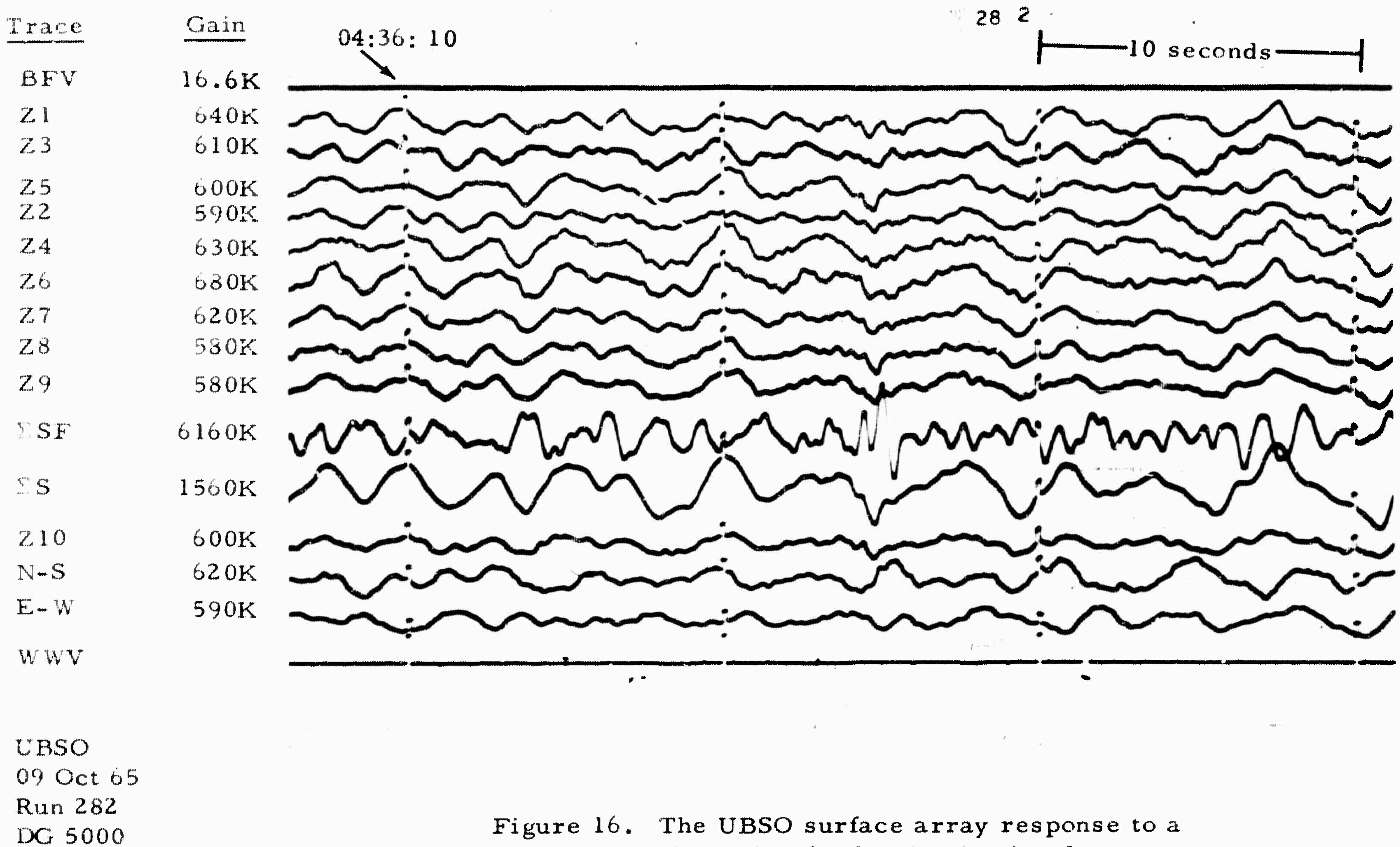

Figure 16. The UBSO surface array response to a typical low-level teleseismic signal.

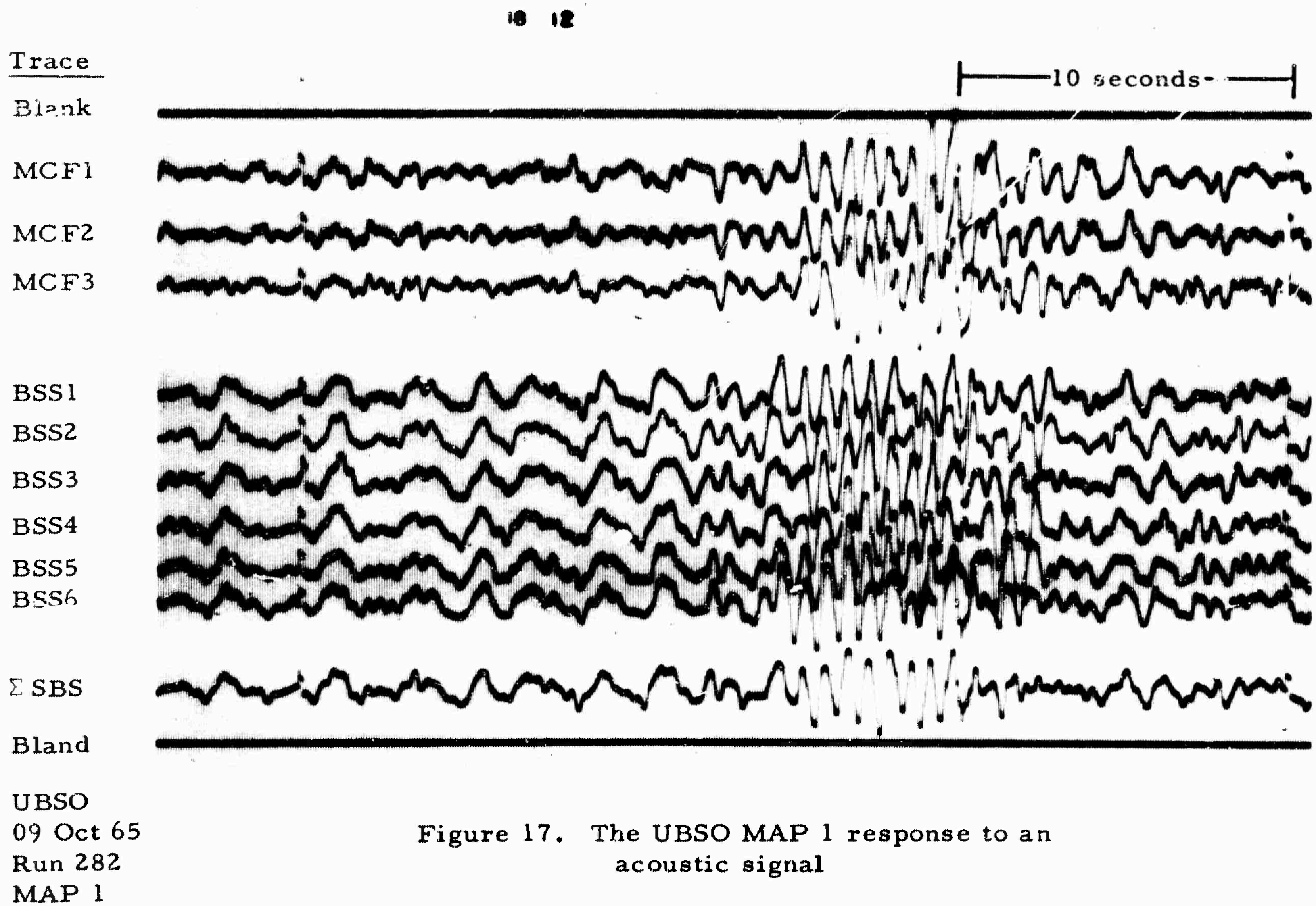

Figure 17. The UBSO MAP 1 response to an acoustic signal

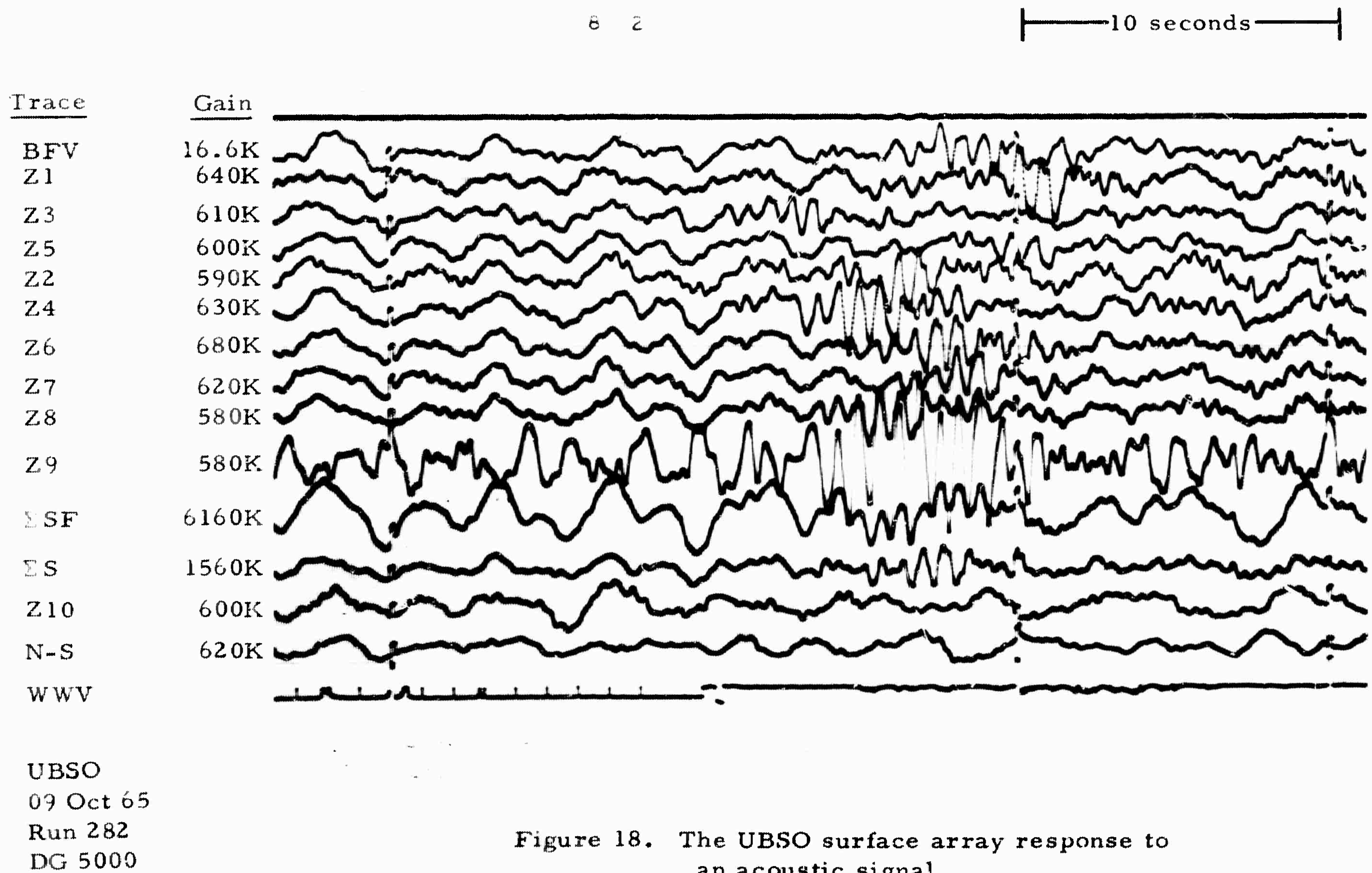

Figure 18. The UBSO surface array response to an acoustic signal.

The new filter boards for MCF 11 and MCF 12 have not been received from TI; in addition, no improved timing boards or filter networks for other equipment have been provided as agreed. A supply of light bulbs was received to keep the units properly maintained.

Refer to appendix 3 for the MAP recording format key.

MAP RECORDING CHARACTERISTICS

1. Input filters: The outputs of all PTA's are passed through band-pass filters (12 dB/oct lowcut at 0.9 cps and 3 dB/oct highcut at 4.0 cps) prior to any other processing by the MAP system.

2. Each MCF is a summation of several seismographs; however, each seismograph is weighted in a predetermined manner. Each of the seismographs has different frequency responses and time delays to produce the desired characteristics of the single summation output.

3. Station time is delayed to 1 second at the center seismometer Z10 (for either surface, subsurface, or combinations in the vertical array). Data arriving at the other instrument positions can be delayed to match that time depending on the position of each instrument relative to the center position and relative to the approaching wavefront. MAP outputs and station time are synchronized for correct world time as recorded on the seismogram.

4. Selected apparent horizontal velocities determine the delay times used. Two velocities have been selected - vertical incidence (infinite horizontal velocity) and 8.1 km/sec (approximately horizontal P-wave velocity across the array). These velocities are programmed in the MAP so that signals with these velocities are enhanced in the recordings. Waves with other velocities are also enhanced, but to a lesser degree.

Three general types of data traces recorded from these processes are:

1. Multichannel filters (MCF): The input levels from each data source are varied and time-delays for selected velocities are chosen. Some additional direct filtering may be used.

2. Beam steering summations (BSS): "Tunes" the array to selected directions by time-delay processes, i. e., the "step-out" of the array is aligned, then summed.

3. Straight summation (ΣS): Unprocessed data except for input filtering.

7.2 BELL TELEPHONE LABORATORIES SPECTRUM ANALYZER AT BMSO

On 20 August, the Project Officer requested that we forward all information available regarding the Bell Telephone Laboratories (BTL) spectrum analyzer being operated at BMSO. One copy of the manual containing a general mechanical description, circuit description, operating instructions, and maintenance instructions for the analyzer and a copy of a paper from the April 1964 issue of the Seismological Society of America bulletin were sent to the Project Officer.

A calibration procedure was devised and an initial calibration was made on 23 August. BMSO personnel now calibrate the analyzer at the specified frequencies during the fourth week of each month.

Mr. Cooper of BTL was contacted to obtain additional information regarding use of the spectrograms. He recommended that we review the BTL Fifth Interim Report, Real Time Spectral Analysis of Seismic Energy on Project VELA-Uniform, dated 1 September 1962. He also suggested that Mr. Dick Walker of BTL might be able to assist with specific questions regarding the analysis of the spectrograms.

7.3 UNDERGROUND LONG-PERIOD VAULT INSTALLATION AT UBSO

Test holes were drilled during September to select the most ideal drilling site for a 50 ft deep, 7 ft diameter hole to be used for a long-period installation. The site selected was about 250 yds east-northeast of the observatory. On 15 October, several shot holes were drilled and small charges were exploded at a depth of 40 ft in an attempt to fracture a hard sandstone stringer. Auger-type equipment began drilling a 24 in. pilot hole on 19 October but could not penetrate the hard stringer at 39 ft.

This hole was subsequently enlarged to a diameter of 8 ft and cased to a depth of 10 ft. At the 10 ft level, the diameter of the hole was decreased to 7 ft and extended to a total depth of 13 ft. At this depth, another sandstone stringer was encountered. It was evident that the drill rig being used could not penetrate this stringer, and on 3 October, a larger rig was brought on site to complete the hole. Drilling was continuing at the end of this reporting period. No new problems have been encountered.

8. RESEARCH INVESTIGATIONS

8.1 STUDIES TO DETERMINE P-PHASE TRAVEL TIME CORRECTIONS FOR BMSO, CPSO, TFSO, UBSO, AND WMSO

Preliminary P arrival-time residual data for BMSO, CPSO, TFSO, UBSO, and WMSO were gathered under Project VT/1124 and were used to determine the P-phase association time-window widths for the ABP. The travel-time residuals, grouped by observatory, were further classified by epicentral distance (10-degree increments), USC&GS reported magnitude, and station-to-epicenter azimuth.

Utilizing the data already processed, we are determining "unbiased" travel-time corrections for each of the five observatories. In addition, the variation of station travel-time corrections as a function of station-to-epicenter azimuth is being studied.

The effectiveness of each of the correction factors developed will be determined using data from each observatory recorded since August 1964. We anticipate that this study, including a report of the results, will require approximately 12 months.

A tentative statistical model for treating the data has been formulated. This model should give the travel time correction for each station and the contribution to the variance of the observed residuals due to magnitude, distance, and azimuth.

8.2 MAGNITUDE CORRECTION FACTORS

Letter approval of our request for authority to conduct magnitude studies jointly under Projects VT/5054 and VT/5055 was received from the Project Officer on 31 August. Work on the magnitude studies will be started according to the schedule in our letter of recommendation submitted on 22 July.

8.3 UBSO ATLAS OF SIGNALS AND NOISE

Letter approval of our request for authority to compile an Atlas of Signals and Noise for UBSO under Project VT/5054 was received from the Project Officer on 19 August. Compilation of the Atlas is in progress.

In general, the Atlas will include the following sections:

INTRODUCTION;
Earthquake Phases Recorded at UBSO;
P and PKP Phases from Various Distances and Azimuths from UBSO;
Representative Noise Samples.

We estimate that the Atlas will be ready for distribution in March 1966.

8.4 AUTOMATED BULLETIN PROCESS

The Automated Bulletin Process (ABP) outputs of April, May, June, and July 1965 data were received from SDL during this reporting period. Processing of the June 1965 ABP data is approximately 50 per cent complete.

During the week of 13 September, Messrs. G. S. Gerlach and J. L. Lobdell visited VSC and SDL and reviewed the status of the ABP. They discussed an approach to future refinements to the ABP in an effort to reduce the work required to check the data after processing.

9. REPORTS AND DOCUMENTS

9.1 Fifty copies of TR 65-58, final report on Project VT/1124, Operation of Three Observatories, were sent to the Project Officer on 7 August 1965.

9.2 Copies of The Registration of Earthquakes at Blue Mountains Seismological Observatory, Cumberland Plateau Seismological Observatory, Tonto Forest Seismological Observatory, and Wichita Mountains Seismological Observatory During February 1965, March 1965, and April 1965 were sent to Dr. C. F. Romney and Mr. B. G. Brooks.

9.3 Fifty copies of TR 65-99, Operation of Two Observatories, Quarterly Report No. 1, Project VT/5054, 1 May through 31 July 1965 were sent to the Project Officer on 26 August 1965.

9.4 A letter request for approval of our plan to install an improved underground vault for long-period seismometers at UBSO was mailed to the Project Officer on 1 September 1965.

9.5 Three sets of noise curves for the month of March for BMSO, CPSO, UBSO, and WMSO were mailed to the Project Officer on 9 September 1965.

9.6 A copy of the list of real property at BMSO, CPSO, and UBSO, which was transferred to Geotech by Texas Instruments was mailed to the Project Officer 20 September 1965.

9.7 A List of Suggested Milestones was published and a copy was sent to the Project Officer on 28 October 1965.

APPENDIX 1 to TECHNICAL REPORT NO. 65-128

STATEMENT OF WORK TO BE DONE
AFTAC PROJECT AUTHORIZATION NO. VELA T/5054

STATEMENT OF WORK TO BE DONE

AFTAC Project Authorization No. VELA T/5054

1. Tasks.

a. Operation.

(1) Continue operation of the Blue Mountains Seismological Observatory (BMSO), ________________________________ ________ and Uinta Basin Seismological Observatory (UBSO), normally recording data continously.

(2) Evaluate the seismic data to determine optimum operational characteristics and make changes in the operating parameters as may be required to provide the most effective observatories possible. Addition and modification of instrumentation are within the scope of work. However, such instrument modifications and additions, data evaluation, and major parameter changes are subject to the prior approval of the AFTAC Project Officer.

(3) Conduct routine daily analysis of seismic data at each observatory and transmit daily seismic reports to the US Coast and Geodetic Survey, Washington D.C. 20230, using the established report format and detailed instructions.

(4) Record the results of daily analysis on magnetic tape in a format compatible with the automated bulletin program (ABP) used by the Seismic Data Laboratory (SDL) in their preparation of the seismological bulletin of the VELA-UNIFORM seismological observatories. The format should be established by coordination with SDL through the AFTAC Project Officer. The schedule of routine shipments of these prepared magnetic tapes to SDL will be established by the AFTAC Project Officer.

(5) Establish quality control (QC) procedures and conduct QC, as necessary, to assure the recording of high quality data on both magnetic tape per magnetic-tape recorder per observatory per week is satisfactory unless QC tolerances have been exceeded and the necessity of additional QC arises. QC of magnetic tape should include, but need not necessarily be limited to, the following items:

(a) Completeness and accuracy of operation logs.

(b) Accuracy of observatory measurements of system noise and equivalent ground motion.

(c) Quality and completeness of voice comments.

(d) Examination of all calibrations to assure that clipping does not occur.

(e) Determination of relative phase shift on all array seismographs.

(f) Measurement of DC unbalance.

(g) Presence and accuracy of tape calibration and alignment.

(h) Check of uncompensated noise on each channel.

(i) Check of uncompensated signal-to-noise of channel 7.

(j) Check of general strength and quality of timing data derived from National Bureau of Standards Station WWV.

(k) Check of time pulse modulated 60 cps on channel 14 for adequate signal level and for presence of time pulses.

(l) Check of synchronization of digital time encoder with WWV.

(6) Provide observatory facilities, accompanying technical assistance by observatory personnel, and seismological data to requesting organizations and individuals after approval by the AFTAC Project Officer.

(7) Maintain, repair, protect, and preserve the facilities of the two seismological observatories in good physical condition in accordance with sound industrial practice.

b. Instrument Evaluation: On approval by the AFTAC Project Officer, evaluate the performance characteristics of experimental or off-the-shelf equipment offering potential improvement in the performance of observatory seismograph systems. Operation and test of such instrumentation under field conditions should normally be preceded by laboratory test and evaluation.

c. Special Investigations: Conduct research investigations as approved or requested by the AFTAC Project Officer to obtain fundamental information which will lead to improvements in the detection capability of each seismological observatory. In recommended multiobservatory research programs and those designed for the individual observatories, environmental and equipment differences that will exist among the observatories during the operational period should be considered.

These programs should take advantage of geological, meterological, and seismological conditions unique to each observatory. Futhermore, the following expected and existing differences could bear on the research programs:

(1) BMSO ________ and UBSO - Surface array designs.

(2) BMSO - Digital spectrum analyzer with dual channel output of short-period and long-period spectrograms developed by Bell Telephone Laboratories, Incorporated (installation expected in fall of 1964).

(3) UBSO - Deep-well seismograph; 10-element array of shallow-borehole seismographs; multiple array processor (installation programmed summer 1965 under Project VELA T/5052; includes training in operation, maintenance, and calibration of the processor and in analysis techniques for appropriate UBSO personnel).

Research might pursue investigations in, but is not necessarily limited to, the following areas of interest: microseismic noise, signal characteristics, data presentation, detection threshold, and array design (surface and shallow borehole). Prior to commencing any research investigation, AFTAC approval of the proposed investigation and of a comprehensive program outline of the intended research must be obtained. Furthermore, research should be planned for completion during the contract period.

APPENDIX 2 to TECHNICAL REPORT NO. 65-128

ALPHABETIC LISTS OF GENERAL EQUIPMENT AND SUBASSEMBLY CODES

ALPHABETIC LIST OF GENERAL EQUIPMENT CODES

WACA	Acoustic amplifier	GMPR	Microfilm printer reader
WACM	Acoustic microphone	MOS	Oscilloscope
WAWI	Anemometer wind indicator	VPV	Pentastrip viewer
WAWD	Anemometer wind direction transmitter	APTA	Phototube amplifer
WAWV	Anemometer wind velocity transmitter	TPA	Power amplifier
WB	Barometer	PPCU	Power control unit
PBAT	Battery	PPS	Power supply
PBC	Battery charger	TPR	Programmer
PBSW	Battery switch	TRC	Radio control
MBR	Bridge	TRR	Radio receiver
DCA	Cable	TRSC	Radio time signal converter
CCC	Calibration control	PRPC	Remote power control
CCSU	Calibration switching unit	FSDF	Seismic data filter
CC	Calibrator	SBB	Seismometer, broad band
TCL	Clock	SEX	Seismometer, experimental
GCM	Copying machine	SIB	Seismometer, intermediate band
DDCM	Data control module	SLP	Seismometer, long period
DDLT	Data line terminal	SSP	Seismometer, short period
RDEV	Develocorder	DSI	Signal isolator
DDSU	Develocorder switching unit	PSXF	Sola transformer
WDSC	Discriminator	BSTP	Station protector
RDR	Drum recorder	RSC	Strip chart recorder
VFV	Film viewer	BSA	Summation amplifier
MFC	Frequency counter	FSF	Summation filter
CFG	Function generator	RTR	Tape recorder
MGM	Gauss meter	DTSU	Tape switching unit
RHE	Helicorder	OTPH	Telephone
AHE	Helicorder amplifier	WT	Thermometer
PIV	Inverter	TTCU	Time control unit
BIA	Isolation amplifier	TTE	Time encoder
DLTM	Line termination module	TTMU	Time mark unit
GMPD	Mass position display	TTS	Timing system
MMEG	Megger	OTRC	Transceiver
WMK	Microbarograph can	MVTM	Vacuum tube volt meter
WMKC	Microbarograph can calibrator	BVP	Vault protector
WMCP	Microbarograph capsule	MVOM	Volt ohm meter
WMFA	Microbarograph filter amplifier	PVR	Voltage regulator
WMOC	Microbarograph oscillator	MVAM	Voltammeter
WMPD	Microbarograph power distributor		

ALPHABETIC LIST OF SUBASSEMBLY CODES

AMP	Amplifier
BCDU	BCD display unit
CSL	Channel selector
CHS	Chassis
CMOD	Control module
DT	Date timer
DDU	Digital display unit
DISC	Discriminator
FDV	Frequency divider
HSPA	Head switching panel assembly
HSPP	Heat sink power pack
INVT	Inverter
MASY	Meter assembly
MONT	Monitor
NKRG	Numeric register
OSC	Oscillator
OSCP	Oscilloscope
PAMP	Power amplifier
PS	Power supply
PFS	Primary frequency standard
PCB	Printed circuit board
PASY	Pump assembly
RCU	Remote centering unit
SSCP	Stroboscope
TSP	Transport

APPENDIX 3 to TECHNICAL REPORT NO. 65-128

MULTIPLE ARRAY PROCESSOR
(MAP 1 AND 2)
RECORDING FORMAT KEY

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MAP 1 (10 Channel Unit-Surface Array)

Channel	Function
MCF 1	Summation of 10 short-period JM vertical seismometers to enhance the recording of vertically incident P-wave arrivals.
MCF 2	Summation of 10 short-period JM vertical seismometers with added low-cut filtering to reduce the reception of long-period microseismic waves. Enhances vertically incident P-wave arrivals.
MCF 3	Summation of 10 short-period JM vertical seismometers to enhance the recording of 8.1 km/sec P-wave arrivals.
BSS 1	Beam steering summation of 10 short-period JM vertical seismometers time-delayed to enhance the recording of 8.1 km/sec P-wave arrivals from 0 degrees azimuth (N).
BSS 2	Same as BSS 1 except it enhances arrivals from 60 degrees azimuth
BSS 3	Same except 120 degrees azimuth
BSS 4	Same except 180 degrees azimuth
BSS 5	Same except 240 degrees azimuth
BSS 6	Same except 300 degrees azimuth
ΣSBS	Straight summation of 10 short-period JM vertical seismographs.

NOTE: All processing in MAP 1 includes a band pass in each input channel.

MAP 2 (19 Channel Unit)

Channel	Function
MCF 11	Summation of 10 short-period Model 18300 Vertical Seismometers in the shallow-buried array to enhance the recording of vertically incident P-wave arrivals.
MCF 12	Summation of 10 short-period Model 18300 Vertical Seismometers in the shallow-buried array summed as rings (1-3-5, 2-4-6, 7-8-9, 10) plus the summation of 6 short-period Geotech Model 23900 Vertical Seismometers in the deep borehole array.
MCF 13	Summation of 6 short-period Model 23900 Vertical Seismometers in the deep borehole vertical array.
MCF14	Time-delayed summation of 3 alternate vertical array elements (1st, 3rd, and 5th deepest) to enhance up-traveling, vertically incident P-waves (Attempts to suppress the surface reflection).
MCF15	Same as MCF14 except enhances down-traveling, vertically incident P-waves (attempts to suppress the initial arrival).
MCF16	Time-delayed summation of 3 alternate vertical array elements (2nd, 4th, and 6th deepest) to enhance up-traveling, vertically incident P-waves.
MCF17	Same as MCF16 except enhances down-traveling, vertically incident P-waves.
BSSV1	Beam steering summation of the 6 vertical array elements to enhance recording of up-traveling vertically incident P-waves.
BSSV2	Same as BSSV1 except enhances up-traveling 8.1 km/sec P-waves.
BSSV3	Same as BSSV1.
BSSV4	Same as BSSV1 except enhances down-traveling, vertically incident P-waves.

BSSV5 Same as BSSV2 except enhances down-traveling 8.1 km/sec P-waves.

BSSV6 Same as BSSV2.

ΣDVS Straight summation of the 6 vertical array elements.

NOTE: All processing on MAP 2 includes a bandpass filter in each data input channel.