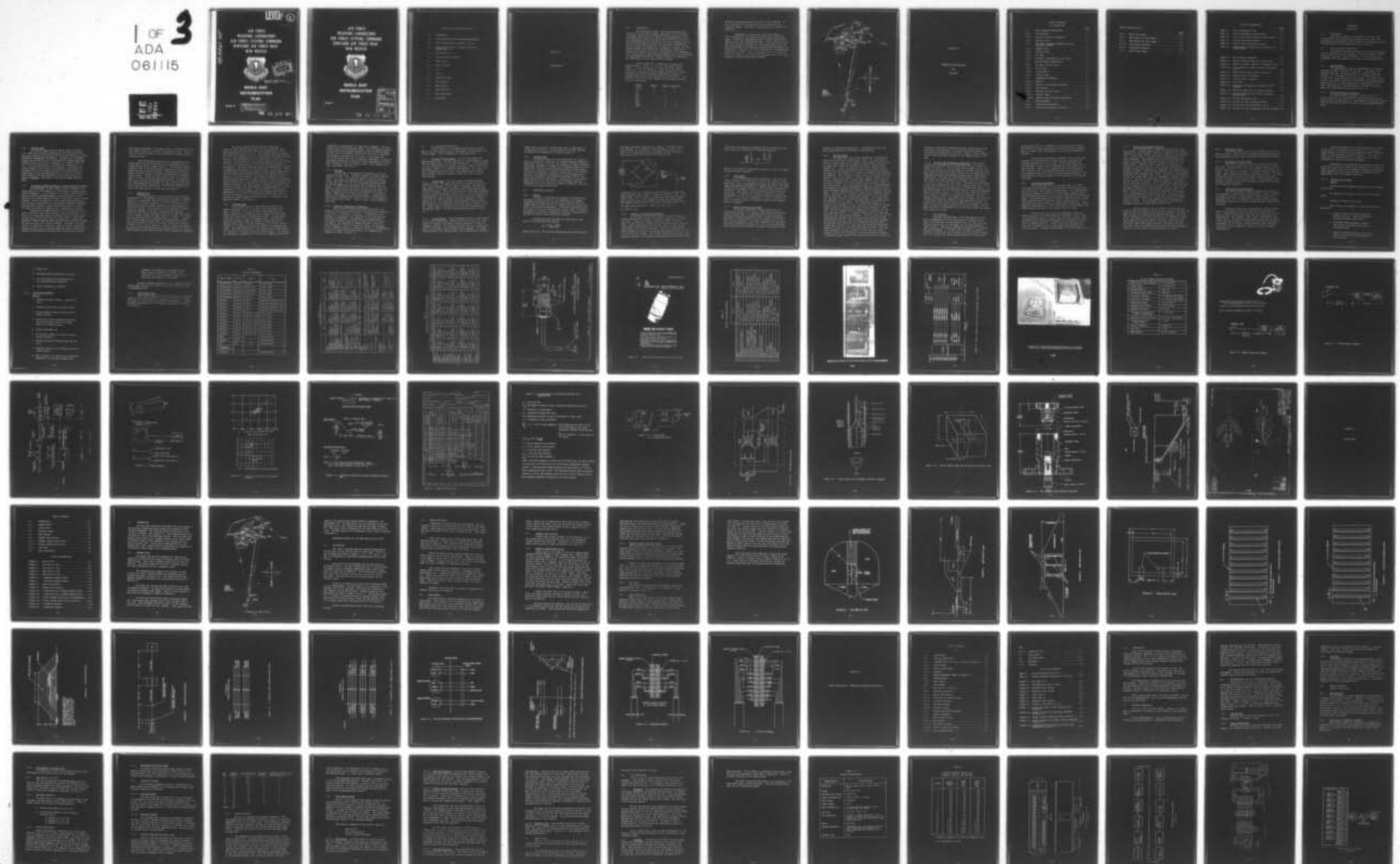
AD-A061 115 AIR FORCE WEAPONS LAB KIRTLAND AFB N MEX F/G 18/3

MIDDLE GUST INSTRUMENTATION PLAN.(U)

JUL 71

UNCLASSIFIED SBIE-AD-E200 209 NL

1 OF 3
ADA
061115



AIR FORCE WEAPONS LABORATORY
AIR FORCE SYSTEMS COMMAND
KIRTLAND AIR FORCE BASE
NEW MEXICO

MIDDLE GUST INSTRUMENTATION PLAN

14 Jun 71

12 JUL 1971

AIR FORCE
WEAPONS LABORATORY
AIR FORCE SYSTEMS COMMAND
KIRTLAND AIR FORCE BASE
NEW MEXICO

AIR FORCE WEAPONS LABORATORY

MIDDLE GUST
INSTRUMENTATION
PLAN

12 JUL 1971

MIDDLE GUST INSTRUMENTATION PLAN

SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

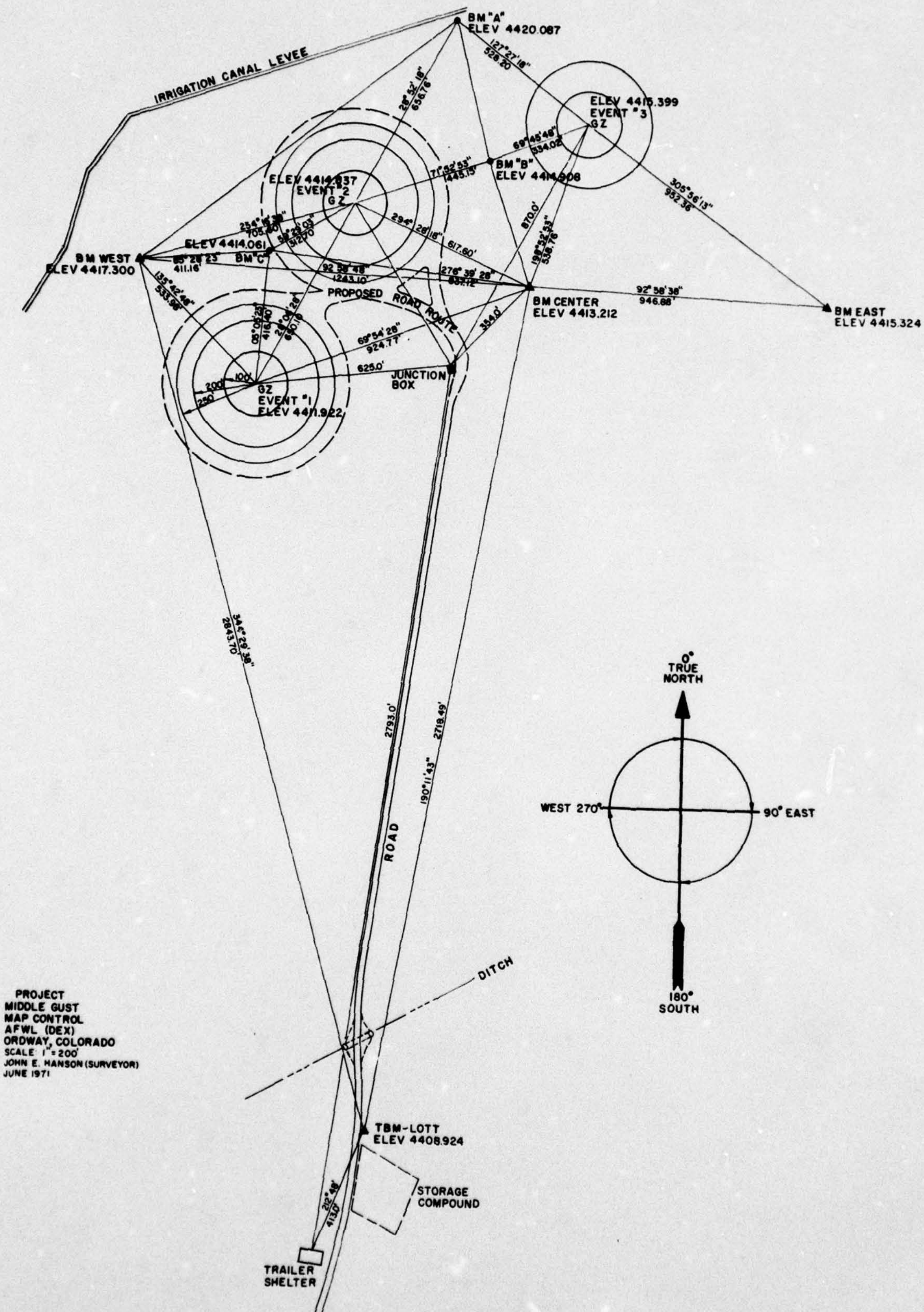
The Experimental Branch, Civil Engineering Research Division of the Air Force Weapons Laboratory will be the office of primary responsibility for design and implementation of the instrumentation system to be used in the MIDDLE GUST test series. This Instrumentation Plan describes the total instrumentation system and the procedures necessary for its proper implementation. It will contain descriptions of all sensors to be used, the information necessary for identifying, calibrating, connecting the sensors, and recording the data. Descriptions of the transducers, their specifications, and packaging procedures will also be included. The instrumentation system to be described will be installed at the MIDDLE GUST test site near Crowley, Colorado.

Project Middle Gust I consists of at least three separate events. Event I is a 20 ton, half buried sphere. Event II is a 100 ton sphere at 2 radii above the surface. Event III is the 100 ton sphere tangent and above the surface. In addition to AFWL and Waterways Experimental Station, 7 separate agencies will also participate in these events. The following is a list of these agencies and the events in which they will participate.

Agency	Event I	Event II	Event III
Boeing	X		X
DRI	X	X	X
SRI_1	X		
SRI_2		X	
BRL		X	
TRW_1		X	
TRW_2		X	X
AMTED		X	X

Detailed instrumentation plans for each of these agencies will not be included in this plan, but will be supplied by the respective agency. Reference to these plans will be made where applicable.

Transducers in each of the test areas (Figure 1) will be connected to the Junction Box with special watertight cable. A 3000 foot (approximate) trunk line will connect this Junction Box to the recording trailers. A more detailed description can be found in Section 3.0. Electrical power to the site will be provided by the Southeast Colorado Power Association (see Section 8.0) Sections 9.0-11.0 will describe the instrumentation system for each event. This is necessary since the MIDDLE GUST Series will consist of at least three separate events, each necessitating a unique instrumentation system.


BM "A"
ELEV 4420.087
IRRIGATION CANAL LEVEE
ELEV 4415.399
EVENT "3
GZ
BM "B"
ELEV 4414.908
ELEV 4414.837
EVENT "2
GZ
BM WEST
ELEV 4417.300
ELEV 4414.061
BM "C"
PROPOSED
ROAD ROUTE
BM CENTER
ELEV 4413.212
BM EAST
ELEV 4415.324
JUNCTION
BOX
GZ
EVENT "1
ELEV 4411.922
ROAD
DITCH
TBM-LOTT
ELEV 4408.924
STORAGE
COMPOUND
TRAILER
SHELTER
0°
TRUE
NORTH
WEST 270°
90° EAST
180°
SOUTH
PROJECT
MIDDLE GUST
MAP CONTROL
AFWL (DEX)
ORDWAY, COLORADO
SCALE: 1" = 200'
JOHN E. HANSON (SURVEYOR)
JUNE 1971

SECTION 2.0

TRANSDUCER SPECIFICATIONS

AND

PACKAGING

TABLE OF CONTENTS

2.0 TRANSDUCERS

Table of Contents Con't

LIST OF ILLUSTRATIONS

TRANSDUCERS

SECTION 2.0

2.0 TRANSDUCERS

This section presents the instruments that are used to obtain free field response data during the test event. Also presented are the procedures that are used for calibration, installation and checkout of the instruments prior to the test.

2.1 AFWL INSTRUMENT DESCRIPTIONS

The specific sensing instruments are described, including a brief disucssion of their operation; this will include the manufacturer's data sheet, where available. A list of the types of instruments that are utilized in the system is presented in Table 2-1.

2.1.1 Accelerometers

The accelerometers used are manufactured by the Endevco Corporation; Models 2264 and 2261 are used. These models are basically the same, differing primarily in range and frequency response. The accelerating force acts on a seismic mass, which in turn loads a semi-conductor bridge element. The bridge network converts the induced strain into a proportional resistance change, which results in a voltage change that is proportional to the applied acceleration. Specifications for the Model 2264 and for Model 2261 accelerometers are given in Table 2-2.

2.1.2 Air Blast Pressure Transducers

Air blast pressure transducers within 100 feet of GZ are of the silicon disk/integrated sensor bridge type, KULITE Series HKS-375-5 (see Table 2-3). Measurements at locations greater than 100 feet from the GZ will be made with strain gage/diaphragm units.

2.1.3 Velocity Gages

The velocity gages used are Spartan Model 601 (Figure 2-2). These were originally developed by the Stanford Research Institute, Menlo Park, California, and later were modified by Sandia Corporation, Albuquerque, New Mexico. The gage is an overdamped pendulum accelerometer with a carrier-excited variable-reluctance sensing element, electrically completed as a standard bridge circuit. The accelerating force is mechanically integrated by a viscous damping fluid acting on the pendulum. The pendulum displacement from the null point (and hence the bridge output) is proportional to the instantaneous velocity of the case within a given frequency spectrum (dependent on the fluid viscosity or degree of damping). See Table 2-4 for velocity gage specifications.

2.1.4 The Sandia Impedance-Mismatch Hi-Stress Transducer (IMHST)

The measurement of shock transit times in a media with a known equation of state appears to be forerunner in producing peak stress information. In this method, use is made of material whose Hugoniot is known and measurements of only one quantity, shock velocity over a predetermined distance is required in order to infer pressure. Since shock velocity is more easily measured than particle velocity, the principle of the impedance-mismatch techniques has been used to produce a peak reading stress gage that covers the range of 10 Kbar to 1 Megabar and is accurate to ±5 percent.

Piezoelectric ceramic detectors (PZT crystals) are used as time-of-arrival or shock wave detectors and when cemented to surfaces of C-7 epoxy and shocked to 300 Kbar produce, a high output (in the order of 100 volts) across a 50 ohm load. A simplified impedance--mismatch gage has been fabricated and fielded on nuclear and high explosive tests using plexiglass. Plexiglass is used because it is impossible to machine a sample of poorly consolidated alluvial soil for use in a pressure gage and secondly because the Hugoniot of the plexiglass matches desert alluvium over a reason-able range of pressures. This gage is easy to fabricate/field and has a high reliability and covers a wide dynamic range. Figure 2-3 shows the physical layout of the piezoelectric crystals mounted in plexiglass blocks.

Data from several crystals can be transmitted on five signal cables from the electronics to the recording van by use of appropriate digital coding circuitry. The circuitry causes a change of state on one of the signal cables when excited by an output from any one of the crystals. Additionally, all of the signals from the crystals are mixed and recorded on a separate record channel. Figure 2-4 shows a block diagram of the system. Figure 2-5 shows the coding electronics housing. The data signals from the system are recorded on direct record or wide band F.M. record magnetic tape tracks. The data are recorded at 120 in/sec tape speed and played back at 1/32 of this speed (3.75 in/sec) and digitized at a 150 KHz rate and plotted.

2.1.5 Manganin Gage

The manganin gage is a piezo-resistive effect Hugoniot measurement of a thermodynamic equation of state based on changes induced by a transmitted shock in a secondary material. As now designed, this secondary material relies on the measurement of shock-induced physical effects caused by the stress induced in a block of C-7 epoxy. The resistance of a thin metallic conductor (manganin) embedded in the epoxy is measured and Hugoniot states are then inferred from the measure of the peak shock stress at the interface between the sample and the C-7 epoxy. This technique is often called the "impedance match" procedure. Normally, the secondary material measurements are advantageous for long-duration recording and using a pulse power supply time durations of from 10 us to 5 ms are possible. However, problems are caused by stress profile modification from reflected waves in the gage and stress profile distortions as the wave travels through the transducer.

The extreme dynamic stress-resistance range and relatively long recording duration of the Manganin/epoxy transducer provides great potential for stress measurements as low as 0.07 Kbar and as high as 290 Kbar. The Manganin gage has drawbacks for it has been primarily used in laboratory and for measuring stress in rock. The configuration that has been useful in rock and the laboratory is unsuitable for long duration recordings in soil because it is not built rugged enough to keep from failing, generally at connections. There have been some significant improvements, however, in ruggedness that warrant the use of one gage of this type. Those using the gage, indicate that one might expect analog information in soil for 20 to 200 microseconds because of the possible early destruction of the gage caused by the extreme environment of soil. Actual recording duration of a gage when used in media of dissimilar shock characteristics is necessarily limited by gage dimensions. At moderate pressures, less than 100 Kbar, laboratory tests have shown recording duration to be approximately 20 microseconds for a 6-inch diameter by 4-inch thick gage. Gage improvements indicate that measurements of a few milliseconds may be possible and because of this and the desirability of analog data at these ranges, SRI is fielding one manganin gage on the first event. For details of the gage and schematic, see Figure 2-6.

2.1.6 Ytterbium Gage

The ytterbium gage is a high output piezoresistive material designed for use in the low to sub-Kbar region (0-40 Kbar). Laboratory tests have yielded a rough measure of the actual piezoresistive coefficient over a range of stresses from 2 Kbar to 40 Kbar where a discontinuity occurs. The gage uses a pulse power supply, as does the manganin gage, consisting of a capacitor discharge system that supplies several amps to the piezoresistive gages. For long recordings, on the order of milliseconds, the capacitance required to provide the current becomes large. Even more important the large currents cause large changes in resistance of the gage because of heating effects. The heating for Ytterbium is proportional to I^2R and the temperature-resistance coefficient is approximately 100 times that of Manganin. The high currents cause a severe heating problem. The Ytterbium gage appears to have sensitivity problems that may be caused by material impurities and there are extreme non-linearities that must be considered. Even though the repeatability and scatter of data between the foil and film gages cast doubt on potential performance, this gage is successfully being used on equation of state measurements at NTS and SRI is fielding 5 (five) on the first event. For a schematic and cable requirements, see Figure 2-7.

2.1.7 PZT Gage

The PZT gage is a piezoelectric transducer of the lead-zirconate-titanate class. This gage produces a potential when subjected to a stress. This potential appears linear with applied stress. Gulf Radiation Technology (GRT) has developed this gage to cover the range .1-10 Kbar for the DASA and has fielded them on the DASA Diamond Dust and Diamond Mine nitromethane shots in Nevada. A review of the time history results of these tests compared with short duration peak data looks exceptionally good. The gage is rugged and has withstood the environment in the range of interest and produced long term analog outputs. An amplifier is required, as an impedance match and line driver for each gage, which can be recovered and reused. Figure 2-8 shows a block diagram of the system.

2.1.8 Thermopile Thermoelectric Transducer

When a shock wave crosses the junction surfaces of two dissimilar metals there appears between the uncompressed extremities of the metals a difference in potential. The magnitude of the potential is proportional to the amplitude of the shock wave and the nature of the metals. This approach to the measurement of stress has been made by the French in nuclear work to as high as 1.6 megabar. The connection of thermal junctions in series to form a thermopile is done to increase the output. The transducer is a low impedance source of a fraction of an ohm, is self-generating and does not require pulse power supplies. The transducer and schematic are shown in Figure 2-9.

2.2 WES INSTRUMENT DESCRIPTIONS

The WES free-field instrumentation consists of experimental air-blast pressure gages, stress gages, accelerometers, and velocity gages. These instruments are described below.

2.2.1 Air-blast Pressure Gages - The air-blast gages are manufactured by WES. The gage consists of a force-sensitive column that has semiconductor strain gages mounted on it. Forces applied to this column, through the exposed end, produce strains; and, hence, resistance changes in the semiconductor members. The circuit is a four arm Wheatstone bridge, which, when supplied with constant input voltage, produces an output voltage that varies directly with pressure.

2.2.2 Stress Gages - The stress gages are diaphragm gages developed by WES. The gage consists of two stainless steel housings, each containing a stiff integral diaphragm. Two matched semiconductor strain gages are bonded to each diaphragm and comprise half-bridges. The partial bridges are electrically completed to form a typical Wheatstone bridge circuit. The two housings are bonded together, and an epoxy rim is cast around the sensing unit to provide the required density and aspect parameters. Forces applied to the stiff diaphragm produce strains, which are sensed and converted to a proportional resistance change; finally, an output voltage change is produced that is directly proportional to the applied stress. The gage specifications are given in Table 2-5.

2.2.3 Accelerometers - The accelerometers used are manufactured by the Endevco Corporation; Models 2264 and 2261 are used. These models are basically the same, differing primarily in range and frequency response. The accelerating force acts on a seismic mass, which in turn loads a semi-conductor bridge element. The bridge network converts the induced strain into a porportional resistance change, which results in a voltage change that is proportional to the applied acceleration. Specifications for the Model 2264 and for Model 2261 accelerometers are given in Table 2-2.

2.2.4 Velocity Gages

The velocity gages used are Spartan Model 601 (Figure 2-2), which were originally developed by the Stanford Research Institute, Menlo Park, California, and were later modified by Sandia Corporation, Albuquerque, New Mexico. The gage is an overdamped pendulum accelerometer with a carrier-excited variable-reluctance sensing element, electrically completed in a standard bridge circuit. The accelerating force is mechanically integrated by a viscous damping fluid acting on the pendulum. The pendulum displacement from the null point (and hence the bridge output) is proportional to the instantaneous velocity of the case within a given frequency spectrum (dependent on the field viscosity or degree of damping). See Table 2-4 for velocity gage specifications.

2.3 TRANSDUCER CALIBRATION

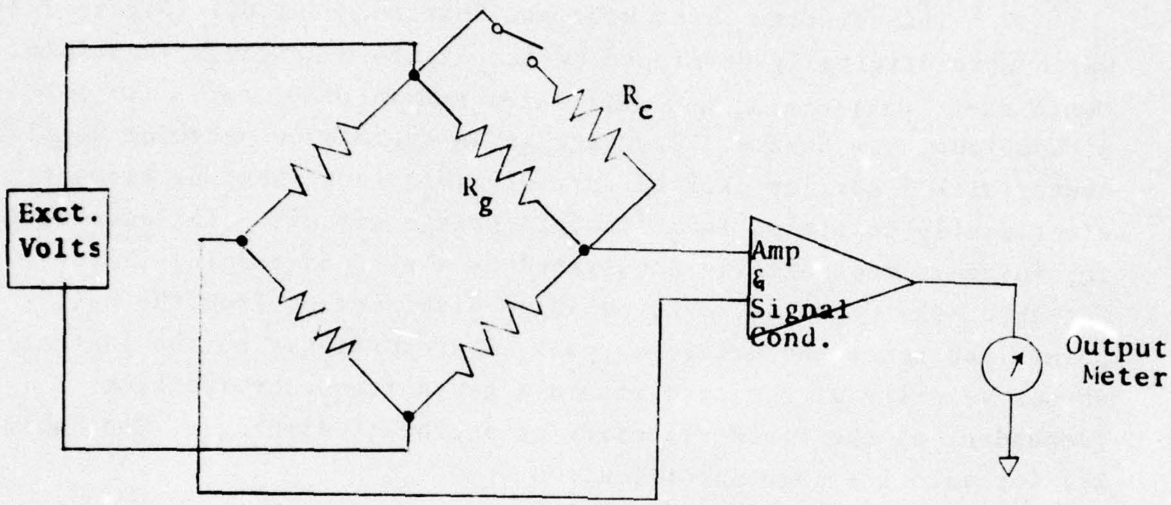
2.3.1 General

All types of transducers are subjected to physical force to produce an output relative to the phenomenon to be measured. Transducers with bridge type circuitry have a specific arm of the bridge shunted by known resistors to produce electrical outputs equivalent to the physical measurement. The transfer characteristic of the system for electrical output versus physical input is calculated and applied to the data to determine an equivalent engineering unit for each of the known shunt calibration resistors.

The equivalent gage resistance for each type of transducer is calculated from the equation:

$$Rg = \frac{X_1 R_{c1} - X_2 R_{c2}}{X_2 - X_1}$$

Where X_1 and X_2 are the equivalent engineering units associated with two shunt calibration resistors R_{c1}, and R_{c2}. The shunt calibration constant, C_A, is defined by the equation $C_A = X(R_c + R_g)$, where X is the engineering unit equivalent to shunt resistor R_c. The circuit shown below describes the relationships:



A physical force of F engineering units applied to a bridge transducer produces E units change in electrical output as read by the output meter. When the force is removed and the switch closed to shunt R_c across R_g, C units change in electrical output result. The transfer characteristic of $\frac{F}{E}$ and the equivalent is $\frac{F}{E}$ C = X in the units associated with F. Then, $C_A = X(R + R_g)$ or

$C_A = \frac{FC}{E} (R_c = R_g)$.

2.3.2 Details of Calibration Procedures

To minimize scaling errors and to determine linearity, several measurements are taken at different points over the operating range. A numerical average is used to produce a best fit curve. Normal operating procedure calls for five points of physical input usually approximating 20%, 40%, 60%, 80%, and 100% of full scale output, if this can be produced. Similarly, four different shunt calibration resistors are applied approximating 100%, 50%, 25%, 12.5% of full scale output. The transfer characteristic used is the numerical average of the transfer characteristics of each input point.

The C_A used is the numerical average of the C_A's produced by each shunt resistor as described by the following equation:

$$C_A = \frac{\sum_{R_{c1}}^{R_{cn}'} \left[(R_c + R_g)C \; \frac{\sum_{F_1}^{F_N} \frac{F}{E}}{N} \right]}{N'}$$

Where N is the number of input points (usually 5), and N' the number of shunt resistors (usually 4).

2.3.3 Acceleration

All accelerometers, except piezoelectric types, are calibrated statically on a centrifuge to 100% of full scale or 1,000 g, which ever is less. Accelerometers of greater than 1000 g full scale range are comparison calibrated on an impact test device. For static calibration, the angular velocity of the centrifuge is measured and converted to acceleration by tables previously calculated for the radius used. For dynamic input levels, the output of a control accelerometer is used with its previously determined transfer characteristic. This control accelerometer is either calibrated elsewhere or calibrated against a standard traceable to the National Bureau of Standards.

2.3.4 Pressure and Soil Stress Gages

All pressure transducers, except piezoelectric, are statically calibrated with nitrogen, reading input pressure from a precision Bourdon gage. For pressures above 3,000 psi, static calibration is done with hydraulic fluid. Dynamic calibration is done only on selected units of a type and usually only if a new type is being considered. Soil stress transducers are calibrated as pressure transducers (Figure 2-10). They are also calibrated after casting in grout plugs made of either insitu material where possible, or material matching grout. The grout plug units are then recalibrated using a universal testing machine.

2.3.5 Velocity Gages

The input level for velocity calibration is produced by free fall in the earth's gravitational field. The time required to fall through enough arc to produce a known change in output sets the input level needed to determine the transfer characteristic (Figure 2-11). Since time multiplied by gravity equals terminal velocity in a constant acceleration field, the free fall produces all velocities the transducer is capable of measuring, both positive and negative. Time is measured either side of zero output such that +100% to -100% of full scale is produced. Because vertical DX type velocity transducers have a spring which produces a force equal to the force of gravity, the force producing the free fall on them is two times gravity. All calibrations are made at a known temperature and corrected to measured environmental temperature based on previously determined damping fluid viscosity versus temperature relationships. Certain special conditions of the DX type transducer require special attention. The transfer characteristic of this transducer is a nonlinear function of excitation voltage. The voltage across the transducer at the time of calibration must be the same as that at the time of recording data. The relationship appears to be unique to each transducer so that correction for excitation voltage changes should be attempted only when no other approach is available. The DX transducer must be operated with a carrier type signal conditioner resulting in reactive effects that can cause problems with shunt calibration techniques. For this reason the circuit configuration including cable length and type, must be the same during calibration as it will be during the actual data recording. The procedure described above for calibrating velocity gages is illustrated in Figure 2-12. Note that when isolation transformer modules are used, as in the WES system described later, this technique produces an average C_A value in K ohms feet per second. Therefore, within the constraint of constant excitation voltage, a calibration shunt resistor value may be selected in the field to represent a wide range of engineering units, limited only by signal-to-noise considerations at one end and possible amplifier saturation from overdrive on the other. Table 2-6 shows relationships of the calibration procedure to the characteristics of the gage.

2.3.5.1 Velocity Gage Calibration Connections - The specific calibration connections for the MIDDLE GUST series are shown in Figures 2-13 and 2-14. The Air Force velocity gages will be calibrated and operated with bridge completion resistors located at the gage, while the calibration shunt resistor will be connected to the terminals provided on the WES-made printed circuit board signal conditioners. The gages will be calibrated with a length of Air Force-type cable that represents the average (± 200 ft.) length of cable to be used in the actual test. The effect of cable length on the value represented by the shunt calibration resistor for this configuration will be determined prior to MIDDLE GUST, Event I. The WES velocity gages will be calibrated with the isolation transformer modules as shown in Figure 5. In this instance, the shunt calibration resistor is located at the gage and is applied by way of a magnetic-latching relay, also located with the gage. The relay coil is operated through the available dc path shown and the relay is latched with a short pulse (24 vdc) applied of one polarity. The relay is reset by reversing polarity of the coil voltage. The WES gages will also be calibrated so as to take into account the average cable length to be used.

2.4 GAGE PLACEMENT

Important considerations in the installation of free-field instrumentation are the locations and orientation of the gages in the test bed, the disturbance of the "in situ" soil conditions in the vicinity of the gages, and the waterproofing of signal circuits. The various procedures described in this section have been developed: 1) to ensure that the gages are properly oriented in relation to the test bed and to their primary response axis; 2) to ensure that their location relative to the test bed is known accurately; 3) to ensure that the soil motion at each gage location is truly representative of the free-field response; and 4) to ensure that all components are sealed and unaffected by moisture.

The procedure descriptions contained in this report are intended to serve primarily as a guide to those concerned with the gage installations in the field. Detailed procedures may vary from gage to gage without affecting the gage response or the recorded data. However, it is expected that these descriptions will indicate to the installation technicians those aspects of the procedures which are critical to proper gage performance. Any deviations from these procedures will be recorded by the installation crews.

2.4.1 Installation Procedures

With the exception of the air-blast gages, all free-field gages are prepackaged in the laboratory and are installed at the test site in 9-inch diameter augered holes. The accelerometers and velocity gages are mounted on a rigid support assembly along with the bridge completion and calibration circuitry for the velocity gages. The mounted gages are electrically completed with the signal cable attached and are installed in sealed metal canisters. The canisters are potted with wax for damping and waterproofing. Stress gages are prepackaged in 6- and 10-inch high by 6-inch diameter soil plugs prepared from native site material and soil slurry.

Only one hole at a time is instrumented in order to obtain systematic and uniform placement conditions. Water influx is anticipated at depths in excess of a few feet; therefore, rapid installation and backfilling is mandatory, and casing of the borehole is standard procedure. Insertion logs are maintained for each hole instrumented, and all gage depths are referenced to a final pad grade. A typical gage placement is shown in Figure 2-15.

2.4.2 Velocity-Accelerometer Canisters

The instrument hole is augered to the specified depth and is cased. The instrument canister is identified, electrically inspected, and then attached to the first segment of the placement tool. A drill chuck is used for holding and aligning the gage during placement. The placement tool is positively locked in place at the proper depth, and then rotated to correct for azimuthal offset. Accurate vertical placement is automatically achieved by the drill and chuck. After proper positioning is assured, the gages are electrically inspected, and the backfilling operation is begun. Instrument holes greater than 10-feet deep are backfilled with a pumpable soil slurry. Injection of this material is made via a grout pipe, which is independently supported from the drill rig. The pipe is placed below the bottom of the canister, and the injection is started. Slurry is pumped to cover the top of the instrument canister by 4 to 5 inches, and the grout pipe and casing is progressively raised as the fill rises . When the proper amount of material has been injected, the grout pipe is removed. After initial set occurs in the backfill, the placement tool is disengaged and removed from the hole. The grout pipe is reinserted and continuous fill is made until the next instrument level is reached. As filling progresses, both grout pipe and casing are raised. This placement technique is used for all canisters located at a depth greater than 10 feet.

Grouting continues up to the level where materials properties cannot be matched by the soil slurry, which is nominally the upper few feet of recompacted and weathered material. The grout pipe is removed at this point, followed by the incremental removal of the hole casing as the backfill increases. Canisters in the upper material are locally grouted in place, and are then backfilled with hand-tamped native material. The stress plugs for this upper region are prepackaged in plugs of the native material. Plugs for the lower region are prepared from the slurry.

2.4.3 Stress Soil Plugs

Installation of the soil plugs is similar to that of the motion canisters. Gage response is continuously monitored during the installation process, and is periodically monitored thereafter.

2.4.4 WES Surface Air-Blast Gages

The air-blast gages are installed along with the final pad grade. The gage mounts consist of rigid GFE conduits which in turn, are grouted in 2- by 2- by 2-foot concrete (see Figure 2-16) blocks. The surface of the mount is painted a thermally reflective shade. Empty aluminum canisters are installed initially. The gages are installed when possibility of damage from dust and surface traffic is reduced to an acceptable level. Gage response is continuously monitored during the installation process and is periodically monitored thereafter.

2.4.5 AFWL Surface Air-Blast Gages

Air blast transducer mounting hardware will consist of two components to enable plug-in installation. Figure 2-17 shows the mounting hardware for measurements within 100 feet of GZ. Watertight caps will be provided on the canister body to enable installation activities to proceed without the gage module being installed.

Mounting hardware will be imbedded in a poured concrete mass at the sensing location such that the sensing surface is flat, in the horizontal plane, and relatively flush with the surrounding plane, and relatively flush with the surrounding free field surface. The geometry of the concrete mass will be established from considerations of maintaining position in the hostile environment for the longest possible duration, and preserving electrical circuit continuity. Figure 2-18 shows a typical installation.

Motion measurements will be implemented for the purpose of monitoring the environment experienced by the transducers. Other channels will measure noise phenomena and other parameters unique to blast pressure measurement channels. Other types of blast pressure transducers will be installed (if possible) as experiments to observe transducer performance.

Recording of the analog data for sensing locations within 50 feet of GZ will be such that one channel will be scaled to record the entire range of the transducer including the overrange. Other channels will be scaled such that the predicted level is approximately 50% of the channel capability.

2.4.5.1 Installation Procedure

General

No fabrication or assembly operations will be performed in the field.

One splice will be made in the field (to the forward cable).

Pouring of the mass in the field.

Major items to be supplied for each blast pressure installation:

A. Length of cable with plug soldered and potted to the end. (length adequate for routing to primary cable trench.)

B. Calibrated transducer/module assembly with internal wrenching screws for installing to body.

C. Canister Body/Flange assembly with watertight cap installed and hose adapter fitting in place.

D. Rubber hose

E. Schematic/hookup information for splice.

F. All items marked with measurement number and measurement designation.

G. Verbal information as required.

2.4.5.2 Installation Sequence

General

1. Establish sensing locations - survey and stake.

2. Excavate for mass and dig access trench.

3. Attach suitable length of rubber hose at adapter fitting.

4. Route interim cable downward through body and hose and draw it until the sleeve seats in its normal position.

5. Install watertight cap.

6. Fix canister assembly at proper elevation in mass excavation.

7. Maintain position of canister and pour concrete.

8. Condition concrete with vibrator and finish surface smooth.

9. After concrete set, module may be installed temporarily for checkout purposes only.

Permanent installation of the module will be done as near as possible to shot day. The watertight cap will be secured in place at all times when the module is not installed.

Specific detailed procedures will be supplied as a field working paper and will be inserted as "as-built" inserts to the Instrumentation Plan.

2.4.6 High Pressure Gages

High pressure gages on the first event will be installed along the 120° radial within a few feet of the explosive charge. See Figure 2-19 for general gage placement information. Detailed placement procedures will be provided by AFWL and SRI personnel in the field.

TABLE 2-1

LIST OF TRANSDUCERS

Type of Gage	Manuf.	Model #	Type
Accelerometer	Endevco	2264M24	Strain Gage
Accelerometer	Endevco	2261CA-10K	Strain Gage
Accelerometer	Endevco	2261CA-2500	Strain Gage
Accelerometer	Endevco	2261CA-250	Strain Gage
Accelerometer	Endevco	2262C-25	Strain Gage
Velocity	Sparton	601M-V	Dampened Pendulous Mass
Velocity	Sparton	601M-H	Dampened Pendulous Mass
Velocity	Sparton	601V-V	Dampened Pendulous Mass
Velocity	Sparton	601V-H	Dampened Pendulous Mass
Pressure	Kulite	HKS-375-5-20K	Strain Gage
Pressure	Kulite	HKS-375-5-30K	Strain Gage
Pressure	Kulite	HKS-375-5-500	Strain Gage
Pressure	Kulite	HKS-375-5-10K	Strain Gage
Pressure	Kulite	HKS-375-5-2K	Strain Gage
Pressure	Kulite	hks-375-5-1K	Strain Gage
Pressure	Kulite	HKS-375-5-5K	Strain Gage
IMHST	Sandia	--	Piezoelectric
Manganin	Pulsar	--	Piezoresistive
PZT	GRT	100	Piezoelectric
Thermopile Thermoelectric	--	--	--
Ytterbium	--	--	Piezoresistive

TABLE 2-2

SHOCK ACCELEROMETER SPECIFICATIONS

	2262C25	2261CA-250.	2261CA-2500	2261CA-10,000	2264M24
Dynamic					
Range (FR)	± 25g	± 250g	± 2500g	± 10,000g	± 30,000g
Over-range	240% of FR	300%	300%	200%	
Sensitivity	≥ 10mv/g	≥ .5mv/g	≥ .04mv/g	≥ .01mv/g	.004mv/g
Excitation	10 VDC	10 VDC	10 VDC	10 VDC	10 VDC
Input Resistance	1000-2000 ohms	750-1000 ohms	750-1250 ohms	750-1250 ohms	
Output Resistance	500-1000 ohms	750-1000 ohms	750-1250 ohms	750-1250 ohms	
Mounted Resonant Frequency	> 2.4 KHz	> 10 KHz	> 30 KHz	> 40 KHz	> 90 KHz
Frequency Response	DC to 750 Hz	DC to 2 KHz	DC to 6 KHz	DC to 10 KHz	
Damping	.7	.7 of critical (if possible)	.7 of critical (if possible)	.7 of critical (if possible)	
Transverse Sensitivity	< 3%	< 3%	< 3%	< 5%	
Linearity & Hystesis	< ±1%	≤ ±1%	≤ ±2%	≤ ±2%	
Zero Unbalance	< ±5% of FR Output	< 4% of FR Output	< 3% of FR Output	< 10%	≤ 50 mv dc
Thermal Zero Shift	< ±4% of FR (0 to 100°F)	< ±2% of FR (0 to 100°F)	< ±2% of FR (0 to 100°F)	< ±2% of FR (0 to 100°F)	± 50 mv dc
Thermal Sensitivity Shift	< 2% FR deviation from 75°F	< 2% FR deviation from 75°F	< 2% FR deviation from 75°F	< 2% FR deviation from 75°F	
Insulation Resistance	> 100 MΩ minimum @ 100VDC	> 100 MΩ	100 MΩ	100 MΩ	
Warmup Time	≤ 1 Minute	≤ 1 Minute	≤ 1 Minute	≤ 1 Minute	≤ 1 Minute
Physical					
Weight	< 1 oz.	< 2 oz.	< 2 oz.	< 2 oz.	1 gram, less cable
Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Anodized Aluminum alloy
Mounting	Base tapped for 10/32 NF x 1/8 stud	Base tapped for 10/32 NF x 1/8 stud	Base tapped for 10/32 NF x 1/8 stud	Base tapped for 10/32 NF x 1/8 stud	
Grounding	Circuit isolated shield not common to case	Circuit isolated shield not common to case	Circuit isolated shield not common to case	Circuit isolated shield not common to case	Circuit isolated shield not common to case
Electrical Connection	2 feet of shielded cable with connector	2 feet of shielded cable with connector	2 feet of shielded cable with connector	2 feet of shielded cable with connector	
Environmental					
Static		± 750g	± 7500g	± 20,000g	
Vibration		± 750g	± 7500g	± 20,000g	
Shock		± 750g, 150 msec, half sine	± 7500g, 170 msec half sine pulse or longer	± 20,000g half sine pulse	± 50,000g, 35 msec half sine pulse
Temperature Range	0° to 100°F (compensated)	0° to 100°F (compensated)	0° to 100°F (compensated)	0° to 100°F (compensated)	0 to 100°F
Humidity	Hermetically Sealed	Hermetically sealed	Hermetically sealed	Hermetically sealed	

TABLE 2-3

SPECIFICATIONS FOR AIR BLAST PRESSURE TRANSDUCERS

	HKS-375-5-20K	HKS-375-5-30K	HSK-375-5-500	HKS-375-5-10K	HKS-375-5-2K	HKS-375-5-1K	HKS-375-5-5K
Pressure Range (F.S.)	0 to 20,000 psig	0 to 30,000 psig	0 to 500 psig	0 to 10,000 psig	0 to 2,000 psig	0 to 1,000 psig	0 to 5,000 psig
Overrange Limit	35,000 psig for 1 sec.	35,000 psig for 1 sec.	750 psig for 1 sec.	15,000 psig for 1 sec.	3,000 psig for 1 sec.	1,500 psig for 1 sec.	7,500 psig for 1 sec.
Input Resistance	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms
Output Resistance	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms	350 ohms
Excitation	5 volts	5 volts	5 volts	5 volts	5 volts	5 volts	5 volts
Sensitivity	.011 mv/psi	.011 mv/psi	.011 mv/psi	.011 mv/psi	.011 mv/psi	.011 mv/psi	.011 mv/psi
Linearity	± 1%	± 1%	± 1%	± 1%	± 1%	± 1%	± 1%
Natural Frequency	> 700 KHz	> 700 KHz	> 350 KHz	> 700 KHz	650 KHz	500 KHz	675 KHz
Shock	To withstand 20,000 g's	To withstand 20,000 g's	To withstand 20,000 g's	To withstand 20,000 g's	To withstand 20,000 g's	To withstand 20,000 g's	To withstand 20,000 g's
Temperature Range	-65°F to +300°F	-65°F to +300°F	-65°F to +300°F	-65°F to +300°F	-65°F to +300°F	-65°F to +300°F	-65°F to +300°F
Insulation Resistance	750 Mohms	750 Mohms	750 Mohms	750 Mohms	750 Mohms	750 Mohms	750 Mohms
Caffe	4 Conductor (1 ft.)	4 Conductor (1 ft.)	4 Conductor (1 ft.)	4 Conductor (1 ft.)	4 Conductor (1 ft.)	4 Conductor (1 ft.)	4 Conductor (1 ft.)
Mechanical Configuration	See Figure 2-1	See Figure 2-1	See Figure 2-1	See Figure 2-1	See Figure 2-1	See Figure 2-1	See Figure 2-1

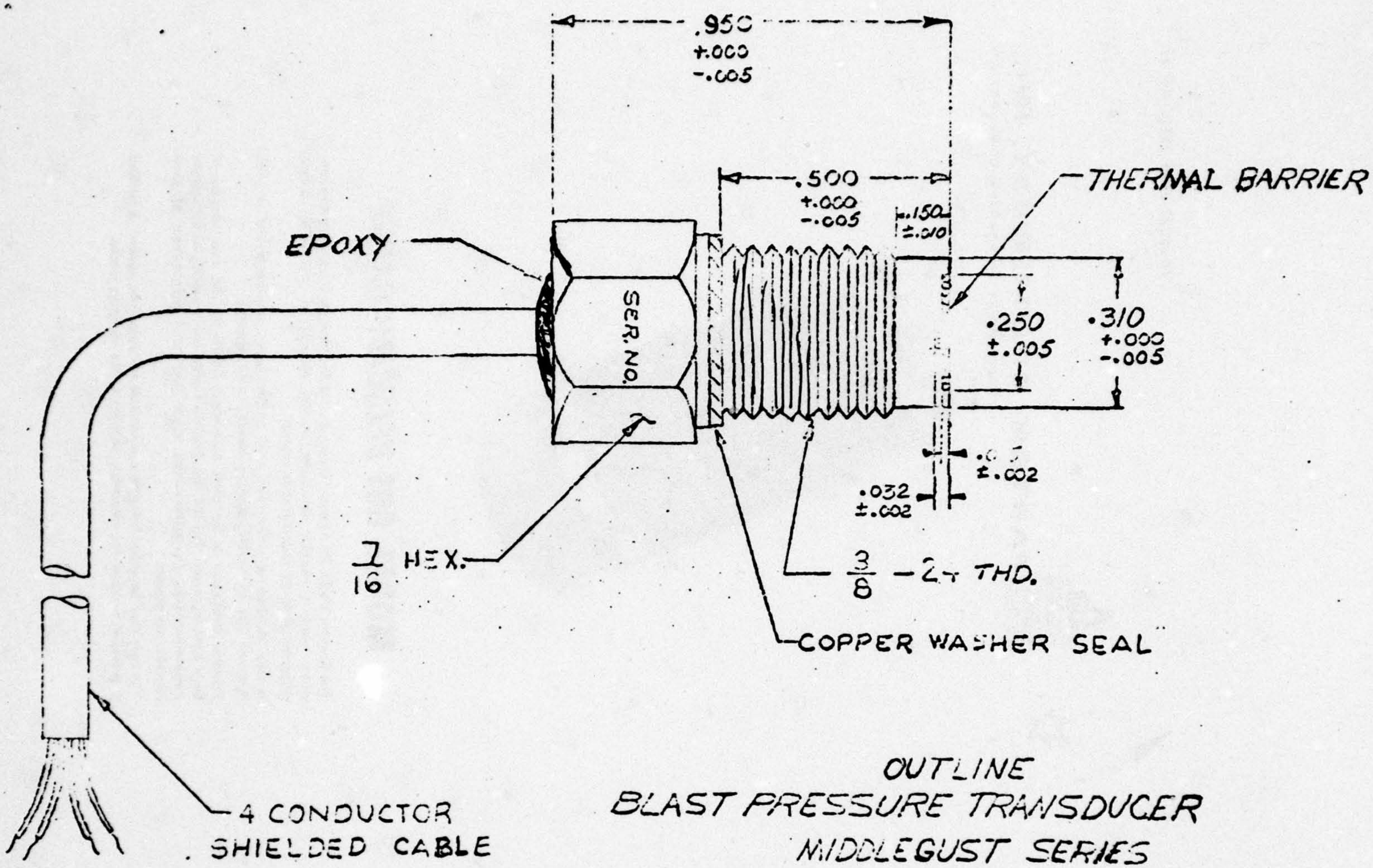


Figure 2-1 Blast Pressure Transducer

HOUSING MTL. 303 SS

PRODUCT DATA SHEET NO. 22

SPARTON SOUTHWEST, INC.
SUBSIDIARY OF SPARTON CORPORATION

MODEL 601 *VELOCITY GAUGE*

The Sparton Model 601 Velocity Gauge is a viscous damped integrating accelerometer using a variable reluctance sensing element to provide an output proportional to its instantaneous velocity.

It may be used in conjunction with carrier system instrumentation or with Sparton's 120 Exciter-Demodulator for DC-to-DC systems.

Primary application is for earth movement studies in the near vicinity of large scale explosions, but the 601 Velocity Gauge can be employed for velocity measurements in any environment where high level accelerations of short duration are present.

The case may be either brass or aluminum at the customers option. A bellows is provided to allow for volumetric changes of the damping media.

Figure 2-2 Sparton Southwest Model 601 Velocity Gage

TABLE 2-4

VELOCITY GAGE SPECIFICATIONS

	601 M	601 V
Range	± 3 to ± 500 ft/sec.	± 3 to ±500 ft/sec
Undampened Natural Frequency	3 Hz ± .25 Hz	3 Hz ± .25 Hz
Resolution	Infinite	Infinite
Linearity of Undampened Gage	0.5% of Full Scale	0.5% of Full Scale
Repeatability of Undampened Gage	0.5% of Full Scale	0.5% of Full Scale
Hysteresis of Undampened Gage	± .25% of Full Scale	± .25% of Full Scale
Shock Load	4000-5000 g's any axis	2000 g's any axis
Temperature Sensitivity	1.5% per °C	1.5% per °C
Output	AC Differential	AC Differential
Power Output	1.0 Watt Maximum	1.0 Watt Maximum
Output Impedance	$(28 + j\omega\, 0.18)$ Nominal	$(28 + j\omega\, 0.18)$ Nominal
Excitation	3 KHz, 10V rms	3 KHz, 10V rms
Weight	520 grams	520 grams

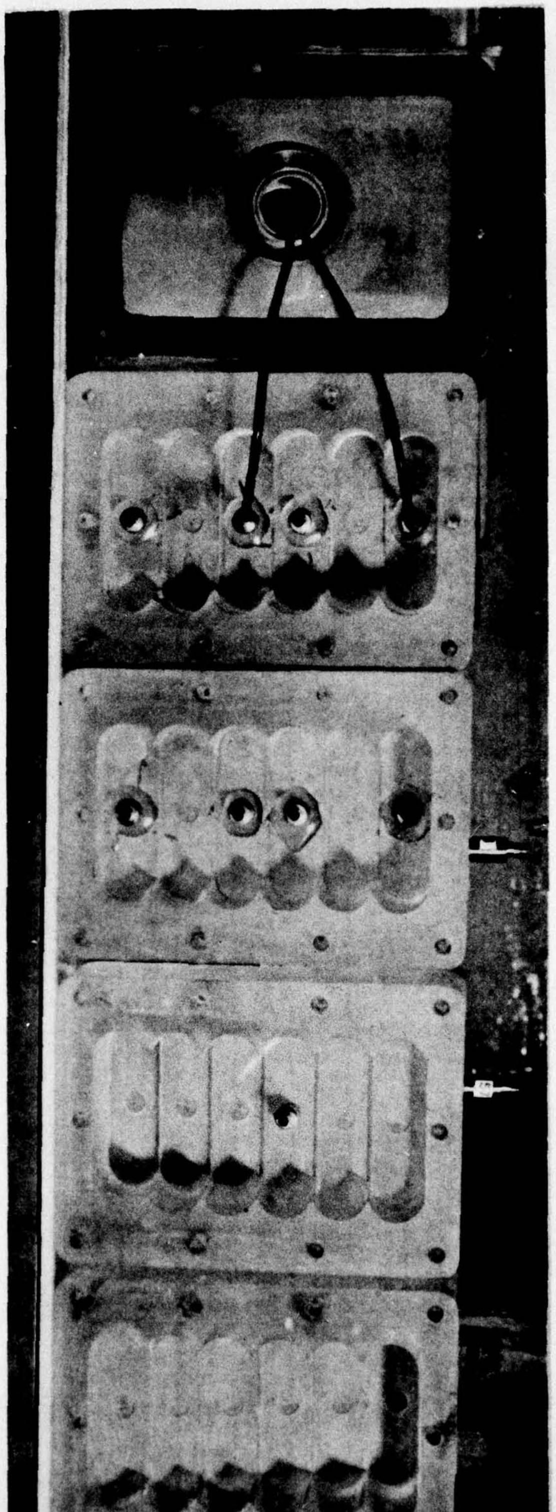


Figure 2-3 Layout of Crystals Mounted in Plexiglass Blocks

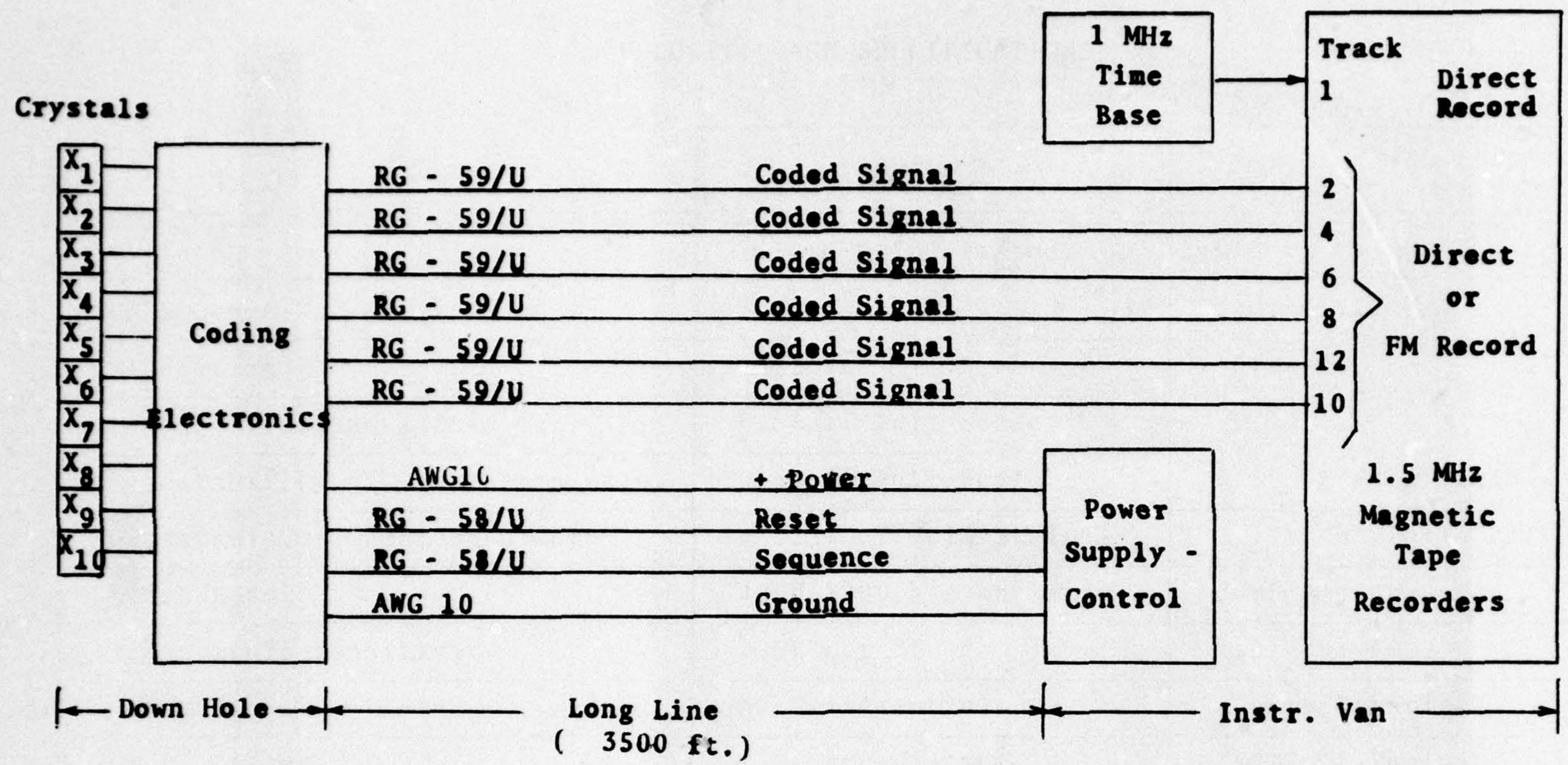


Figure 2-4 Block Diagram of High Stress Measurement System (IMHST)

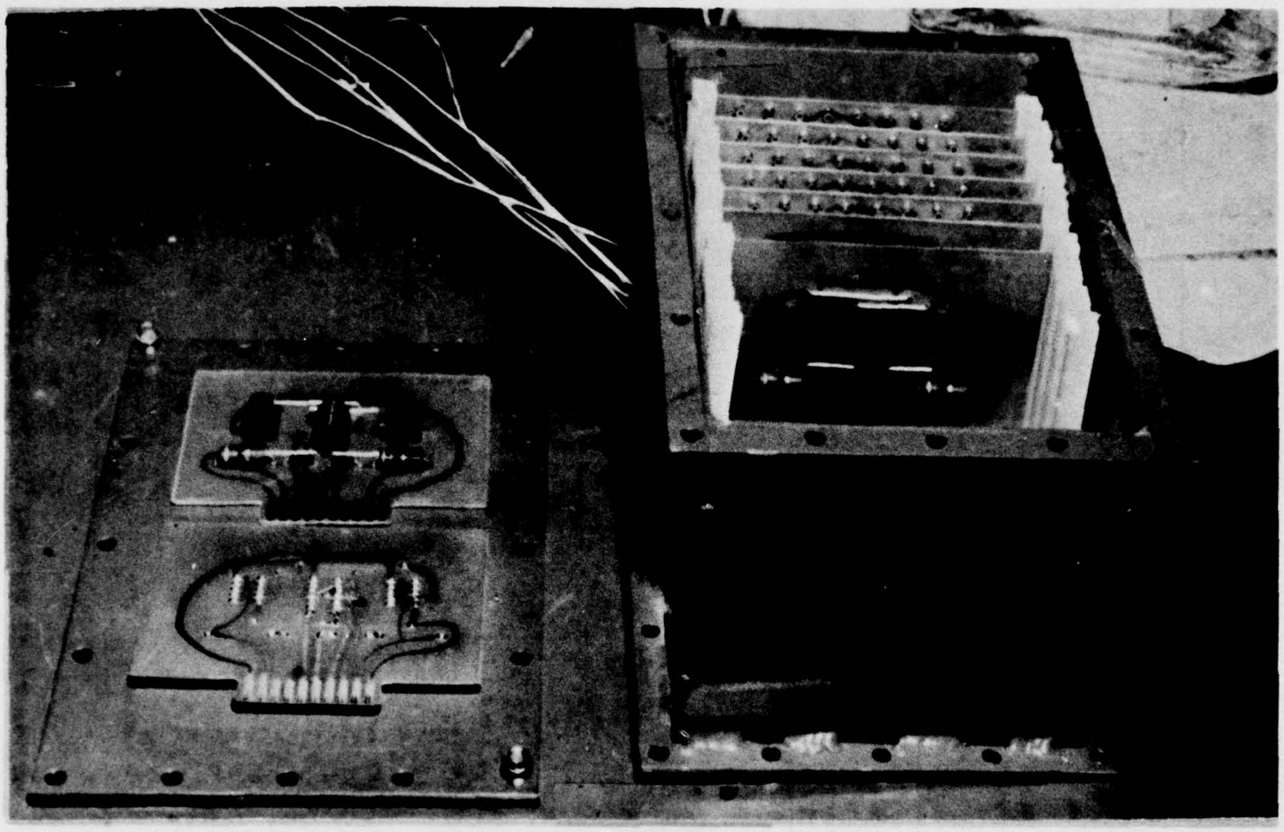
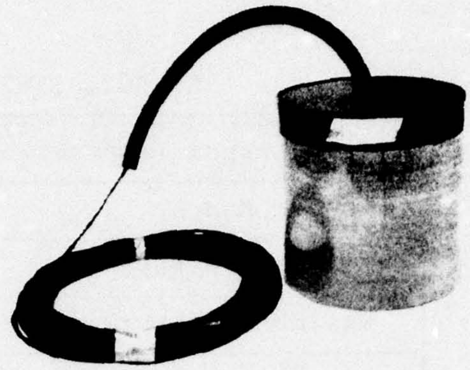


Figure 2-5 IMHST System Coding Electronics Housing

TABLE 2-5

SE SOIL STRESS GAGE SPECIFICATIONS

Gage Output (Approximately)	0.20 mv/v/psi
Linear Range	0 to 3000 psi
Design Pressure	2000 psi
Maximum Pressure Limit	3000 psi
Linearity, Maximum	0.4 Percent Full Range
Hysteresis, Maximum	1.6 Percent Full Range
Temperature Range	-30 to +150 F
Suggested Excitation	6 to 10 Volts
Maximum Excitation	21 Volts
Acceleration Sensitivity Normal to Diaphragm	0.04 psi/g
Apparent Strain Sensitivity	20 to 30 in,/in./psi
Thermal Sensitivity (zero shift)	1 psi/F
Natural Frequency	40,000 Hz
Rise Time	6 sec
Gage Modulus	4.52×10^5 psi



Sensor: Manganin grid, approximately 1 in.^{2} x 0.003 in. thick, 51 ± 1 Ω
The grid is positioned approximately 0.250 in, from the epoxy surface.

Sensitivity: Nominally 0.30 volts/kbar when powered by a 500 volt source

Size: 6 in. diameter x 6 in. long (MF6) or 8 in. diameter v 8 in. long (MF8)

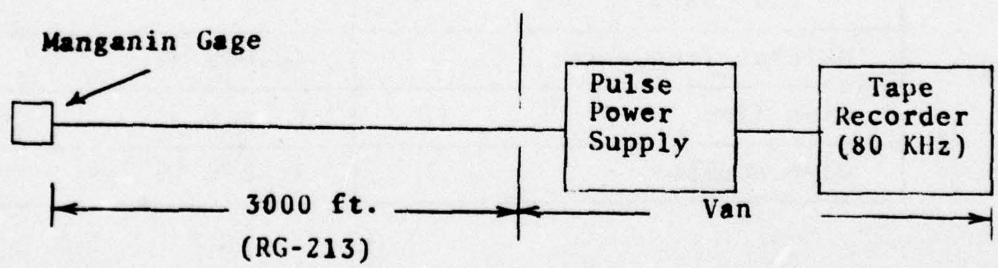


Figure 2-6 Manganin Gage and Schematic

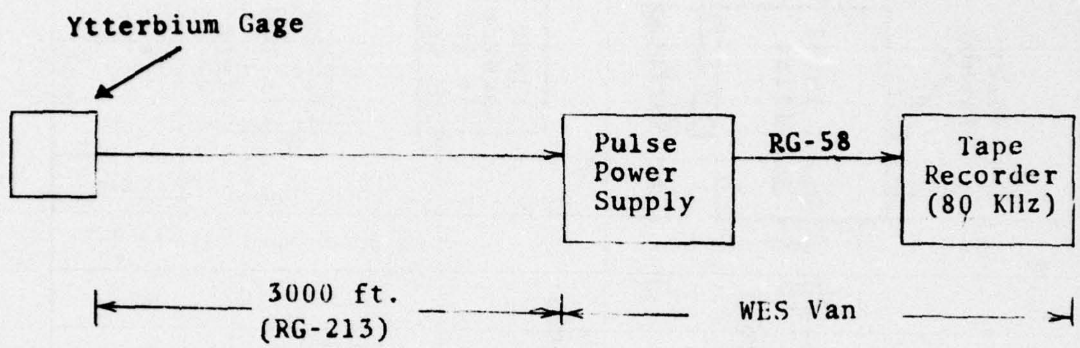


Figure 2-7 Ytterbium Gage, Schematic

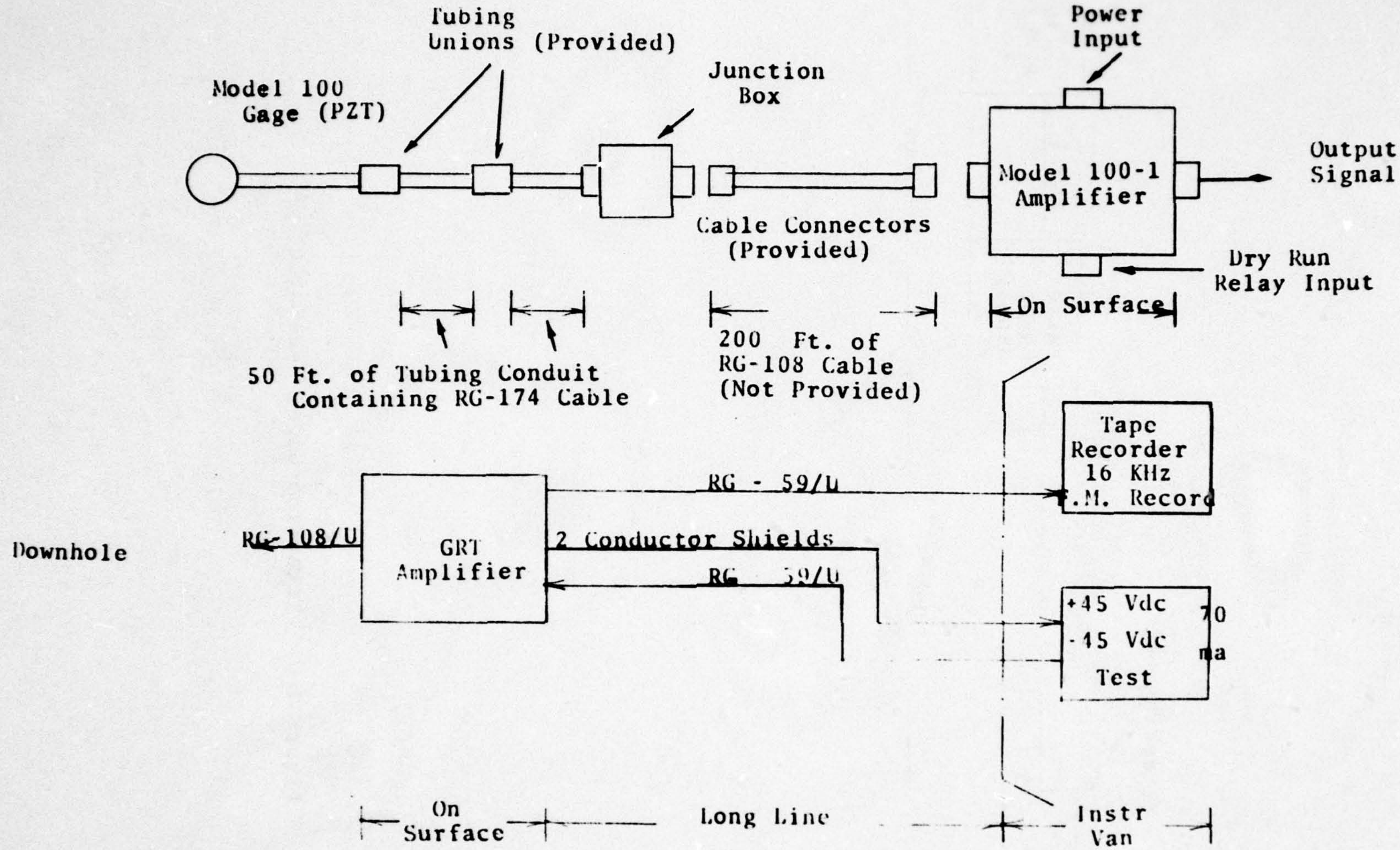


Figure 2-8 GRT System

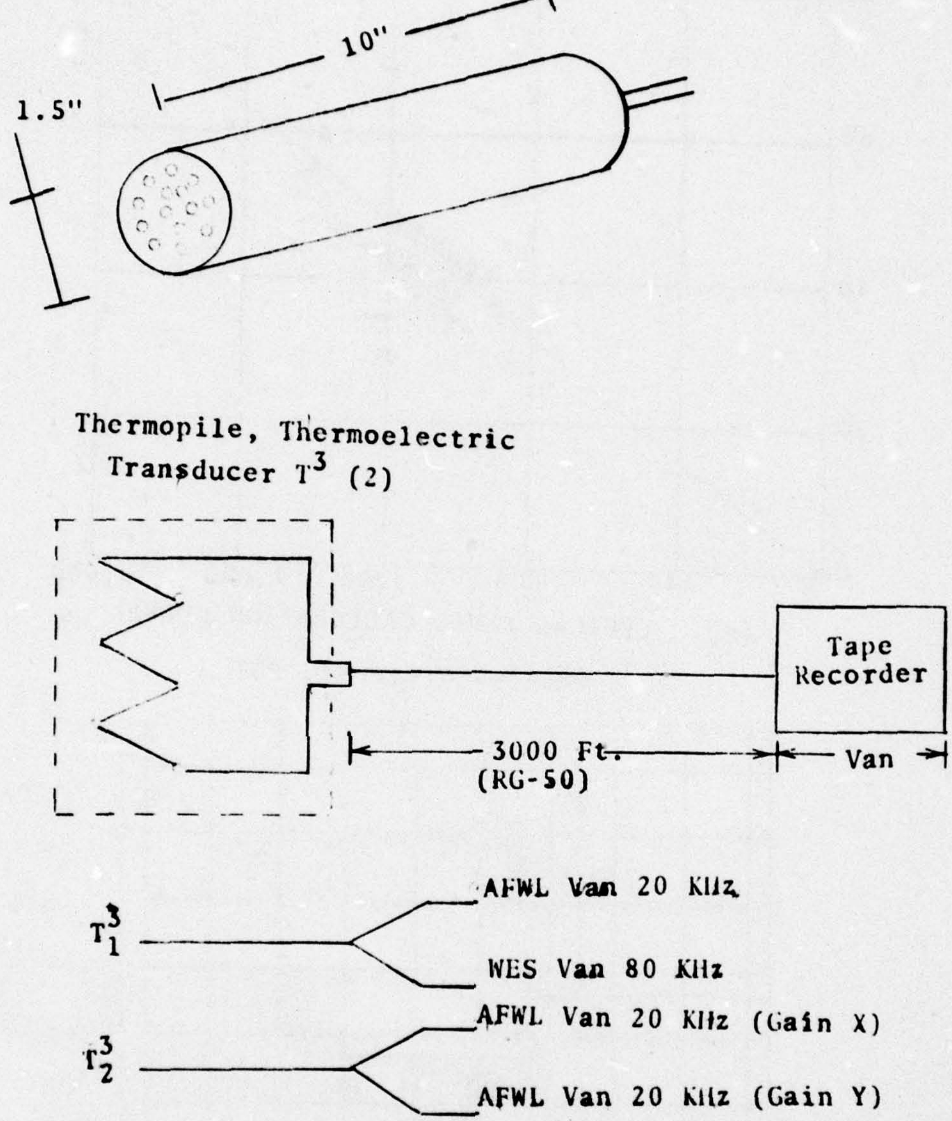
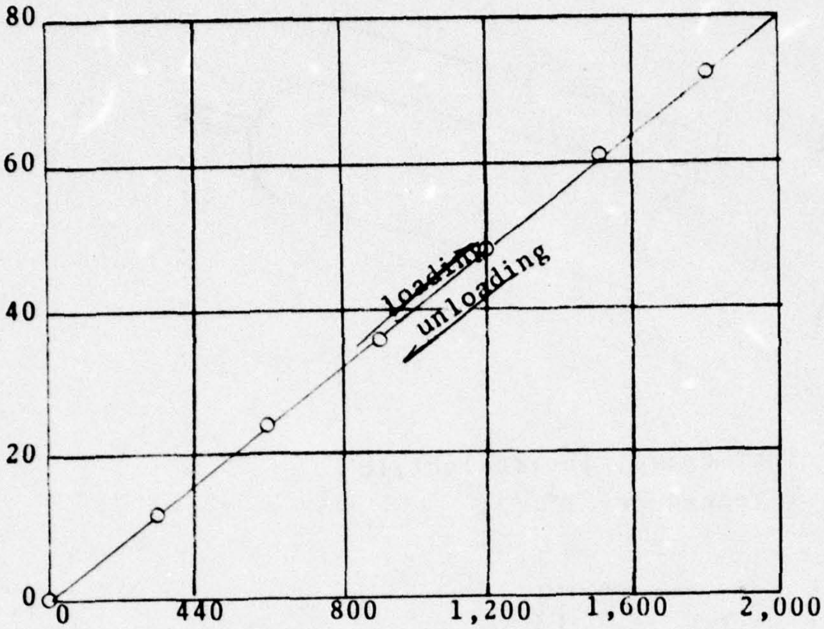
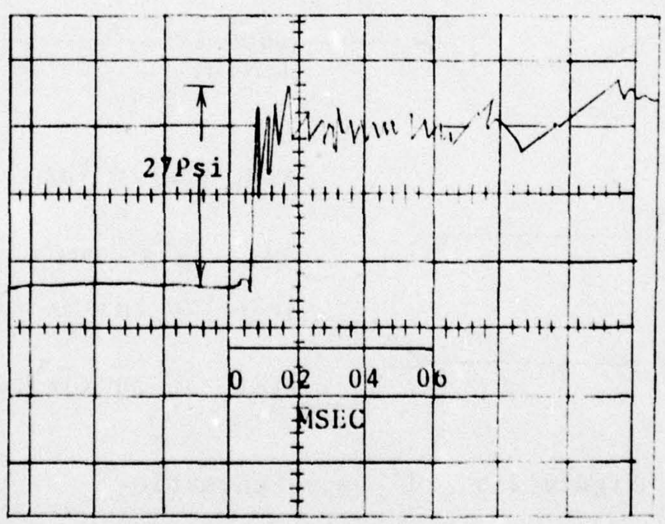


Figure 2-9 T^3 Gage Schematic



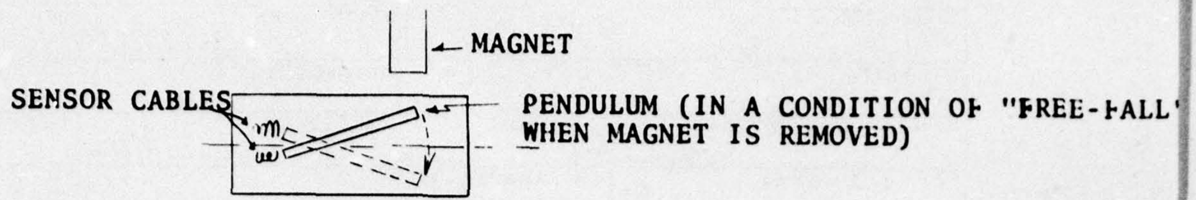
(a) TYPICAL FLUID CALIBRATION CURVE

Applied Pressure, PSI

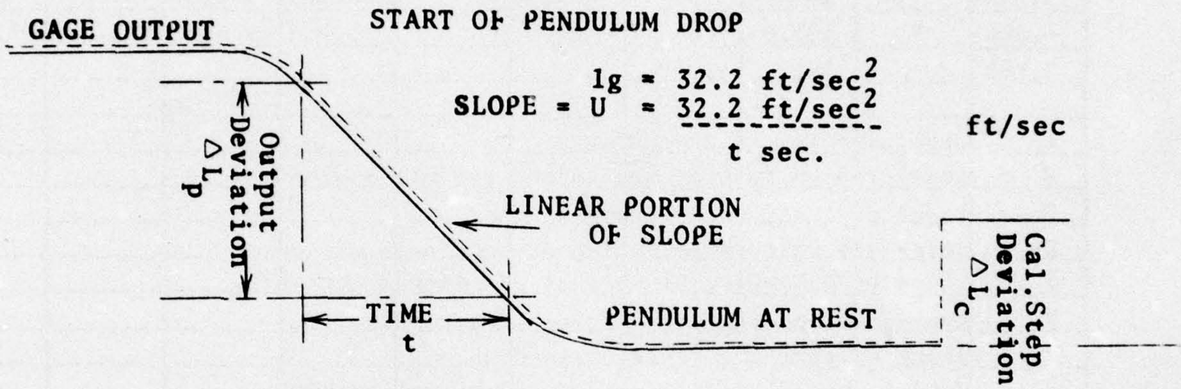


(b) GAGE RESPONSE TO A STEP AIR SHOCK

FIGURE 2-10. TYPICAL SE GAGE STATIC AND DYNAMIC RESPONSE



SECTION VIEW OF VELOCITY GAGE



CAL STEP CALCULATIONS:

$$\frac{U \text{ ft/sec}}{\Delta L_p} = \frac{X \text{ ft/sec}}{\Delta L_c}$$

Then $X = \dfrac{U \Delta L_c}{\Delta L_p}$

Where X = Cal. step velocity equivalence, ft/sec
ΔL_p = Gage output deviation over time interval Δt
ΔL_c = Cal.step deviation, in units of ΔL_p

FIGURE 2-11. CALIBRATION METHOD FOR DX MODEL HORIZONTAL VELOCITY GAGE

SUBJECT: DX Velocity Transducer Calibration				DATE:
TRANSDUCER S/N:	SENS:	VISCOSITY: ______ CS		ORIENTATION:
SYSTEM:		CONNECTION:		
BRIDGE COMPLETION: ______ Ω	TEMP: ______ °F	E_V: ______ V_{RMS}		MODE: 1
CABLE LENGTH: ______ Ft	CALIBRATED BY:			C_A = 535 $\frac{K\Omega \, Ft}{SEC}$

t MSEC	G $\frac{Ft/SEC}{MSEC}$	U_{IN} Ft/SEC	E_R VOLTS	S $\frac{Ft/SEC}{VOLT}$	S_A $\frac{Ft/SEC}{VOLT}$	R_c KΩ	E_c VOLTS	U_E Ft/SEC	C $\frac{K\Omega \, Ft}{SEC}$
1,074	.0322	34.6	2	17.3		40.284	.762	13.2	532
2,152	"	69.4	4	17.4	17.35	20.284	1.525	26.5	539
3,238	"	104.0	6	17.35		10.284	3.006	52.4	539
4,314	"	139.0	8	17.4		5.284	5.865	102.0	539
5,780	"	186	10						

t = Drop time in milliseconds.

G = Acceleration in feet per second per millisecond.

U_{IN} = Input velocity in feet per second.

E_R = Reference voltage for which drop time is measured.

S = Slope of output curve in feet per second per volt.

S_A = Average slope in feet per second per volt.

R_c = Shunt calibration resistor in KΩ.

E_c = Output voltage resulting from shunt calibration.

U_E = Velocity which is equivalent to the shunt calibration.

C = Shunt calibration constant in kilohms feet per second.

C_A = Average shunt calibration constant.

Mode:
1. Transformer module calibration.
2. Calibration at amplifier.
3. Calibration at transducer.
4. Calibration by 6-wire single shunt.

N = Number of input points (E_R).

N' = Number of shunt resistors (R_c).

$$U_{IN} = t\,G \qquad S = \frac{U_{IN}}{E_R} \qquad S_A = \frac{\sum_{E_R=2}^{E_R=10} S}{N} \qquad U_E = S_A E_c$$

$$C = U_E R_c \qquad C_A = \frac{\sum_{R_c=40.284}^{R_c=5.284} C}{N'} \qquad R_{CAL}(K\Omega) = \frac{C_A}{\text{SET RANGE (Ft/sec)}}$$

Figure 2-12 Typical Calibration Data

TABLE 2-6. RELATIONSHIPS OF CALIBRATION PROCEDURE TO DX VELOCITY GAGE

C_A - KΩ ft per sec.

C_{A_θ} = KΩ degrees (related to basic electrical sensitivity of unit).

μ = Viscosity in centistokes.

E_v - Excitation voltage used (rms).

Eo = Excitation voltage for which calibration is known (rms).

K = A constant for each transducer.

$\frac{C_A}{C_{A_\theta}}$ = 3.2 +2 for a brass pendulum. This factor has the units ft per second per degree, and is the mechanical transfer characteristic.

$\frac{C_A}{C_{A_\theta}}$ for aluminum is 3 times that of brass.

$C_A = C_{A_\theta}$ (1-K $\log_{10}\frac{Ev}{Eo}$

K ≈ .13 for Sparton short armature.

K ≈ .24 for Sparton long armature.

K ≈ .3 for CEC long armature.

C_{A_θ} ≈ 8 for any long armature.

C_{A_θ} ≈ 40 for any short armature.

NOTE: Any short armature is linear for $\pm$ 3° about null; any long armature is linear for $\pm$ 10° about null with 6% bilinear disagreement between slopes. A long armature element produces the same output at 2° that a short armature one does at 10°. The calibration points used are approximately $\pm$ 1.6° on long armature units and $\pm$ 8° on short armature units. This produces acceptable linearity on all units tested.

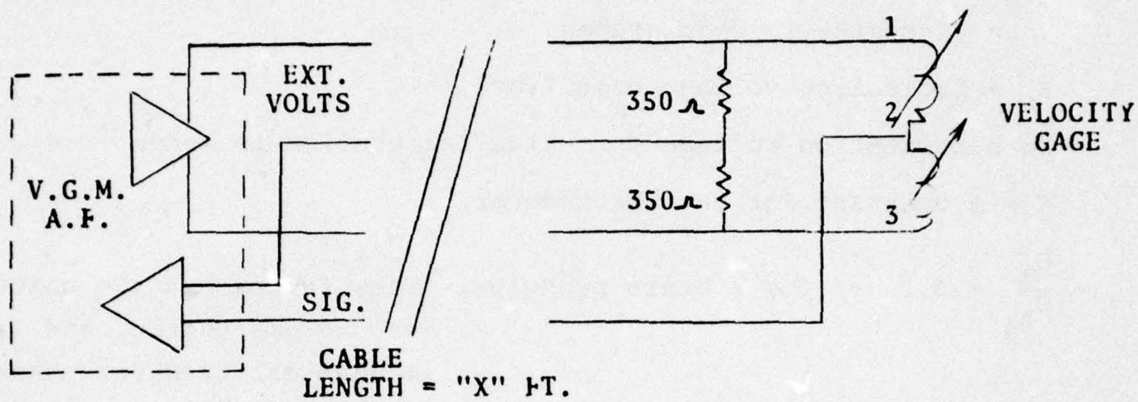


FIGURE 2-13. VELOCITY GAGE
A.F. CALIBRATION HOOK-UP

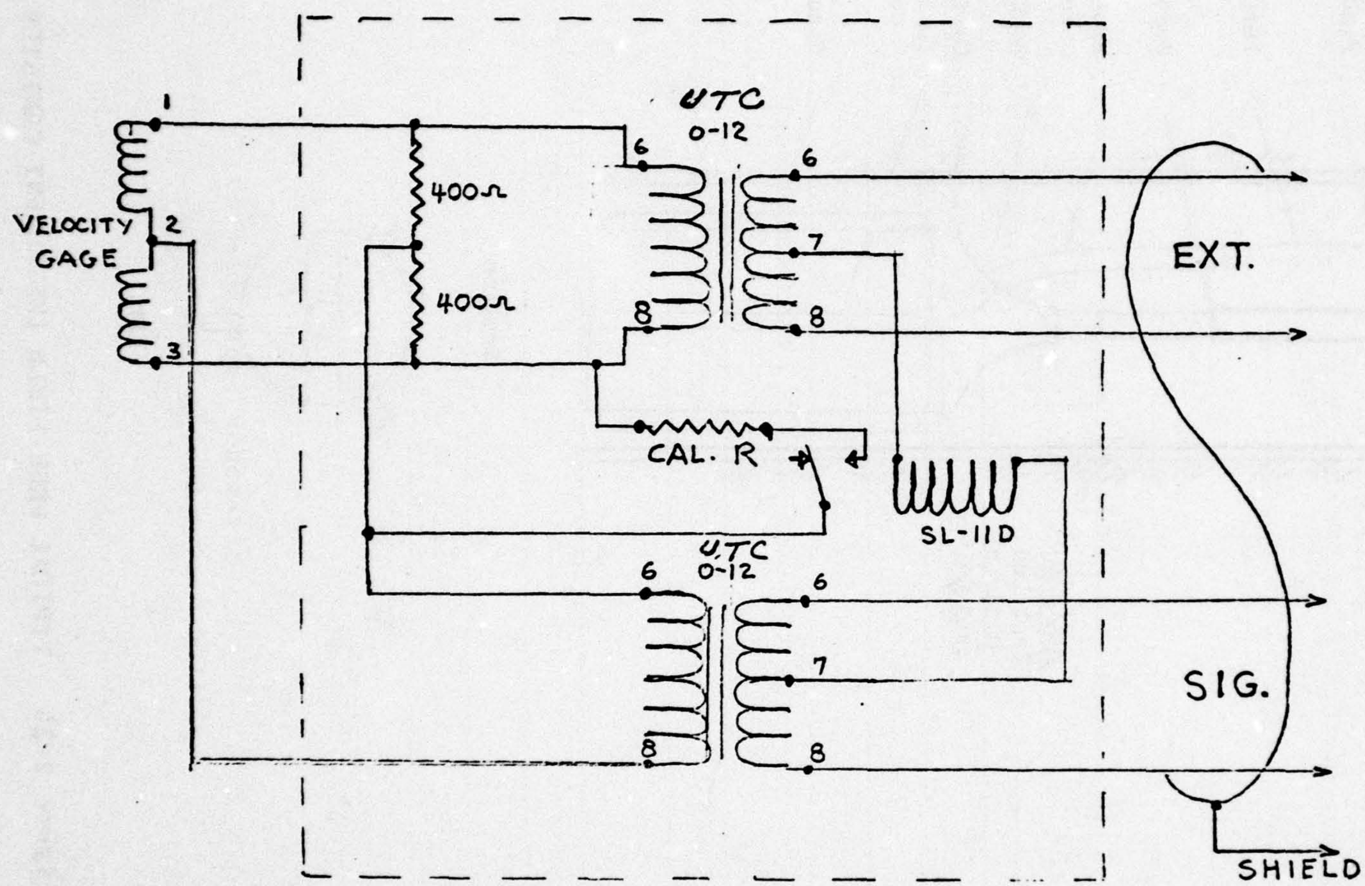
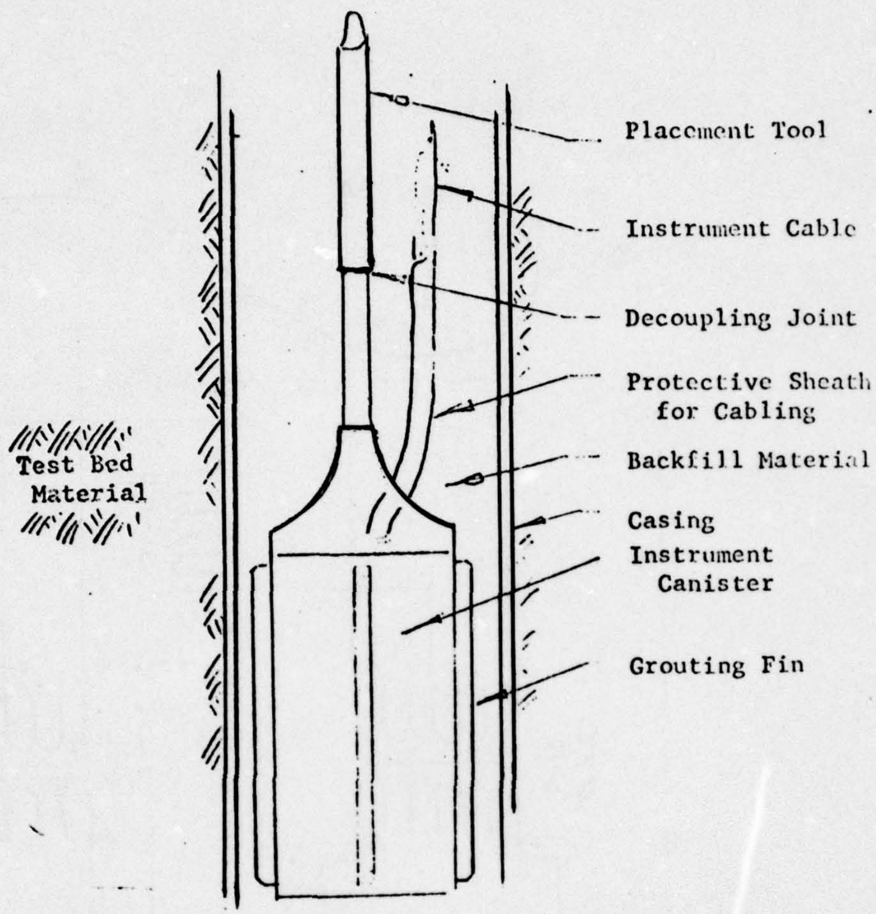
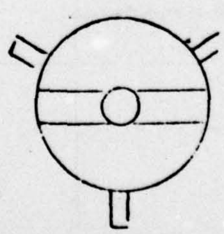


Figure 2-14 WES VELOCITY GAGE HOOK-UP



Section



Plan

Figure 2-15 TYPICAL FREE-FIELD INSTRUMENT CANISTER PLACEMENT

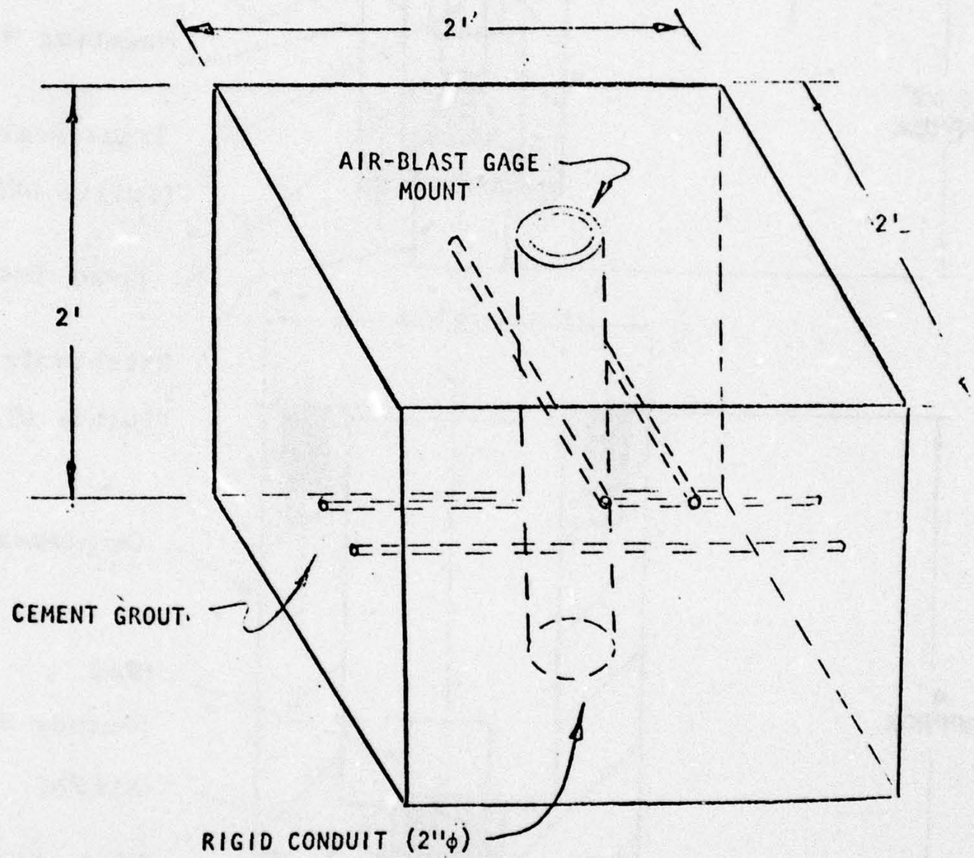


Figure 2-16 TYPICAL SURFACE MOUNT FOR WES TEST BED AIR-BLAST GAGE

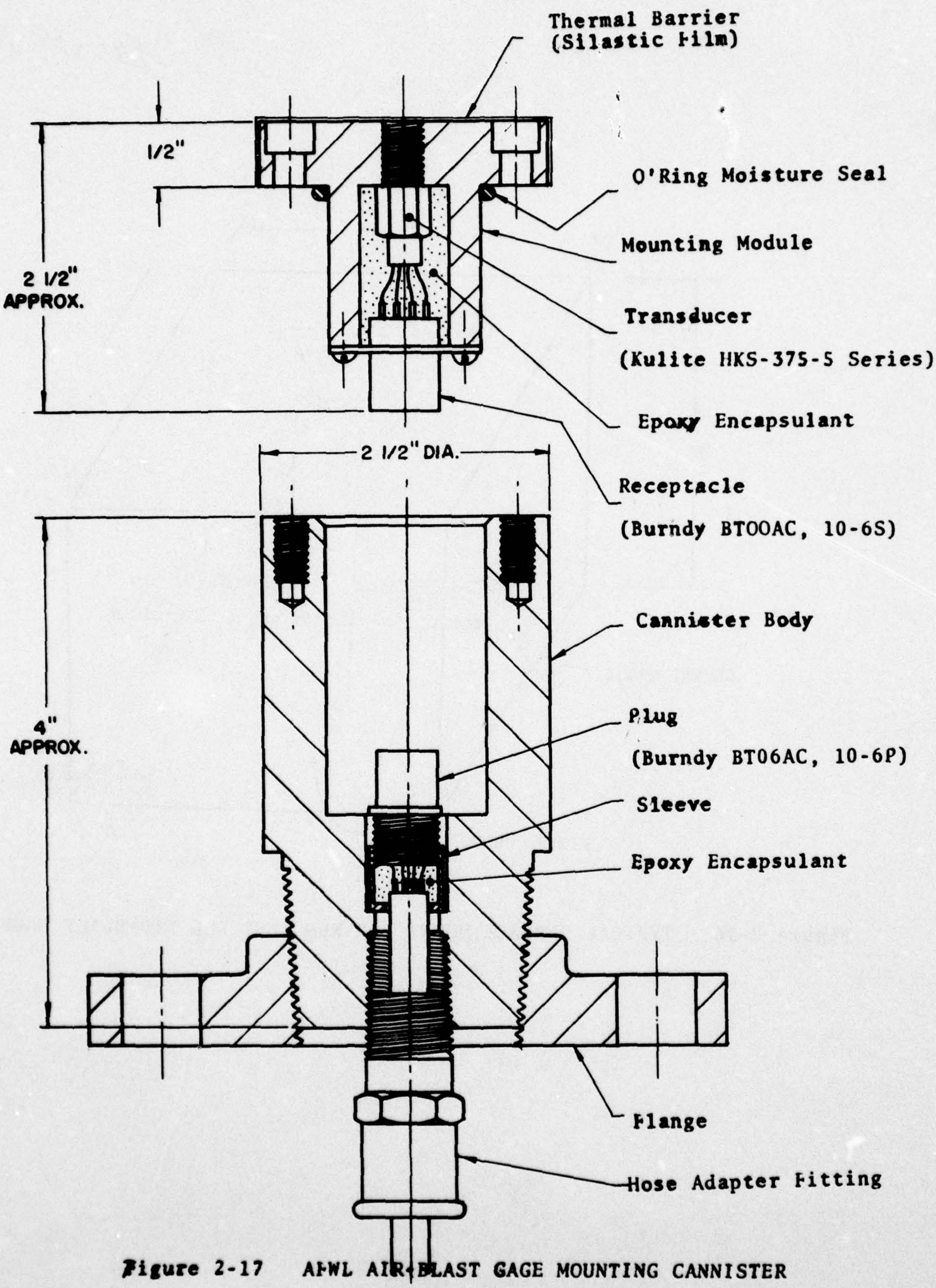


Figure 2-17 AFWL AIR-BLAST GAGE MOUNTING CANNISTER

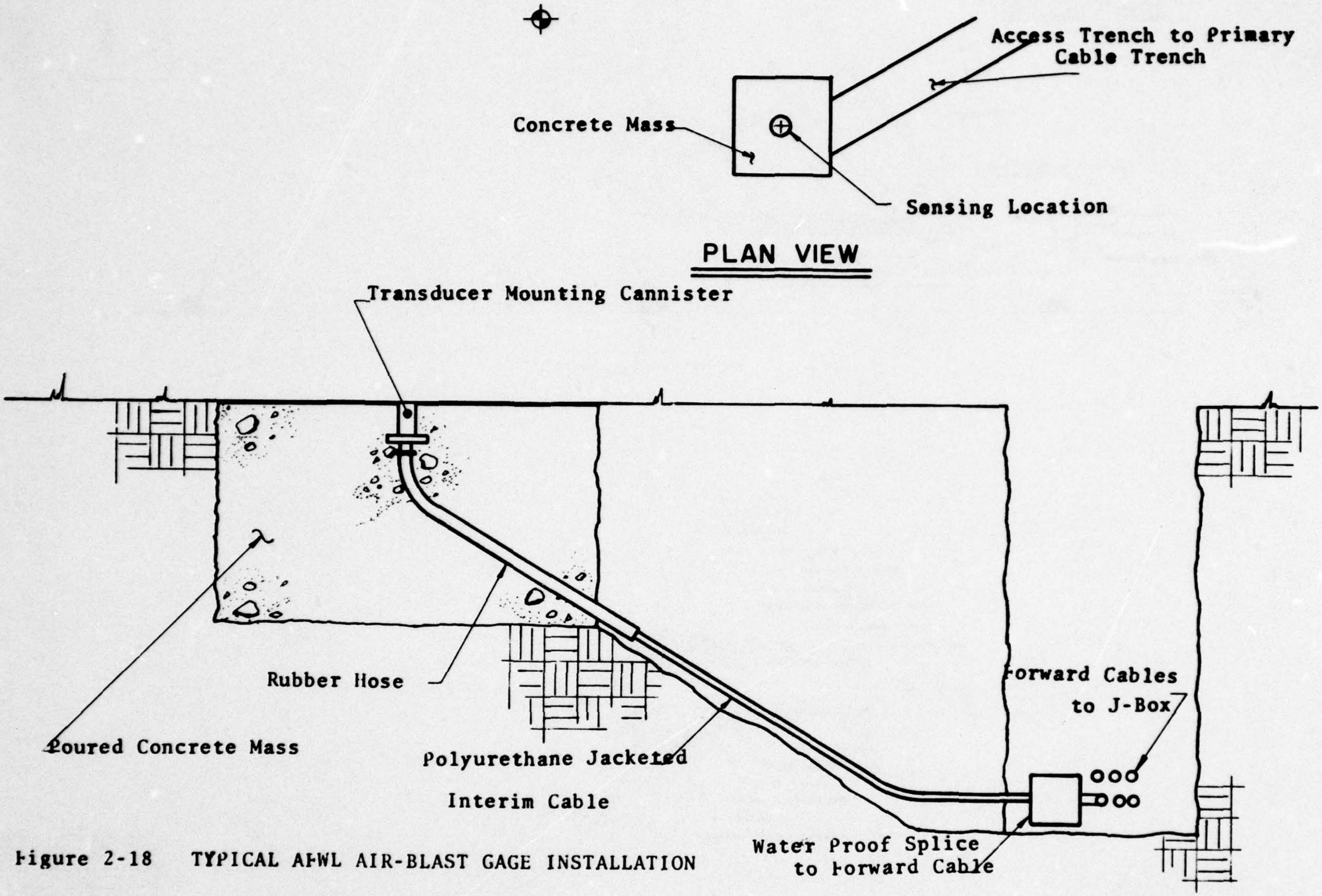
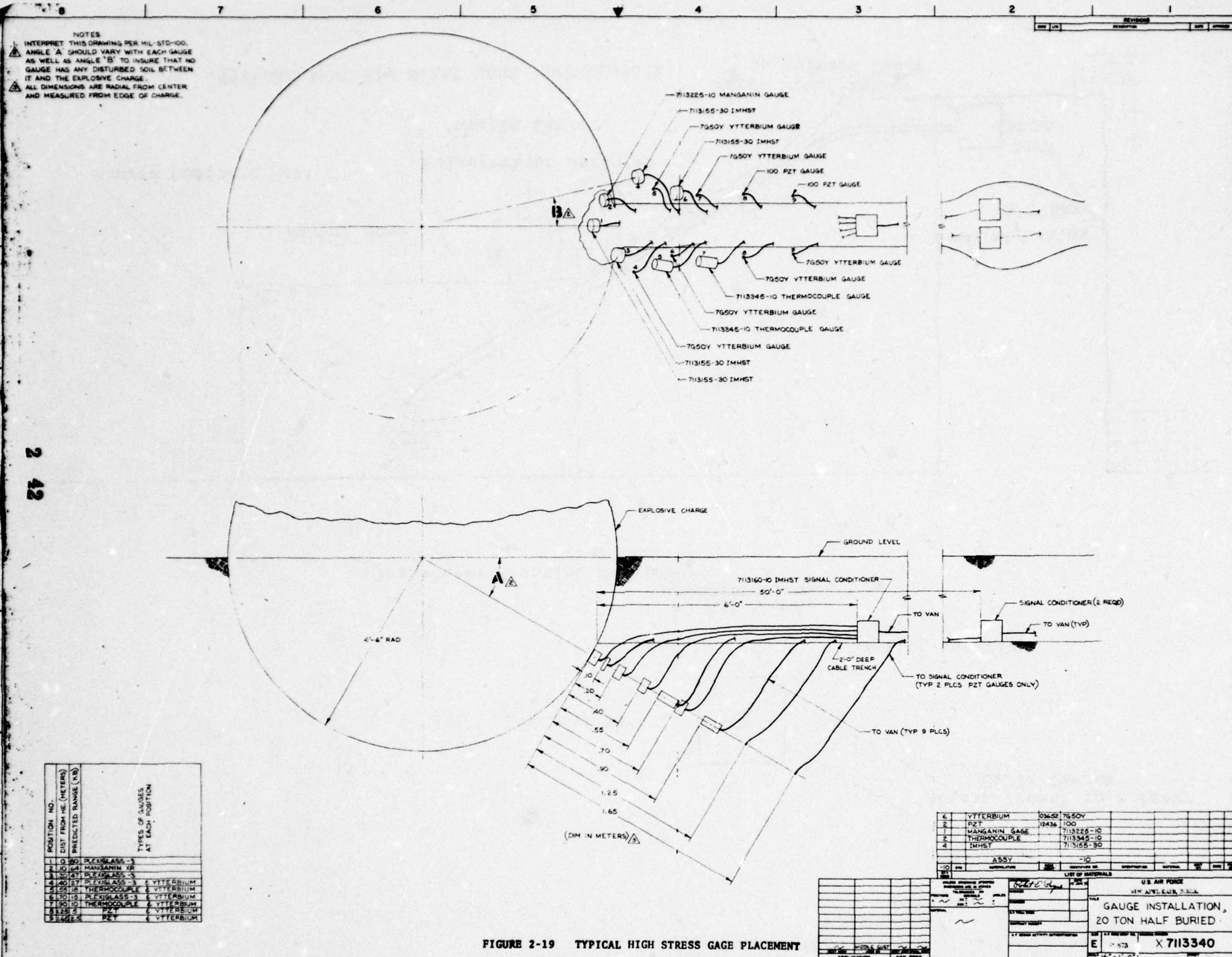


Figure 2-18 TYPICAL AFWL AIR-BLAST GAGE INSTALLATION



POSITION NO.	DIST FROM HE. (METERS)	PREDICTED RANGE (KB)	TYPES OF GAUGES AT EACH POSITION
1	0	80	PLEXIGLASS -3
2	.10	64	MANGANIN XR
3	.20	47	PLEXIGLASS -3
4	.40	27	PLEXIGLASS -3 & YTTERBIUM
5	.55	18	THERMOCOUPLE & YTTERBIUM
6	.70	15	PLEXIGLASS -3 & YTTERBIUM
7	.90	10	THERMOCOUPLE & YTTERBIUM
8	1.25	5	PZT & YTTERBIUM
9	1.65	2.5	PZT & YTTERBIUM

FIGURE 2-19 TYPICAL HIGH STRESS GAGE PLACEMENT

SECTION 3.0

CABLE SYSTEM

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

3.1 INTRODUCTION

The data cable system for the Middle Gust Event supplies the necessary transmission path between the transducer and the recording equipment. The individual cable for each gage is collected in a forward J Box (Figure 3-1). The trunkline cables then run from the J Box to the recording trailers. This two step cable routing allows reuse of the trunkline cables for all three events. The forward cables to each transducer will of necessity be replaced for each event. Cables used by AFWL and WES will pass through this J Box. Cables used by other agencies in general will run directly from the gage to the recording trailer.

3.2 FORWARD CABLES

The cables used for the transducer to J Box runs are especially selected low noise types to minimize pick up of shock induced noise. Both 4 and 7 conductor cables are used for this function. The velocity gages are run with 4 conductor cables, all other transducers will use 7 conductor cables.

The transducers are supplied with a pigtail of cable to which the 4 and 7 conductor cables are attached using the splicing procedures in Section 3.6. Each cable should be permanently marked in accordance with the procedures indicated in Section 3.5.

The cables are run from the gage location to the J Box in backfilled trenches. The depth and location of these trenches are chosen to minimize cable damage. Details of this layout for each event are contained in Chapter IX through XI.

The free end of the forward cables are passed through the 1 foot square cable entrance ports in the Northwest end of the J Box. AFWL transducer cables will enter the west opening, the WES cables will enter the east opening. These cables are then

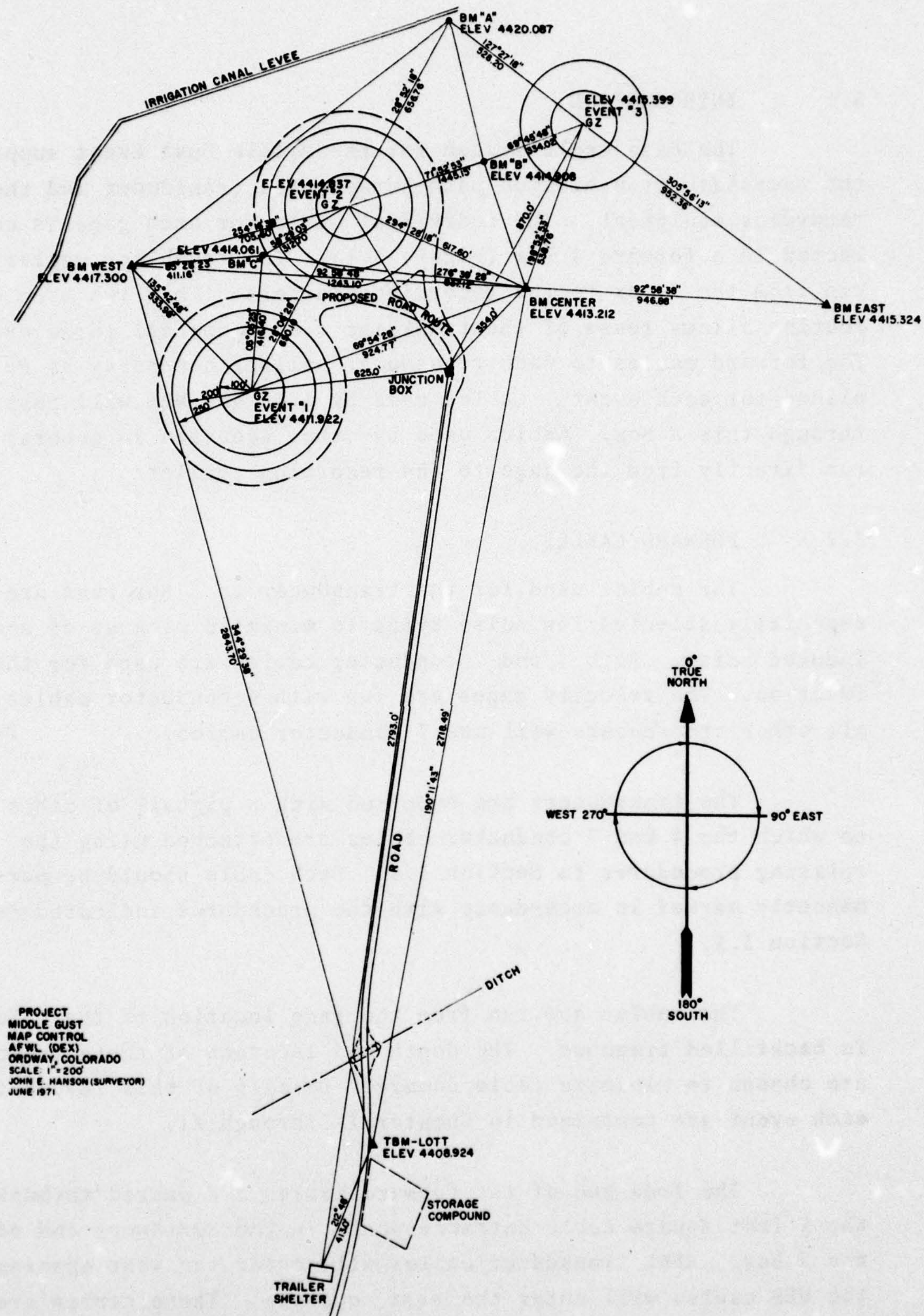


Figure 3-1 Plan of Site

routed to the appropriate terminal boards as indicated in the measurement list. All AFWL cables will be terminated in the left-hand half of the J Box (facing the open end) as shown in Figure 3-2. WES cables will be terminated in the right hand half of the J Box. The AFWL cables will be terminated in the J Box as indicated in Section 3.7

Termination details for the WES cables are not shown.

3.3 JUNCTION BOX

The J-Box is a poured concrete structure approximately 15 feet long x 8 feet wide and 6feet 6 inches high. Details of this structure are shown in Figures 3-2, 3-3, 3-4, and 3-5. The Box is surrounded by an earth berm extending about 18 feet from the box.

Access ports on the Northwest wall provide access for the forward cables. The final (shaded) portion of the berm shown in Figure 3-2 will be emplaced immediately prior to each event after all cable work is completed. This portion must be removed after each event to permit installation of cables for following events. The open end of the box provides egress for the trunkline cables.

The box is divided by the central row of terminal boards into two compartments. The AFWL cables will be terminated in the southwest side of the structure. WES cables will terminate in the Northeast side of the structure. Terminal boards for the AFWL cables are shown in Figure 3-6 and 3-7. The terminal boards are 4 x 8 sheets of plywood on which are mounted standard Cinch Jones series 141 barrier strips. These are then nailed to the 2 x 4 furring strips which have been bolted to the concrete.

Details of the WES half of the J-Box will be supplied by them.

3.4 TRUNK LINE CABLES

A permanent run (trunk line) of six conductor and four conductor cables will be established from the J-Box to the trailer shelter. These cables will be laid on a raised earth berm. They will then be covered with at least 12 inches of soil. (See Figure 3-8.)

These cables must cross the Bob Creek Waste Ditch near the road crossing. A wooden trestle crossing will be provided next to the road fill. This structure will extend far enough on each side to allow adequate water flow around the road crossing in the event of excessive water flow in the ditch.

Trunk line cables will be routed through the 5 foot culverts installed in the trailer shelter berm. These will be laid in the racks on either side of the culverts to reduce the possibility of damage. No cables may be left on the floor of the culverts where they may be damaged by subsequent operations.

These cables must be terminated to the entry terminal boards inside of the recording trailers in accordance with the measurements list. Termination procedures are detailed in Section 3.7. Cables not required for event A will be marked, have their ends sealed, and be coiled inside the shelter near the culvert entry. These coils must be hung on racks or hooks to aleviate tangling and damage.

Treatment of the WES trunk line cables is expected to be similar; details are not supplied.

3.5 CABLE MARKING

All cables must be identified permanently at the time of installation. Cable numbers will be indicated by hot stamping the cable itself or by use of slip and shrinkable identification bands. These must contain the cable sequential number and be consistant from forward cable/gage pigtail splice to the trailer terminal board. Cables will be identified on each side of every terminal board (trailer and J-Box), near exit of cable from culvert inside trailer shelter, near ground surface at top of gage drill hole and at gage pigtail/cable splice.

3.6 FORWARD CABLE SPLICING

Forward cable splices (Figure 3-9) are required (1) at the Forward-Forward cable junction, and (2) at the transducer Pigtail forward cable junction. Procedures to be followed in making these splices are given in Sections 3.6.1 and 3.6.2.

3.6.1 Forward, Forward Cable Splice

Remove three to four inches of the outer sheath using a seamstress stitch remover or other suitable tool. Caution shall be used to prevent damage to the insulation around the shield or the nylon tape under the shield. If the insulation around the shield or nylon tape is damaged, remove an additional 3/8 inch of the outer sheath. Proceed to cut away the filler flush with the outer sheath, install a piece of 3/64 inch shrink tubing over the drain wire leaving enough drain wire exposed for crimping a window splice, and install a piece of 1/4" shrink tubing 1 inch long over the drain wire and the pair of wires. This tubing is used to insure isolation of the shield from the other shields. Slip the 1/4 inch tubing down over the drain wires and conductor pair until it covers the shield and nylon tape. Repeat the above steps on the other pairs and drain wire in the cable. Apply heat from a heat gun until the shrink tubing becomes a tight fit.

Prepare the other cable to be spliced as above. Strip wires, then splice together as shown in Figures 3-10 and 3-11, using API window splice part No. 320559 and API tool No. 99447 or 59170 or MS 23037-1A.

After all splices are complete, cover the entire splice and a 2 inch overlap on both ends with API sealing and dielectric compound part No. 602213. After sealing and dielectric compound has been applied, cover entire area with Scotch #88 all weather electrical tape. The alternate method of waterproofing is: before the splice is made, slip a piece of API shrinkable tubing with sealant over one end of the cable. After splice is completed, place tubing over splice so that the sealant in each end is extended over the outer sheath of the cable. Shrink with heat gun. Check cable for continuity and check all shields for isolation from each other and isolation from the conductors.

3.6.2 Pigtail Forward (PF) Cable Splice

The accelerometer PF cable splice is to be made by WES personnel during the assembly of the free field canister. The splice shall be made in the manner indicated in Figure 3-12. The splice shall be strain relieved through the use of a cable clamp or other similar device. The exact techniques to be used in these procedures shall be specified by WES engineering personnel.

Figure 3-13 shows the connections for the velocity gages. Pins 1, 2, and 3 are solder loop pins on the top of the gage proper. Pin 4 is the junction of the two bridge completion resistors. Pins 2 or 4 connected as necessary to obtain a positive going output voltage for the previously established + sense direction. This shall be properly documented by WES calibration personnel during the calibration procedures.

3.6.3 Coax Cable

Coax cables for high pressure measurements will not be run through the J-Box. (See Section 2.1.5, through 2.1.8, and Figures 2-3 through 2-9 and 2-19.

3.7 CABLE TERMINATION

Remove six to eight inches of the outer sheath using a seamstress stitch remover or other suitable tool. Caution shall be used to prevent damage to the insulation around the shield or the nylon tape under the shield. If the shield insulation, shield, or nylon tape is damaged, remove an additional 3/8 inch of the outer sheath. Cut away the filler flush with the outer sheath. Cut the conductors and drain wire to lengths shown in Figures 3-14 and 3-15. Install a piece of 3/64 inch shrink tubing over the drain wire leaving enough drain wire exposed for crimping a spade lug , API part No. 34541. Install a piece of 1/4 inch shrink tubing one inch long over the drain wire and the pair of wires. This tubing is used to insure isolation of the shield from the other shields. Slip the 1/4 inch tubing down over the drain wire and the conductor pair until it covers the shield and nylon tape. Repeat the above steps on the other pairs and drain wire in the cable and apply heat from a heat gun until the shrink tubing becomes a tight fit.

Strip insulation from conductors, crimp on API spade lug part No. 34541 with API tool No. 49557 or 59170 or MS-25037-1A. Connect to barrier strip as shown in Figures 3-12 and 3-13. Check cable for continuity and check all shields for isolation from each other and isolation from the conductors.

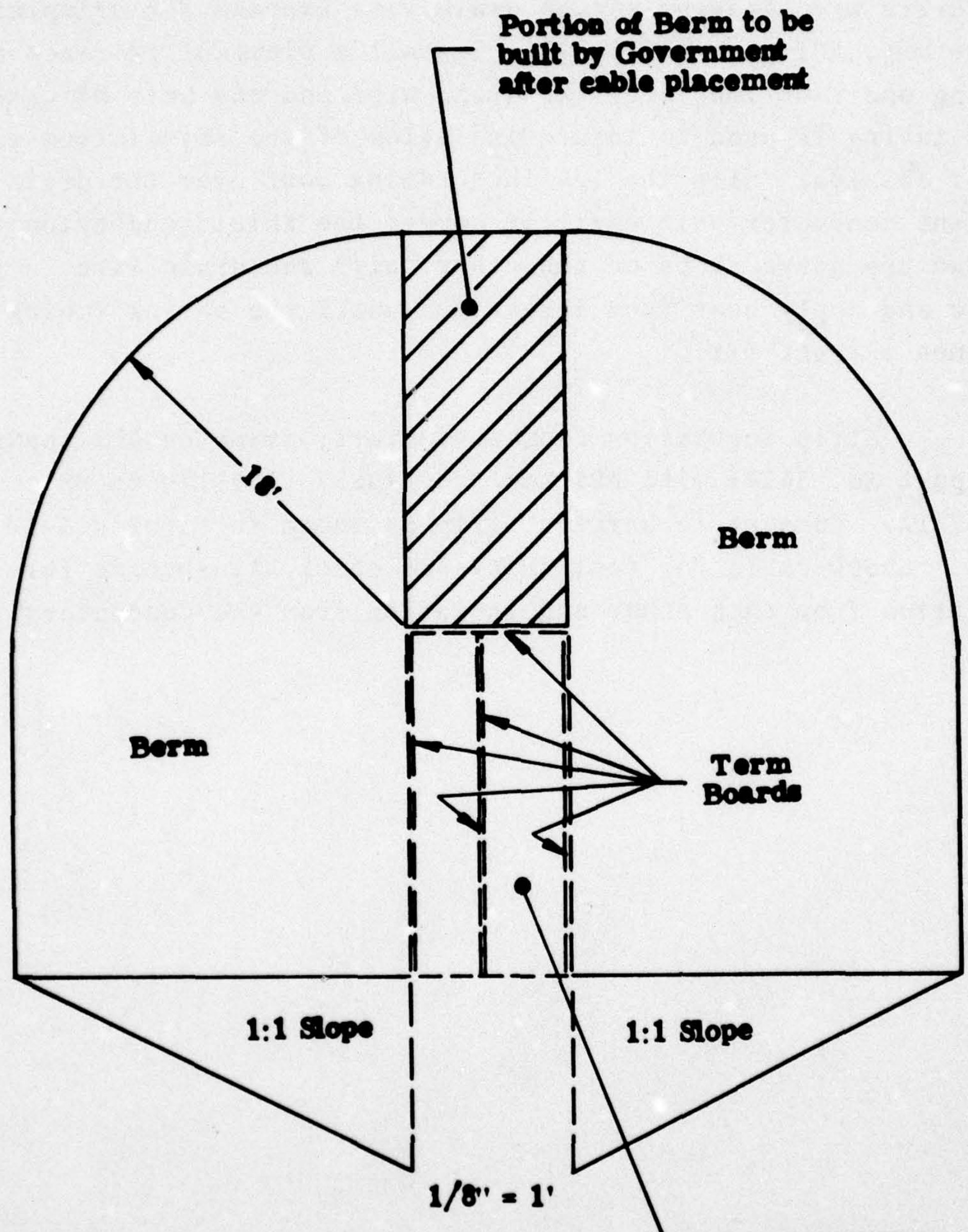


FIGURE 3-2 TOP VIEW OF J BOX

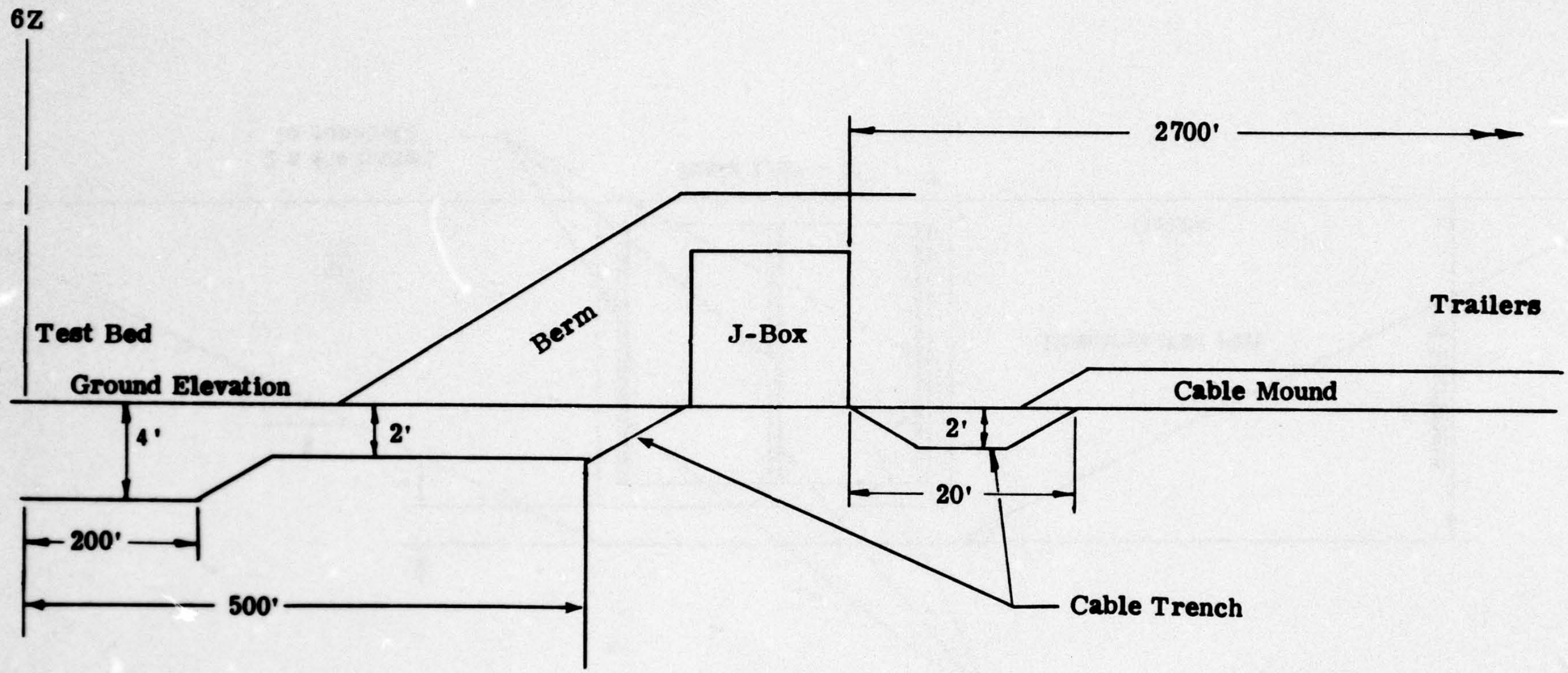


FIGURE 3-3 SIDE VIEW OF J BOX

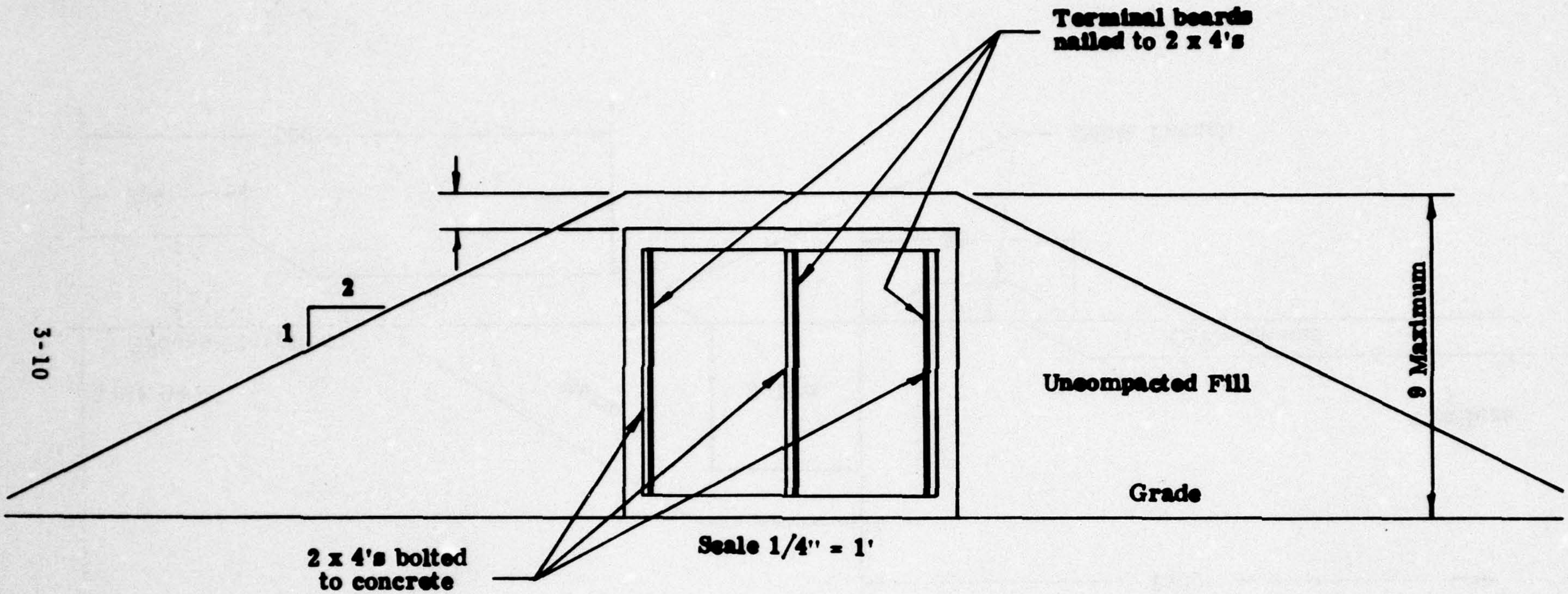


FIGURE 3-4 REAR VIEW OF J BOX

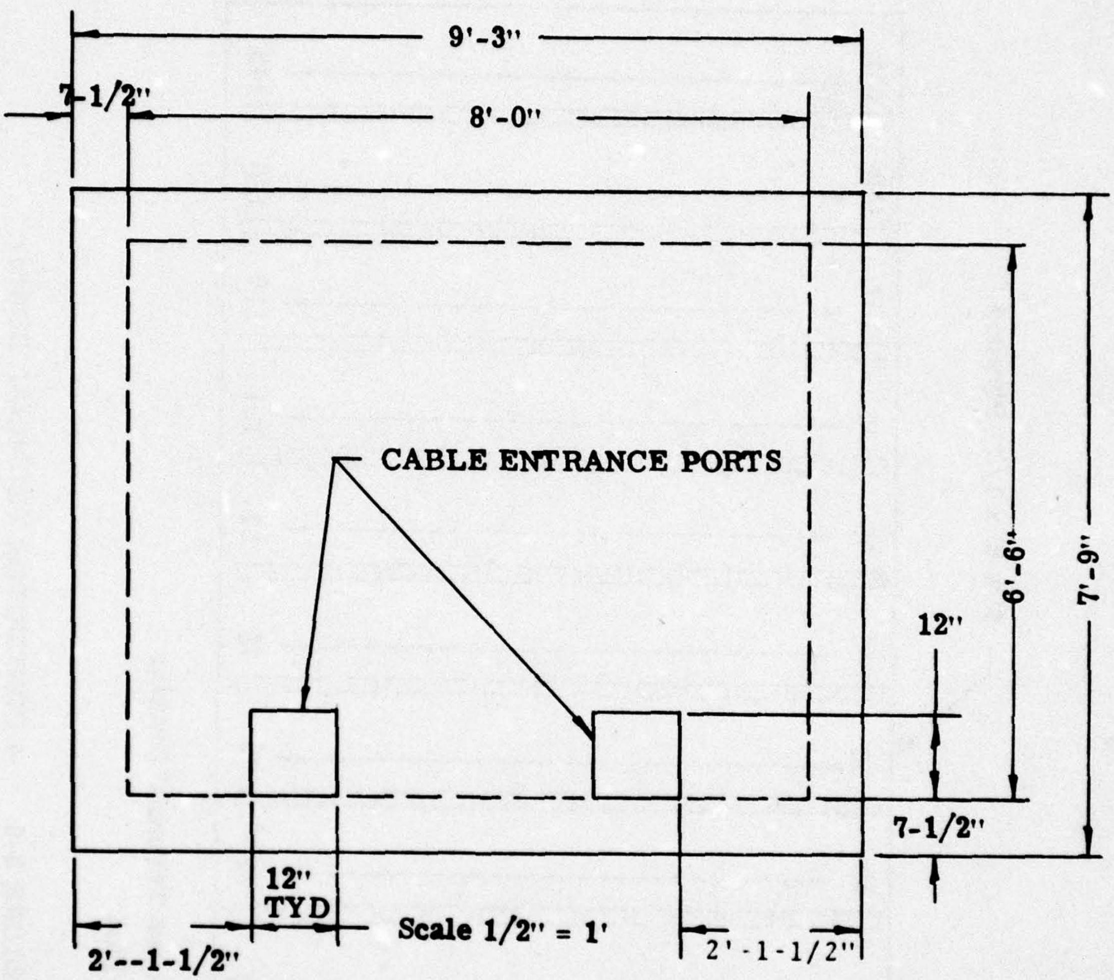
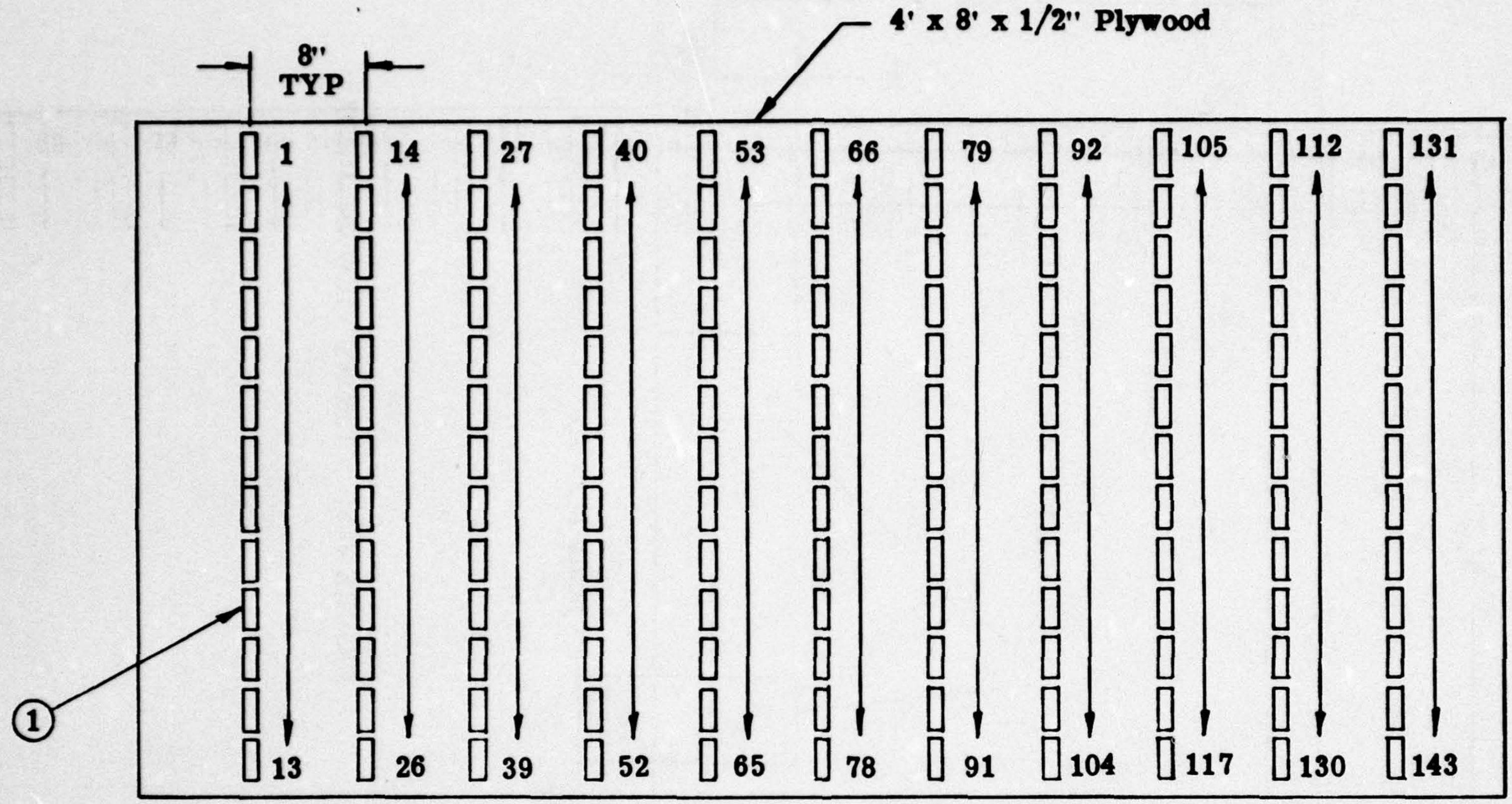
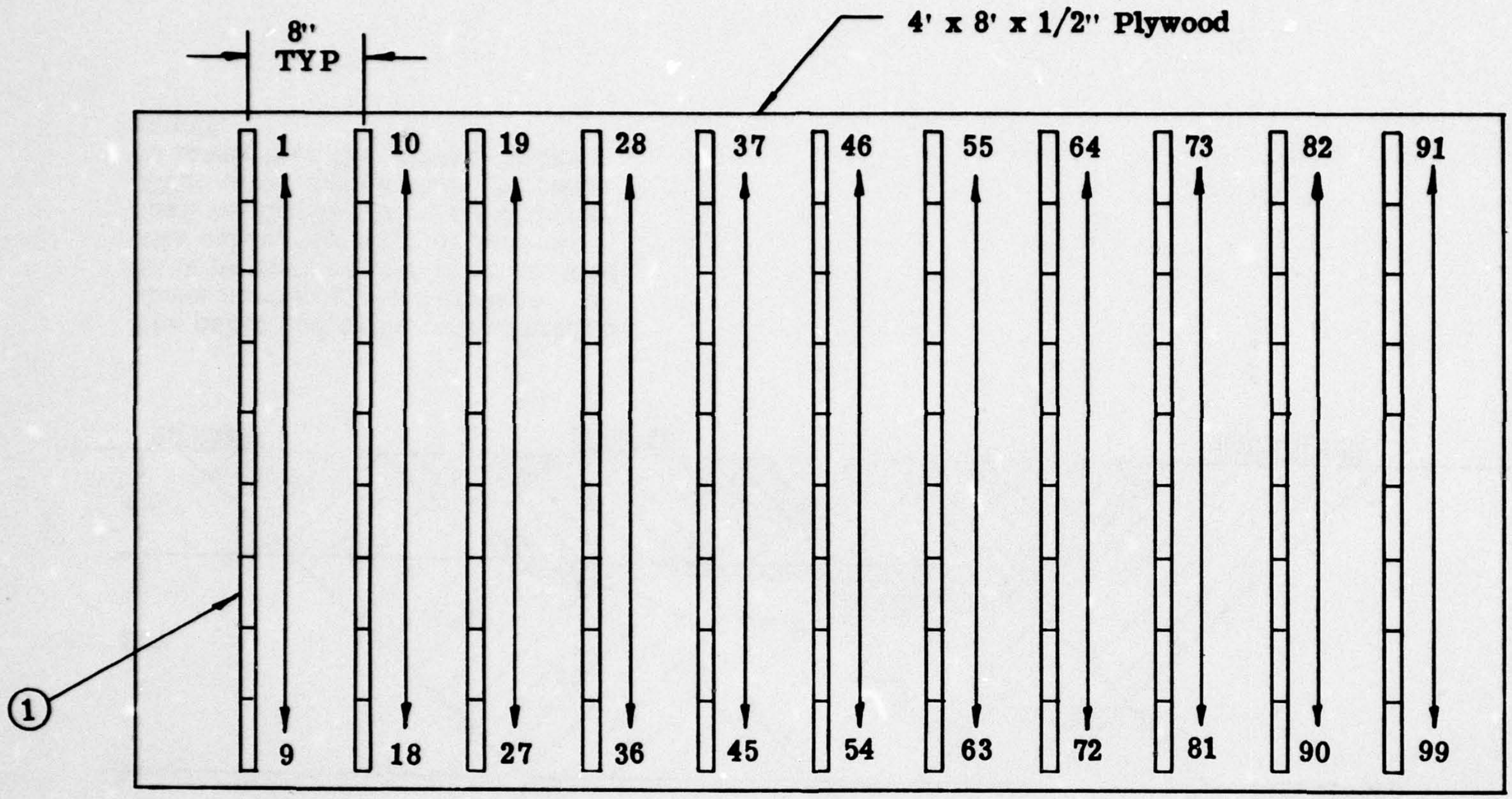


FIGURE 3-5 FRONT VIEW OF J BOX



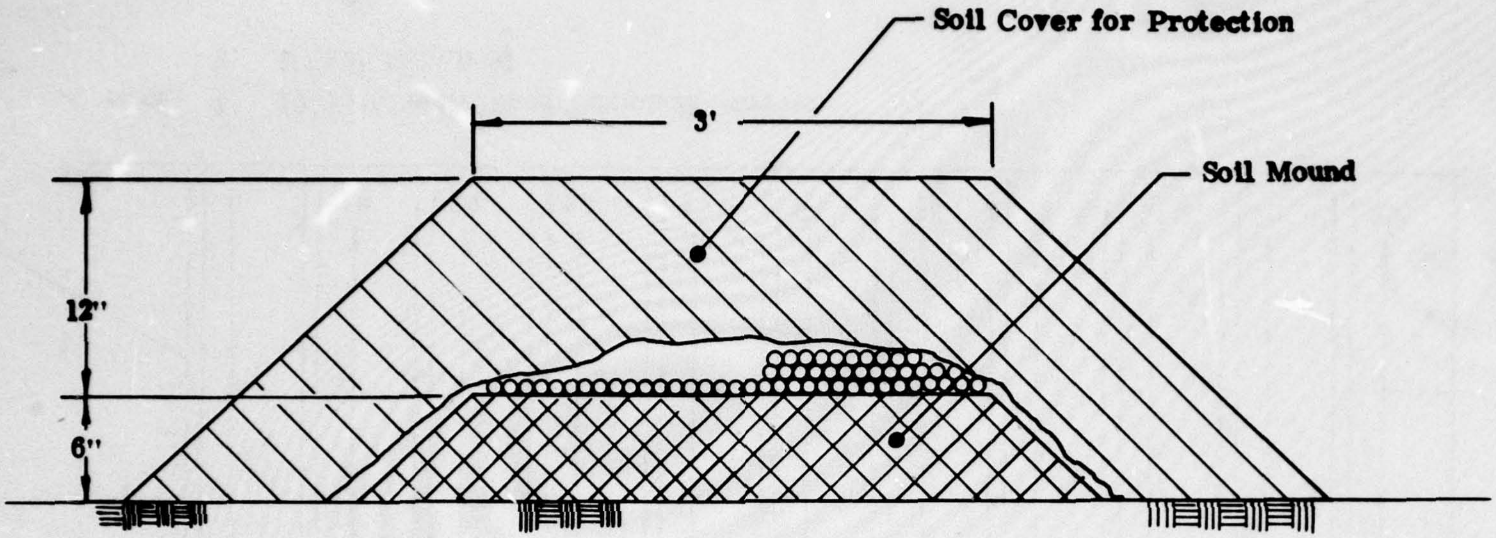
Note: 1. 6-141 Cinch Jones Terminal Barrier
2. One each required

FIGURE 3-6 4 CONDUCTOR TERMINAL BOARD



Note: 1. 10-141 Cinch Jones Terminal Barrier
2. 2 Each Required

FIGURE 3-7 7 CONDUCTOR TERMINAL BOARD



The cable and cable mound shall be above normal ground surface. If ditch or ravines are to be crossed with cable, the ditch or ravines shall be filled. At no point on the 2700' cable mound shall the cable be lower than the surface water runoff.

FIGURE 3-8 TRUNK LINE SECTION

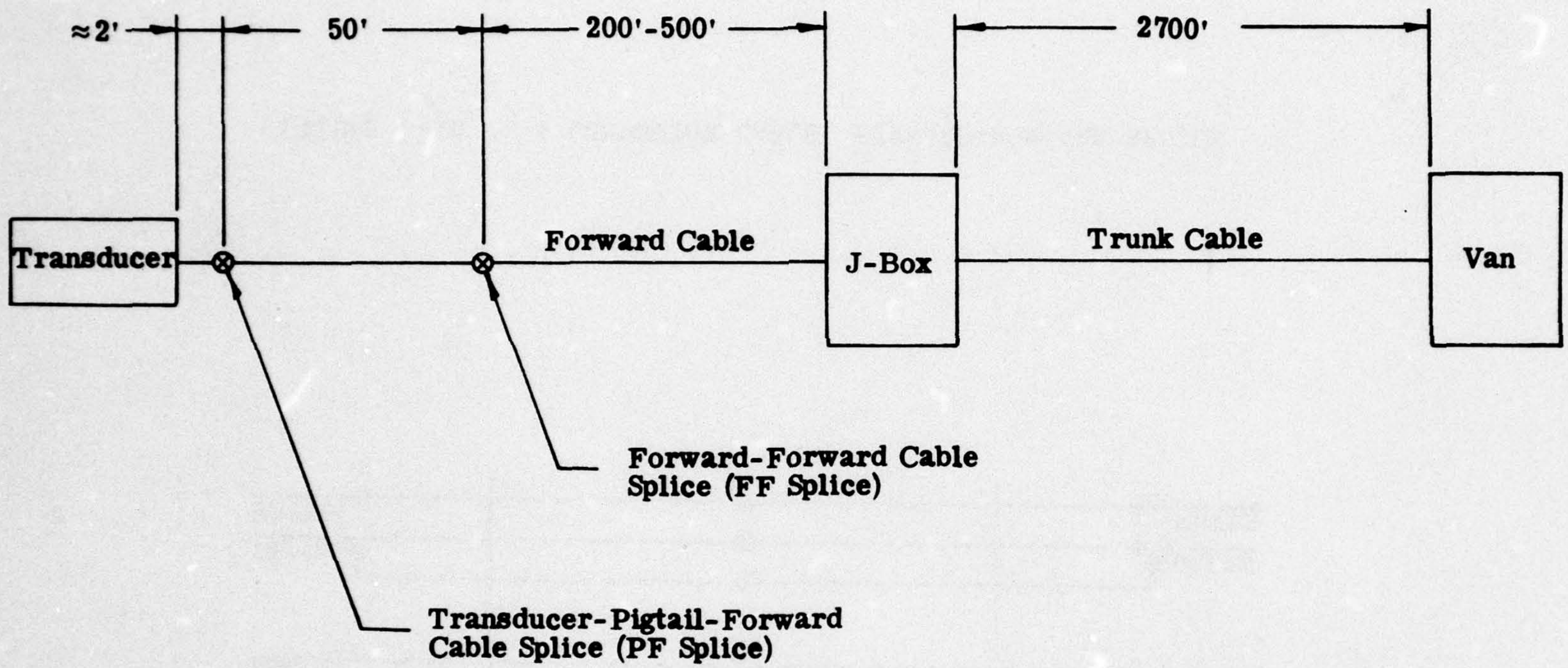


FIGURE 3-9 FORWARD CABLE SPLICE

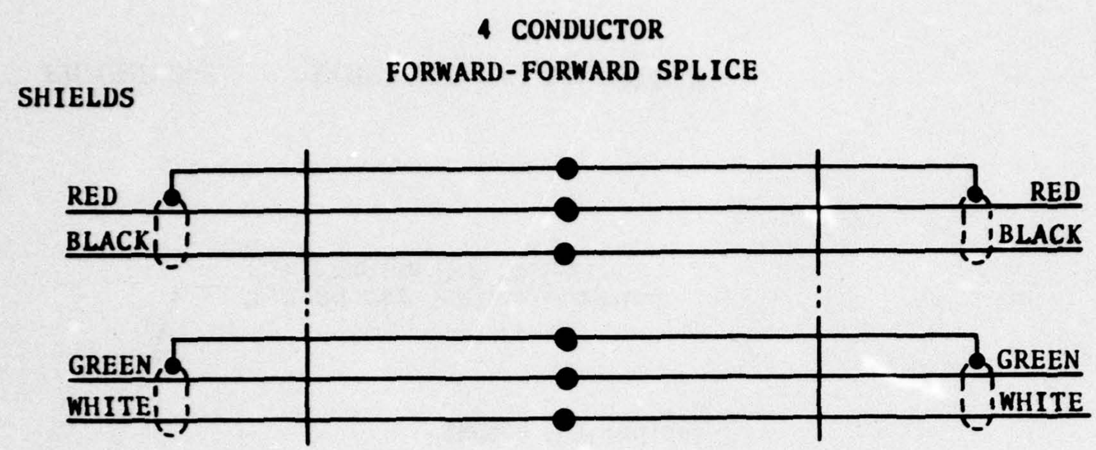


FIGURE 3-10 4 CONDUCTOR CABLE, FORWARD-FORWARD SPLICE

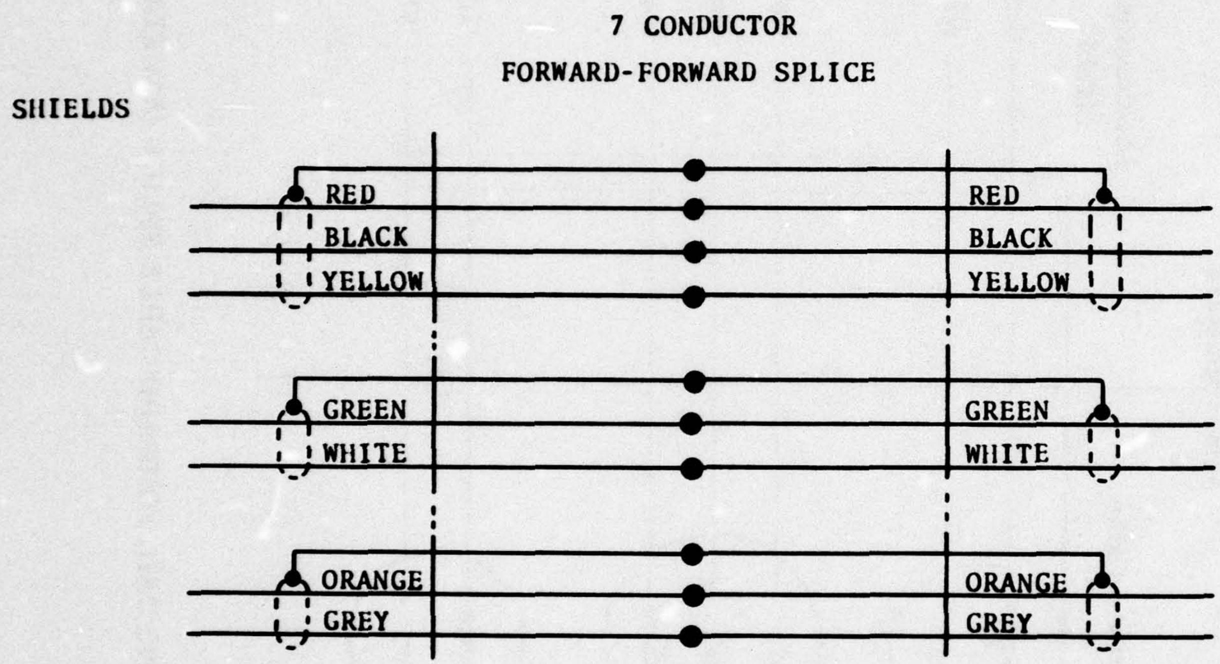


FIGURE 3-11 7 CONDUCTOR CABLE, FORWARD-FORWARD SPLICE

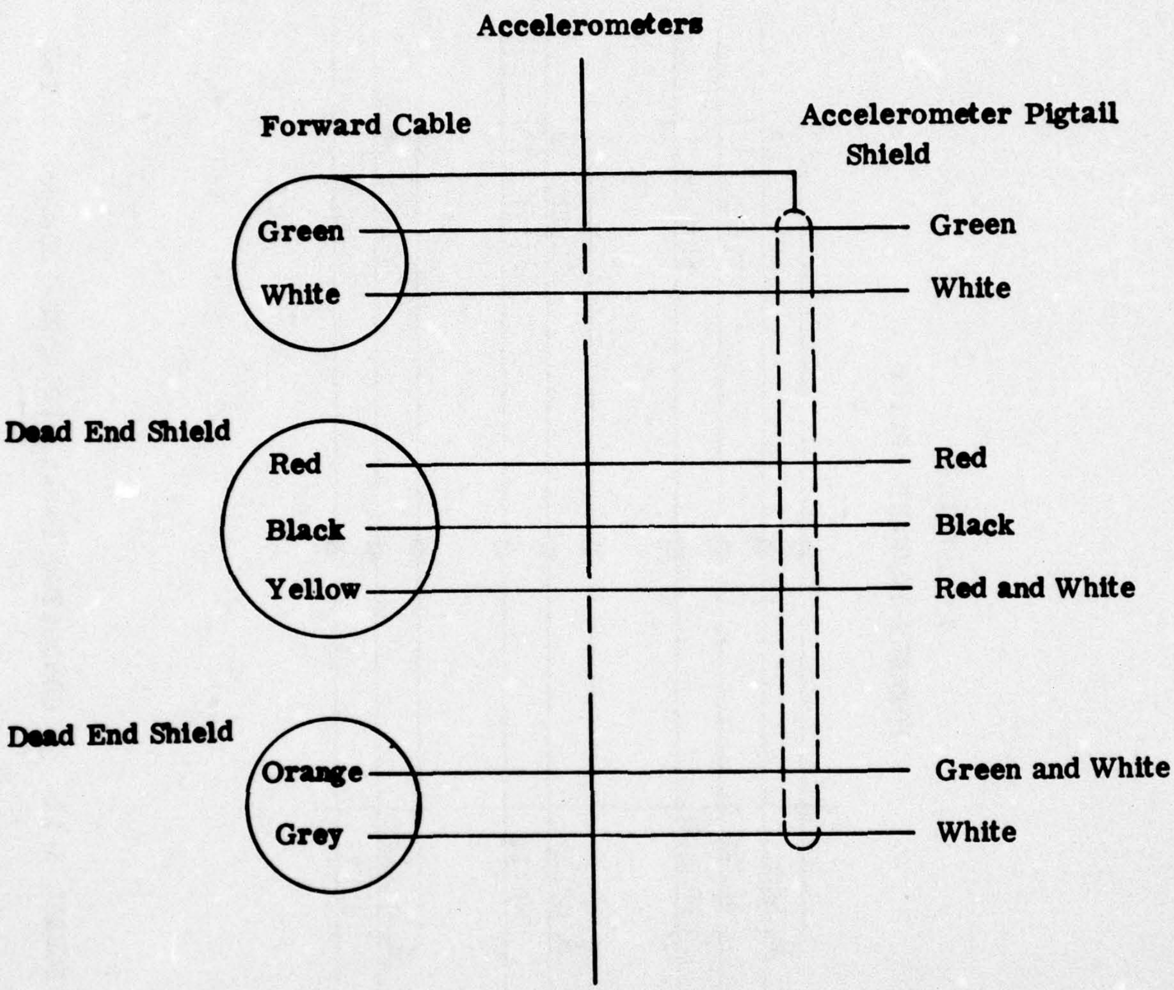
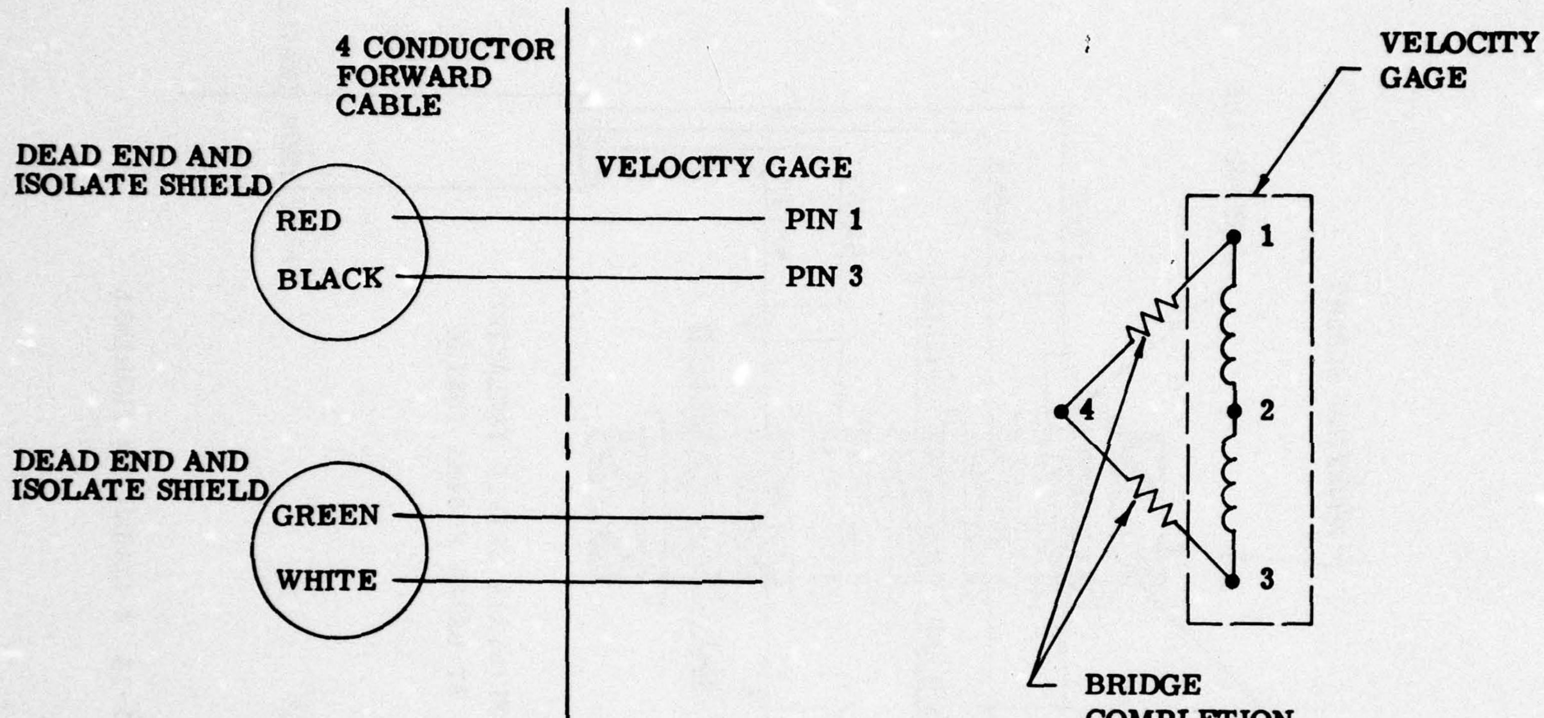


FIGURE 3-12 PIG TAIL FORWARD CABLE SPLICE (ACCELEROMETER)



Pins 2 and 4 connected as necessary to obtain a positive giving output voltage for the established "+" sense direction (see Section 5.5).

FIGURE 3-13 PIGTAIL FORWARD CABLE SPLICE (VELOCITY)

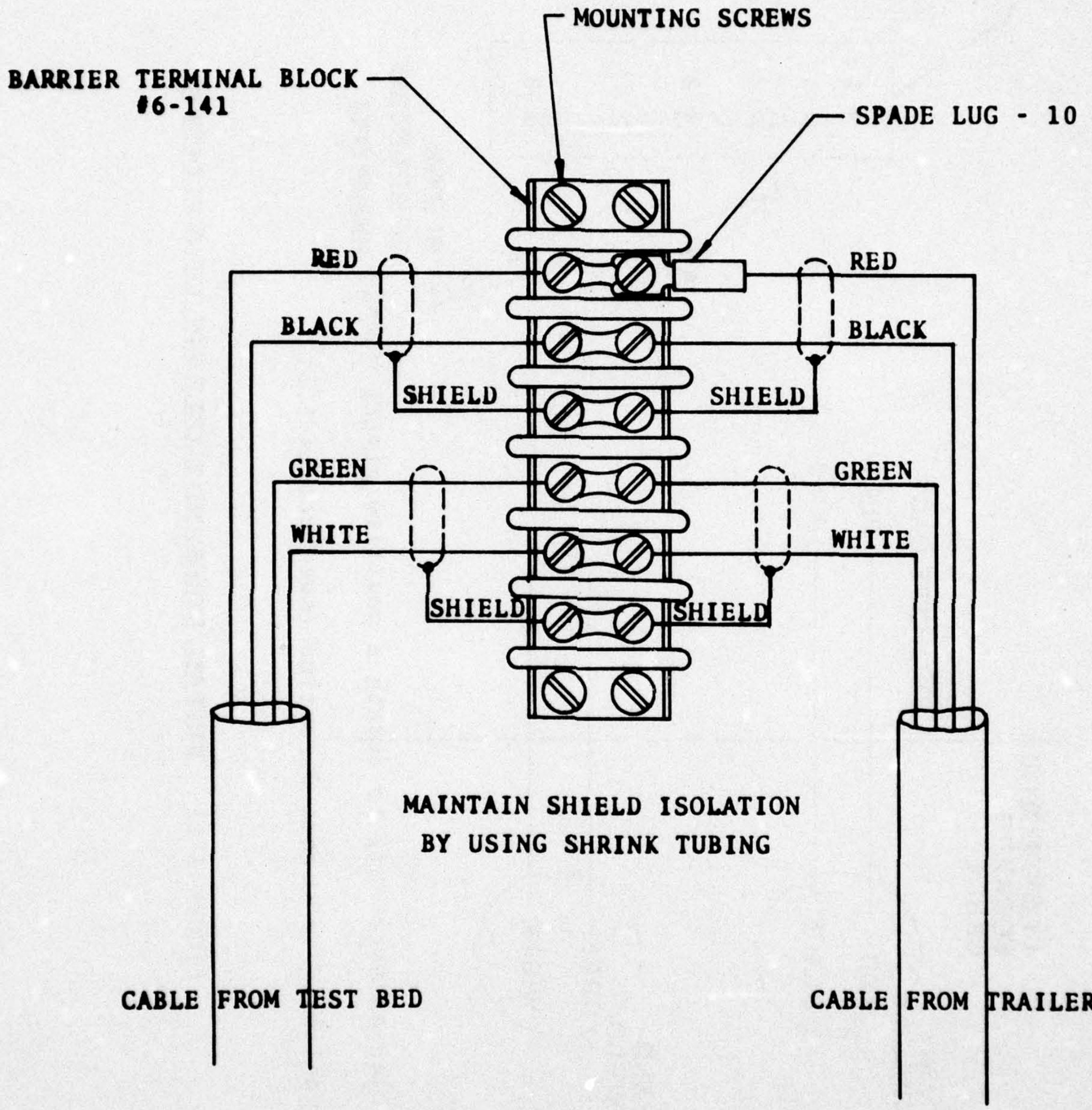


FIGURE 3-14 4 CONDUCTOR TERMINAL

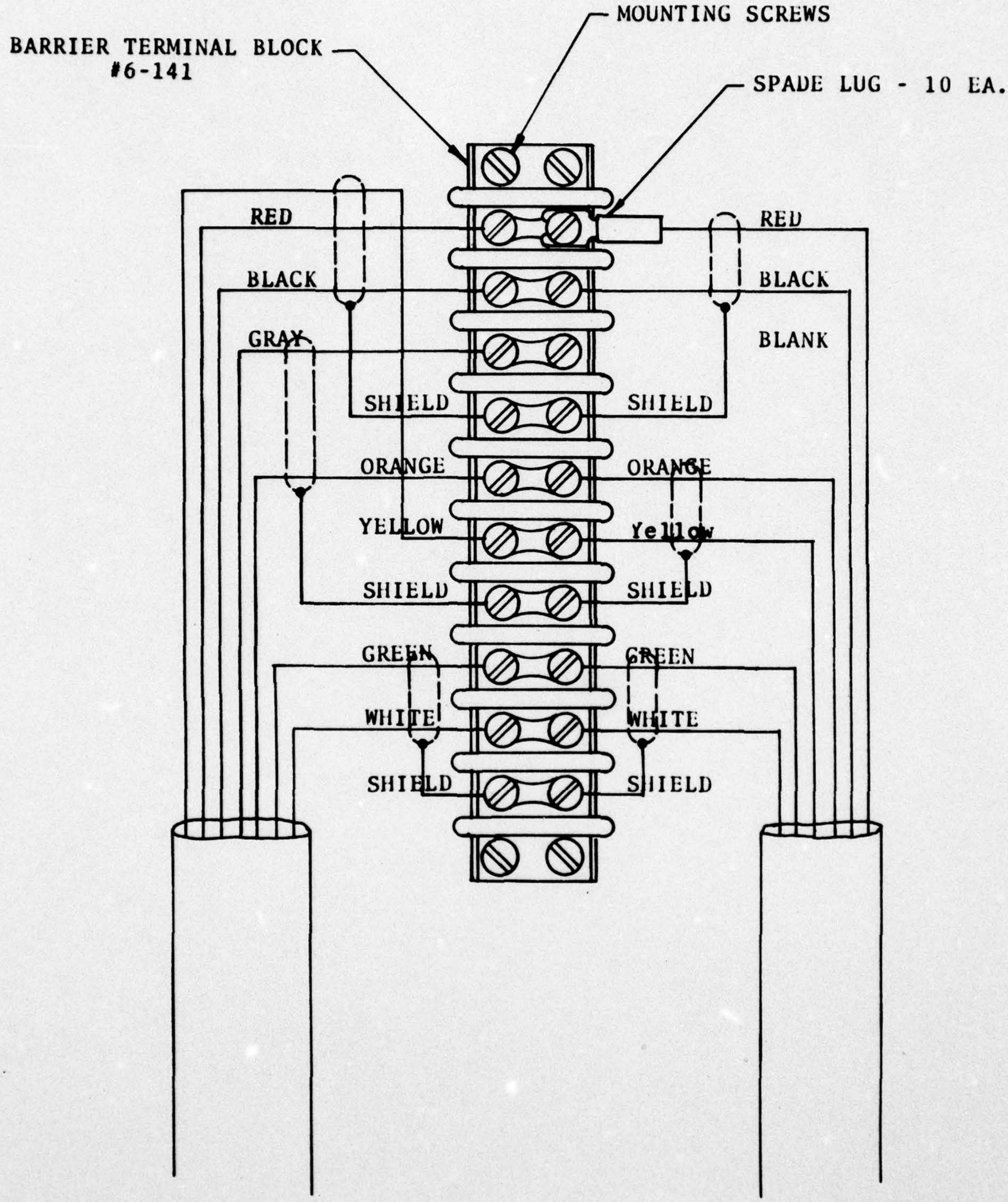


FIGURE 3-15 7 CONDUCTOR TERMINAL

SECTION 4.0

SIGNAL CONDITIONING - RECORDING SYSTEM/VAN CAPABILITIES

TABLE OF CONTENTS

4.0

Con't

LIST OF ILLUSTRATIONS

4.1 INTRODUCTION

This section describes trailer physical arrangement, lists the equipment complement, and gives brief descriptions of equipment function. The S-IV-3 is primarily designed to provide signal conditioning for low level transducer and record these signals on magnetic tape using constant bandwidth low/high level voltage controlled oscillators.

To aid in the acquisition and analysis of data, the trailer provides other functions. These functions include playback capability, timing and control, test equipment for calibration and checkout, radio, and direct communications.

Air conditioning is provided for all the racks and also for personnel. Heaters are installed in the bottom of each rack for dehumidifying the air and warming equipment in extremely cold weather. Personnel heaters are installed in the floor outlets. Personnel comfort is provided for by thermostat control.

Three isolated input power circuits are provided. One circuit is for instrumentation, one for non-instrumentation, and one for the air conditioner.

4.2 PHYSICAL DESCRIPTION

S-IV-3 is a 40 by 10 foot trailer. Figure 4-1 is a plan view of the trailer, and Table 5-1 lists primary trailer specifications.

The air conditioner is a 17 ton self-contained unit providing the following functions: ventilation, heating control, cooling, dehumidifying, and filtering. Operating life between overhauls is a minimum of 3000 hours. The unit has three independent systems for cooling. Each system can be operated independently of the other(s). Satisfactory operation is obtainable over a nominal temperature range up to 125^{o}F with maximum solar radiation. Access to all major units is through removable panels and doors on front of van. A nontoxic and nonflammable refrigerant (Freon 12) is used. Three stage comfort heating, thermostatically controlled uses A/C blowers for operation.

The unit operates from 208 V AC, 3ph 4-wire, 60 Hz power, 200 amperes. Voltage variation must be within ±10 percent and frequency variation within ±5 percent.

4.3 INSTRUMENTATION VAN S-IV-3 RECORDING CAPABILITY

Instrumentation Van III is divided into two complete measuring systems for ease of personnel operation. Each system has a present recording capability of 168 channels of information or a total van capability of 336. With the addition of signal conditioning and multiplex, this capability can be expanded to 252 channels per system or 504 total. Individual multiplex outputs and tape recorder inputs are contained on the patch panel. For explanation purposes, only one system will be considered from this point. (Refer to Figures 4-5 and 4-6. Patch panel #1, #2). Refer to Figure 4-2, 4-3 for a typical instrumentation block diagram and wiring diagram. Refer to Figure 4-4 for a recording block diagram.

4.3.1 Tape Recorder

CEC/Data Tape VR 3700 Direct Response 2.0 MHz. FM response to 500 KHz. 14 track. 1 each.

4.3.2 Signal Conditioning

SRC Model 2542 signal conditioner and Model 2542 power supply. All transducer power, calibration, balance, and bridge completion circuits are contained in these modules. 1 each per channel. Total 168. A servo screw driver is provided with these units for automatic balance.

4.3.3 Multiplex

One multiplex consists of 18 voltage-controlled oscillators with the constant bandwidth frequencies as listed in Table 4-1, one line driving amplifier (mixer), and one crystal oscillator. The crystal oscillator provides a reference frequency for tape speed compensation and is common to all multiplexes. A VCO auto-cal system is available for rapid automatic calibration of VCO units through the use of a servo gun. This unit does not forego the setting of the VCO's manually. There are a total of nine complete multiplexes with a partial of multiplex 10. Multiplex 10 contains the lower six frequencies only.

4.4 READOUT EQUIPMENT

(Refer to Figure 4-7)

4.4.1 Discriminators

The van contains a single complement of discriminators to support both measuring systems. Housings are contained in each system for quick plug-in of the discriminators. The output of the multiplex recorders is connected to the patch panel where the desired track is selected and fed to the discriminator bank. Discriminator output is also connected to the patch panel so that the desired channel may be directed to the readout system. One discriminator (the nineteenth in the discriminator bank) functions as a tape speed compensator.

4.4.2 Galvo Driver - Honeywell 7 Channel.

One to seven channels of demodulated information may be conditioned with this unit for application to oscillograph galvanometers. All inputs to the galvo drivers are located on the patch panel.

4.4.3 Oscillograph - CEC Model 5-124

All connections to this item are made within the rack containing both the galvo drivers and oscillograph.

4.5 AFWL VAN NO. 4 (S-IV-4)

This section describes the AFWL Recording Van No. 4. This van contains equipment for recording 182 channels of data and the necessary support and readout equipment. The van is completely self-contained, except for power and reference signals. Figure 4-8 shows the arrangement of equipment in Van No. 4.

4.5.1 RECORDING CAPABILITY

The AFWL Van No. 4 is equipped with four magnetic tape recorders; two Ampex AR200's and two Ampex FR600's. These recorders provide the following recording capability.

1. 28 wide-band channel at 0 to 20 KHz

2. 154 multiplex channels of the following frequency bands:

   70 channels at 0 to 1 KHz
   42 channels at 0 to 2 KHz
   42 channels at 0 to 4 KHz

4.5.2 SIGNAL CONDITIONING

Signal conditioning is required for all of the gages recorded in Van No. 4 to provide (1 identification, (2) calibration, (3) amplification, and (4) power supply. In every case, this equipment provides a hard-wired path for the signal, with no relay contacts in the wiring from the gage to the records. All of the signal conditioning components that are not installed in the gage canister are installed in the van. (In Van No. 4, these components are for velocity gages only. The function of these components are shown in Figure 4-9 and are described in the following sections.)

4.5.3 WES System for Velocity Gages

The Sparton Southwest velocity gage requires a carrier-amplifier system such as the WES carrier system. Briefly, the system consists of a 3 KHz oscillator, an AC bridge network which includes the transducer, a demodulator, a filter, and an amplifier.

4.5.4 RECORDING EQUIPMENT

The recording equipment of Van No. 4 consists of two Ampex AR200 wide-band magnetic tape recorders and two Ampex FR600 multiplex magnetic tape recorders.

4.5.4.1 Wide Band System

The Ampex AR200 tape recorders each record 14 channels of information in the FM mode that may vary in frequency from 0 to 20 KHz. By substituting the input and output modules on any selected channel, that channel can be made capable of recording signals varying in frequency from 0.1 to 250 KHz in the direct-recording mode.

4.5.4.2 Multiplex Systems

The two Ampex FR600 recorders are connected in parallel in order to provide redundant information and higher reliability. The total recording capacity of the multiplex system is, therefore, that of one recorder, giving 14 tracks of 11 channels each (a total of 154 channels) and one voice annotation track. The voice track is recorded direct (no modulation).

4.5.5 VOLTAGE CONTROLLED OSCILLATOR (VCO)

The VCO's used are transistorized units that accept the outputs of various types of transducers and converts them to frequency modulated signals. The VCO's were designed to accept differential data signals to ± 2.5 volts. Center frequency and deviation from center frequency is determined by a modular plug-in frequency unit. The system in Van #4 will be equipped with 154 VCO's and plug-in frequency units as follows:

VCO No.	QUANTITY EACH	CENTER FREQUENCY kHz	DEVIATION ± kHz	FREQUENCY RESPONSE (kHz) MOD. INDEX OF 2
1	14	192	8	4
2	14	160	8	4
3	14	128	8	4
4	14	96	4	2
5	14	80	4	2
6	14	64	4	2
7	14	48	2	1
8	14	40	2	1
9	14	32	2	1
10	14	24	2	1
11	14	16	2	1
TOTAL	154			

4.5.6 READOUT EQUIPMENT

Van No. 4 is equipped with readout equipment so that oscillograph plots of individual or multiple traces can be obtained immediately after the test takes place. This capability, however is limited to the FR600 recorders, because the AR200 recorders do not record in duplicate and do not have dubbing (duplicating) capabilities. Therefore, the tapes will not be played back until they are duplicated.

The components of the readout system in Van No. 4 are shown in Figure 4-10. The output tracks of the multiplex recorders to be plotted are selected at the output amplifier selector panel. With the present wiring of the van, only two tracks can be selected at one time. Normally, one track is selected to supply test data, and the second track provides reference data. In the playback patch panel, the two tracks are connected, by using patch cords, to the two discriminator banks. The discriminator banks are wired to the digiswitch panel, which selects the input to the galvo driver amplifiers. The digiswitches are set to numbers one or two, indicating that the channels to be plotted are supplied by discriminator banks 1 or 2 (test data or reference data).

The arrangement described above feeds 14 channels of data to the oscillograph simultaneously. Normally, only one or two tracks of test data are plotted at a time with two or three data reference channels. The other channels from the discriminator banks that are not to be plotted are omitted by turning off the power to the corresponding galvo drivers.

4.5.7 Time Control System

Van No. 4 has a complete time control system for controlling the operating of the van during the recording cycle. It starts and stops the recorders, provides coding and calibration signals to all the channels, provides real-time and countdown-time displays. It should be noted that the timing signals discussed in this section are not the IRIG time signals. The timing signals generated by the time code generator are used to perform control functions as indicated above. The IRIG time signals provide time identification signals in the recording channels.

The principal components of the control system are:

- WWV Receiver
- Time Code Generator
- Control Function Generator

4.5.7.1 WWV Receiver - The WWV receiver is tuned to Station WWV, Fort Collins, Colorado, which transmits a continuous time signal. The WWV receiver only provides audio (voice) and visual (oscilloscope) traces of accurate time signals. These signals are used by the operating personnel as a time base to synchronize the time code generator.

4.5.7.2 Time Code Generator - The time code generator consists of an accurate time signal generating circuit, which provides real and countdown time displays, and control for starting, stopping, and synchronizing the time displays. The time code generator also provides signals that are used by the other components of the control system to perform various time-based functions.

4.5.7.3 Control Function Generator - Van No. 4 has a control function generator (CFG) that is able to control ten functions; that is, to close and open automatically ten circuits during and after countdown. These control functions will be used to perform the countdown operations that must be sequenced with countdown, such as starting and stopping the recorders. (Ref. Figure 4-11).

Each function has two sets of digiswitches, which are capable of controlling the start and stop functions to tenths of a second. The maximum length of time that can be selected in the CFG is minus or plus 99 minutes, 59 seconds. Each function also has an override switch that can be used to start or stop the function independently. These override switches have three positions: start, automatic, and stop. The CFG uses the time code signals generated by the time code generator.

The CFG system is controlled by a master enabling switch; thus, it will be inoperative any time this switch is not in the enable position. If the enabling switch is placed in the hold position when the CFG is in operation, at any time during countdown, the operation of the CFG is stopped. When the switch is returned to the enable position, the CFG continues to switch as programmed; however, any time settings that take place while the CFG is in hold will not be actuated.

4.5.7.4 Time Synchronization - Time synchronization in Van No. 4 is obtained from a WWV receiver. Real time is first synchronized by presetting a start time on the real time display on the time code generator. When the time from the WWV station has been preset, the operator pushes the start button, which starts the real time display and activates the time code generator in synchronization with WWV. After manual synchronization, the time on the real time display is more accurately synchronized to WWV by using the one-pulse-per-second signal being generated by the time code generator to trigger the horizontal sweep of an oscilloscope, and by using the WWV signal (5 sinusoidal cycles starting every second) to display as the vertical input to the oscilloscope. Synchronization will be accomplished when the start of the WWV signal coincides with the triggering of the horizontal sweep. Figure 4-13 pictorially indicates this synchronization requirement. The time code generator is advanced or retarded, as required, until synchronization is achieved.

The final step in the time synchronization procedure is to synchronize the TCC Van time signals with those of Van No. 4. This is done by displaying the TCC Van Time signal and the time signal from Van No. 4 on an oscilloscope. The synchronization procedure described above is then repeated.

4.5.7.5 <u>Countdown Clock</u> - The countdown clock can be started manually, but is normally preset to start automatically at a given time. The length of the countdown period is also preselected in the countdown control panel. In Van No. 4, the countdown clock is started automatically.

4.6 POWER SYSTEM

Van No. 4 does not contain any power sources, but has a power distribution system and means of monitoring and protecting the system.

Each instrumentation rack has a power panel that controls the power to all the equipment in that rack. The availability of power to the rack is dependent on the operation of the blower at the bottom of the rack.

4.7 AIR CONDITIONING

Van No. 4 has air conditioning for both personnel and equipment. The personnel system consists of one unit housed outside and beneath the van. The equipment system consists of a number of blowers installed in the individual instrument racks.

4.7.1 Personnel - The personnel air conditioning system is an all-weather temperature and humidity control system. The temperature inside the van can be controlled to $\pm 3^{\circ}F$. Since the equipment cooling system discharges within the van, the personnel system actually carries the cooling load of both systems. The system has a 20-ton cooling capacity.

The air conditioning system components are located outside the van, and the controls are located inside the van; however, a separate power panel for the air conditioning system is also located outside the van next to the air conditioning unit. This power panel has a weatherproof cover. The conditioned air enters the van through ducts that are located above the ceiling and exhaust through ducts in the floor of the van. The power for the air conditioning unit is obtained from the nonessential portion of the main power panel of the van.

The air conditioning system is turned off manually at T-15 minutes to eliminate the possibility of noise interference in the recording systems:

4.7.2 Equipment - In addition to the main air conditioning system, each instrument rack has a blower at the bottom of the rack for circulating air through the equipment mounted on that rack. Each rack also has a power control panel just above the blower, which controls the power for all the equipment installed in that rack. The power passing through the rack is controlled by a fan-type switch, which is activated by the motion of air from the blower. If the blower is inoperative, the switch is open and all of the equipment in that rack is inoperative. There is no manual override to this safety device.

The blower system described above is not installed in the racks that contain the tape recorders. The tape recorders have their own air circulating systems.

TABLE 4-1

TRAILER SPECIFICATIONS

CHARACTERISTIC	SPECIFICATION
Dimensions	486 in. long, 120 in. wide, 168 in. high
Volume	5670 cubic feet
External gross Weight	53,800 lbs
Trailer Manufacturer	Timpte, Denver, Colorado
Model Number	TT10SH142
Serial Number	14777
Work Performed By	Air Force Special Weapons Center, Kirtland AFB, New Mexico
Tire Size	8-12 ply, 10.00 x 20
Air Conditioner	Airflow Co. Model MAC-30-S4, 17 ton capacity at 125°F outside ambient. Refrigerant is Freon 12, Federal Specification BB-F-671
Racks	Vent Rack
Towing Information	Semitrailer has a 5th wheel connection, 2-ft minimum ground clearance, air brake, king-pin swing radius of 5 ft or less.
License Plate	None

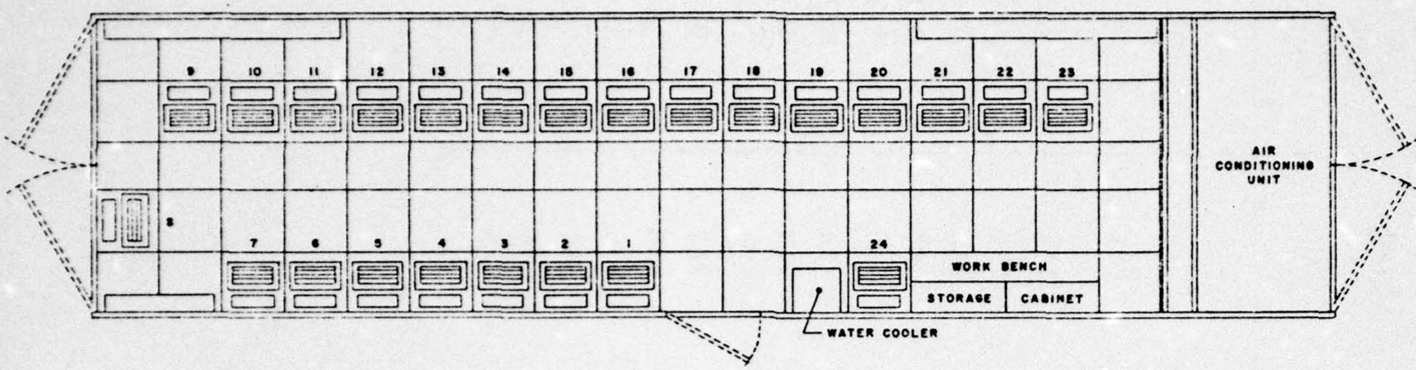
TABLE 4-2

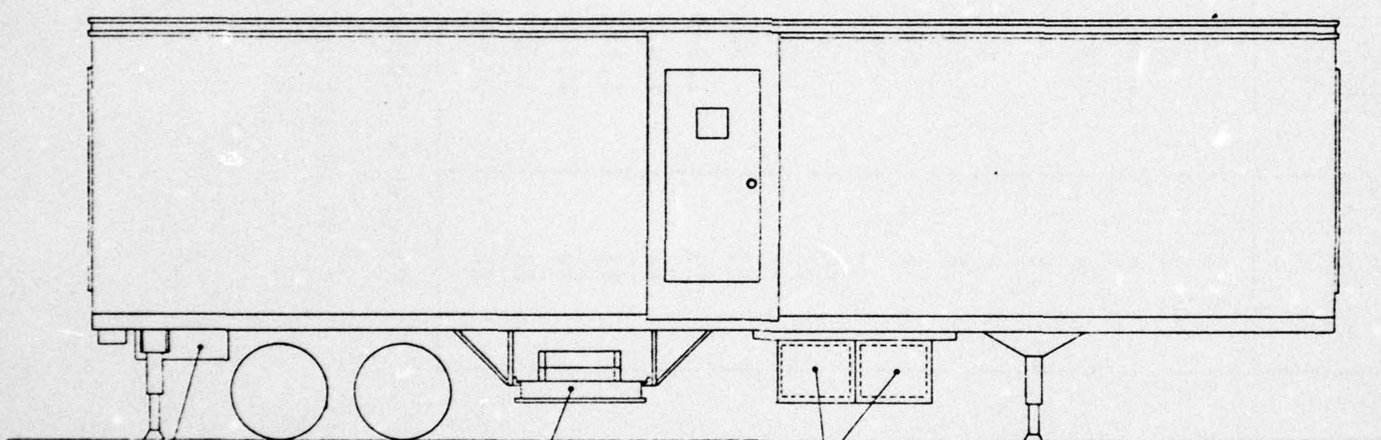
CONSTANT BANDWIDTH FREQUENCIES,
CHANNELS 1 THRU 18 (TWO SYSTEMS)

CHANNEL*	CENTER FREQUENCY (KHz)	LOWER BAND-EDGE (KHz)	UPPER BAND-EDGE (KHz)
1	160	140	180
2	230	210	250
3	300	280	320
4	370	350	390
5	440	420	460
6	510	490	530
7	580	560	600
8	650	630	670
9	720	700	740
10	790	770	810
11	860	840	880
12	930	910	950
13	1,000	980	1,020
14	1,070	1,050	1,090
15	1,140	1,120	1,160
16	1,210	1,190	1,230
17	1,280	1,260	1,200
18	1,350	1,330	1,370

Reference Frequency 1,510 KHz (Pre Emphasis 0 db)

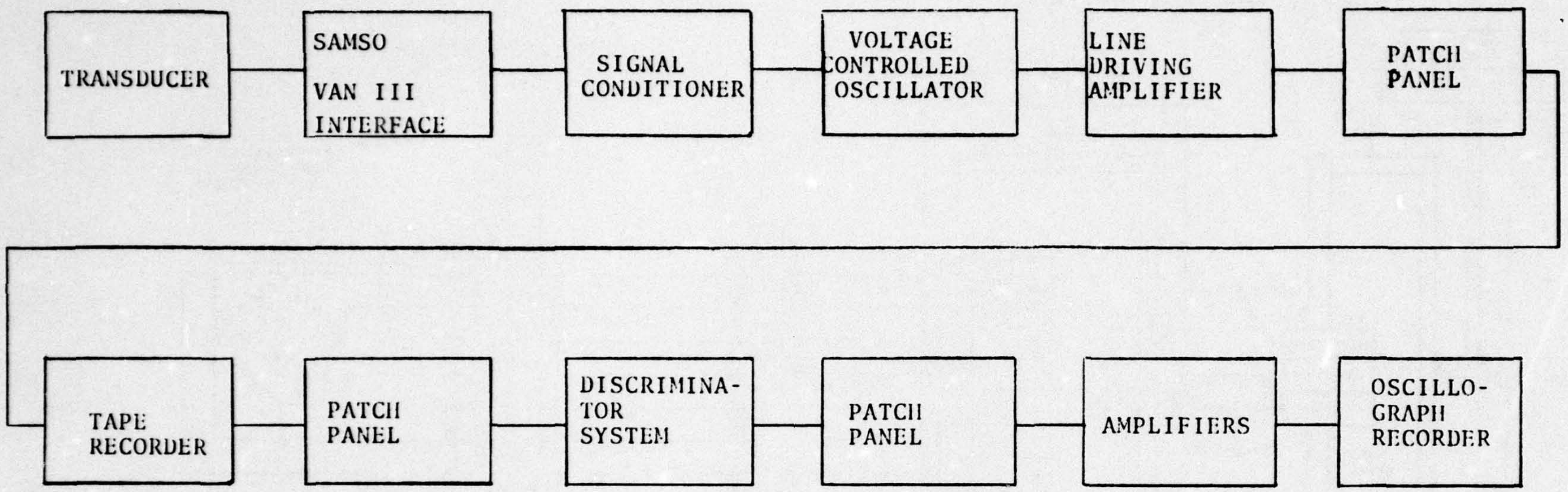
* All Deviations ± 20 KHz





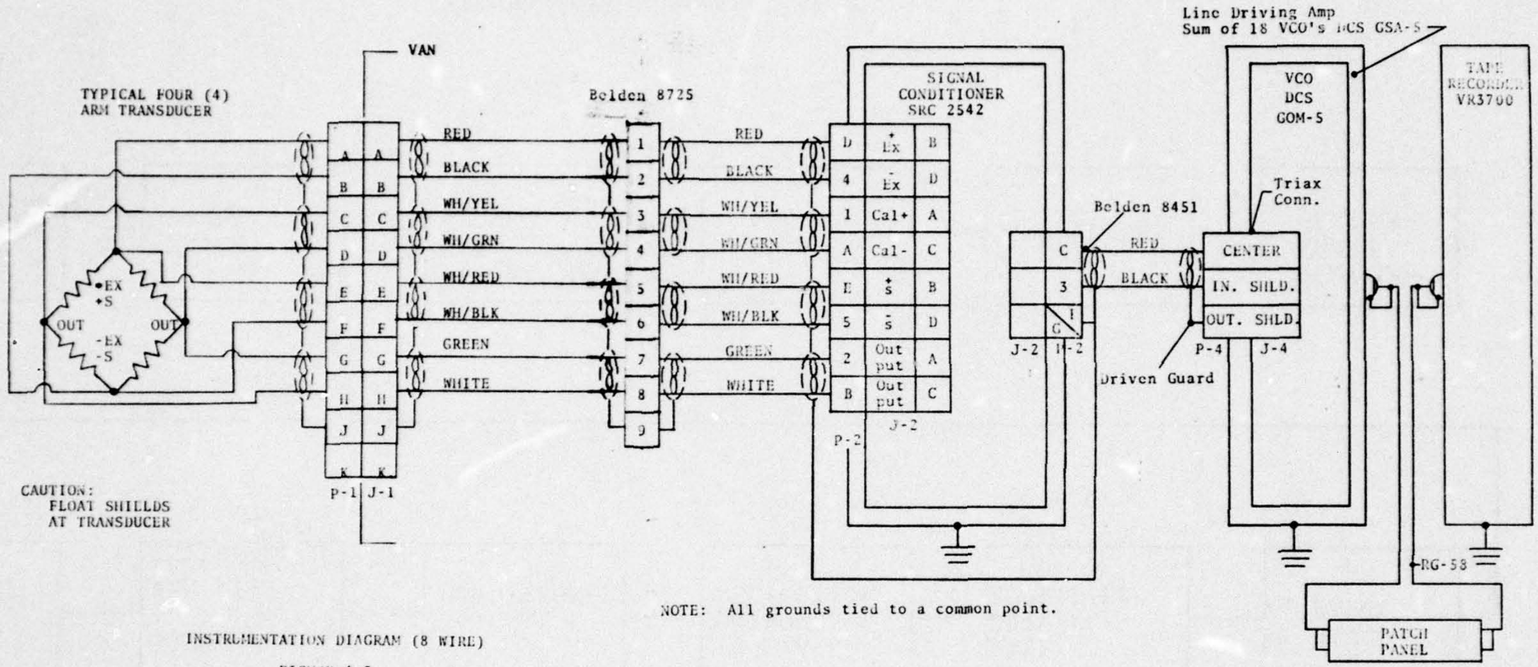
SAMSO VAN III PLAN VIEW

Figure 4-1



INSTRUMENTATION BLOCK DIAGRAM

FIGURE 4-2



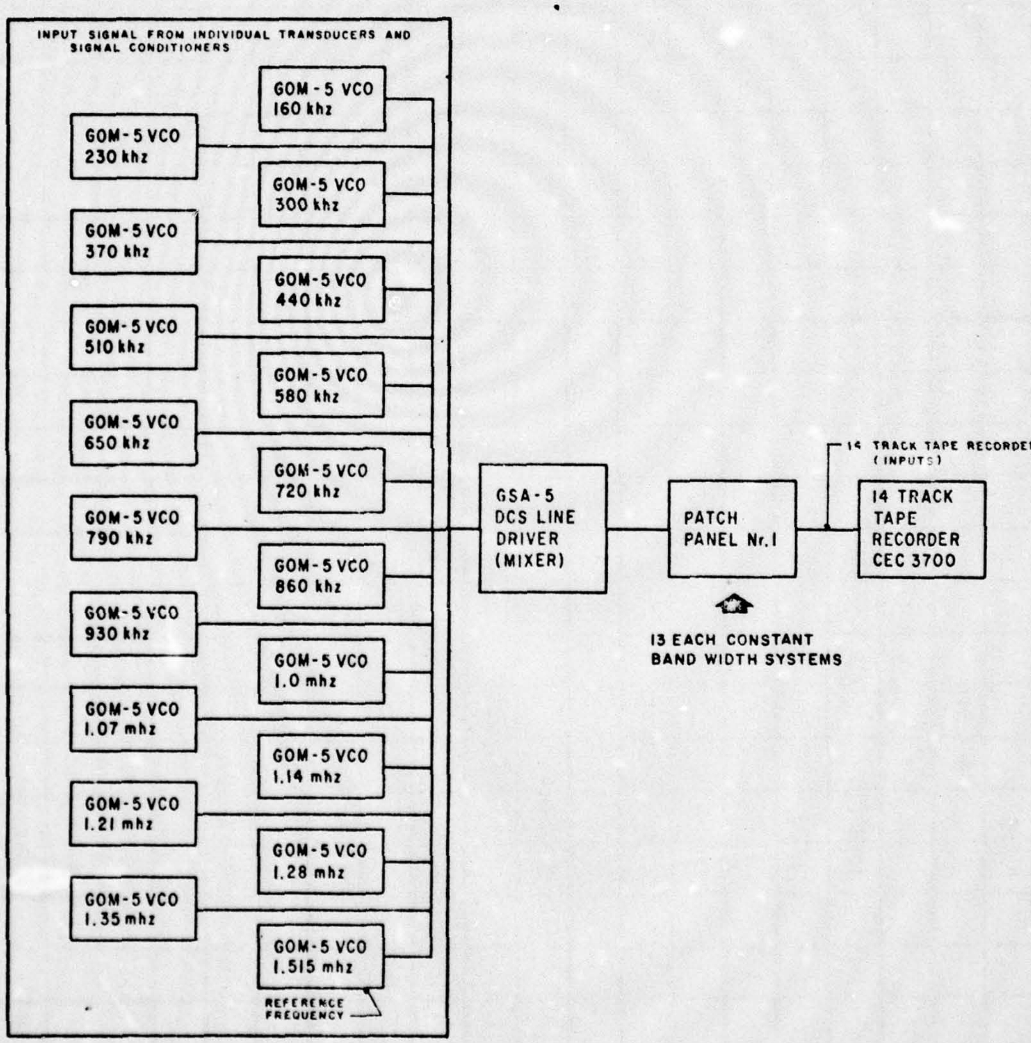
NOTE: All grounds tied to a common point.

INSTRUMENTATION DIAGRAM (8 WIRE)

FIGURE 4-3

INSTRUMENTATION DIAGRAM (8 WIRE)

FIGURE 4-3



RECORDING BLOCK DIAGRAM

Figure 4-4

AD-A061 115 AIR FORCE WEAPONS LAB KIRTLAND AFB N MEX F/G 18/3

MIDDLE GUST INSTRUMENTATION PLAN.(U)

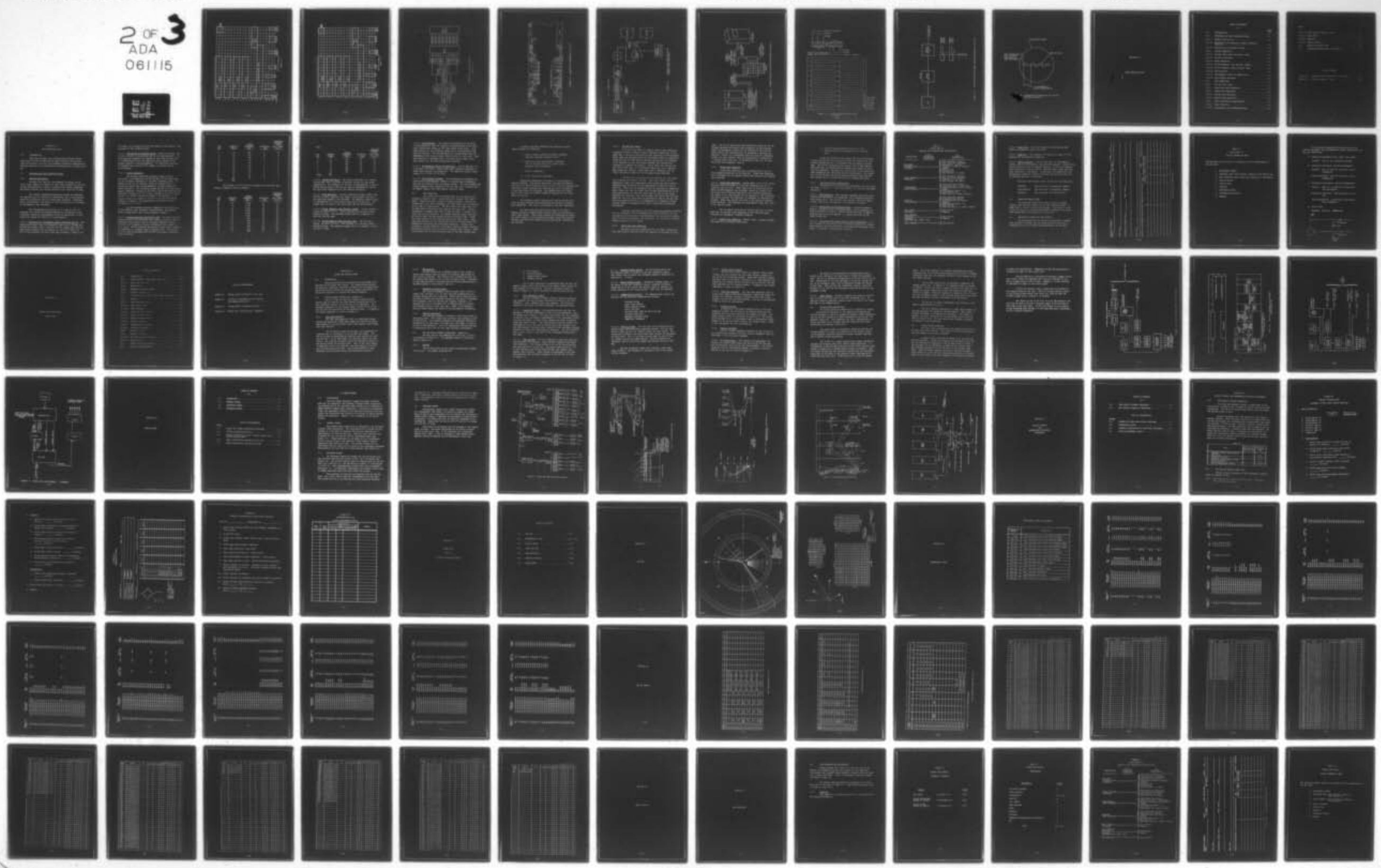
JUL 71

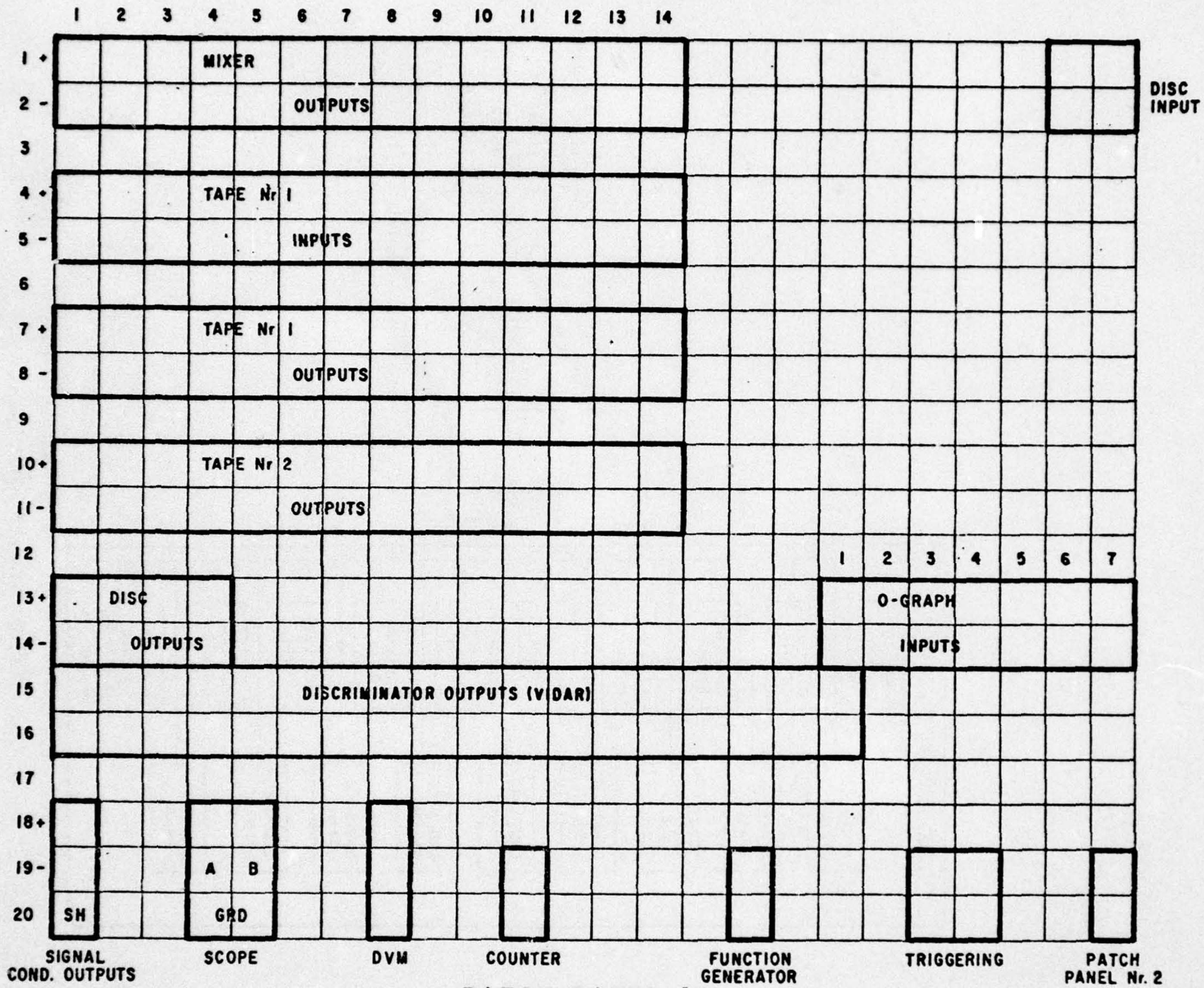
UNCLASSIFIED SBIE-AD-E200 209 NL

2 OF 3

ADA

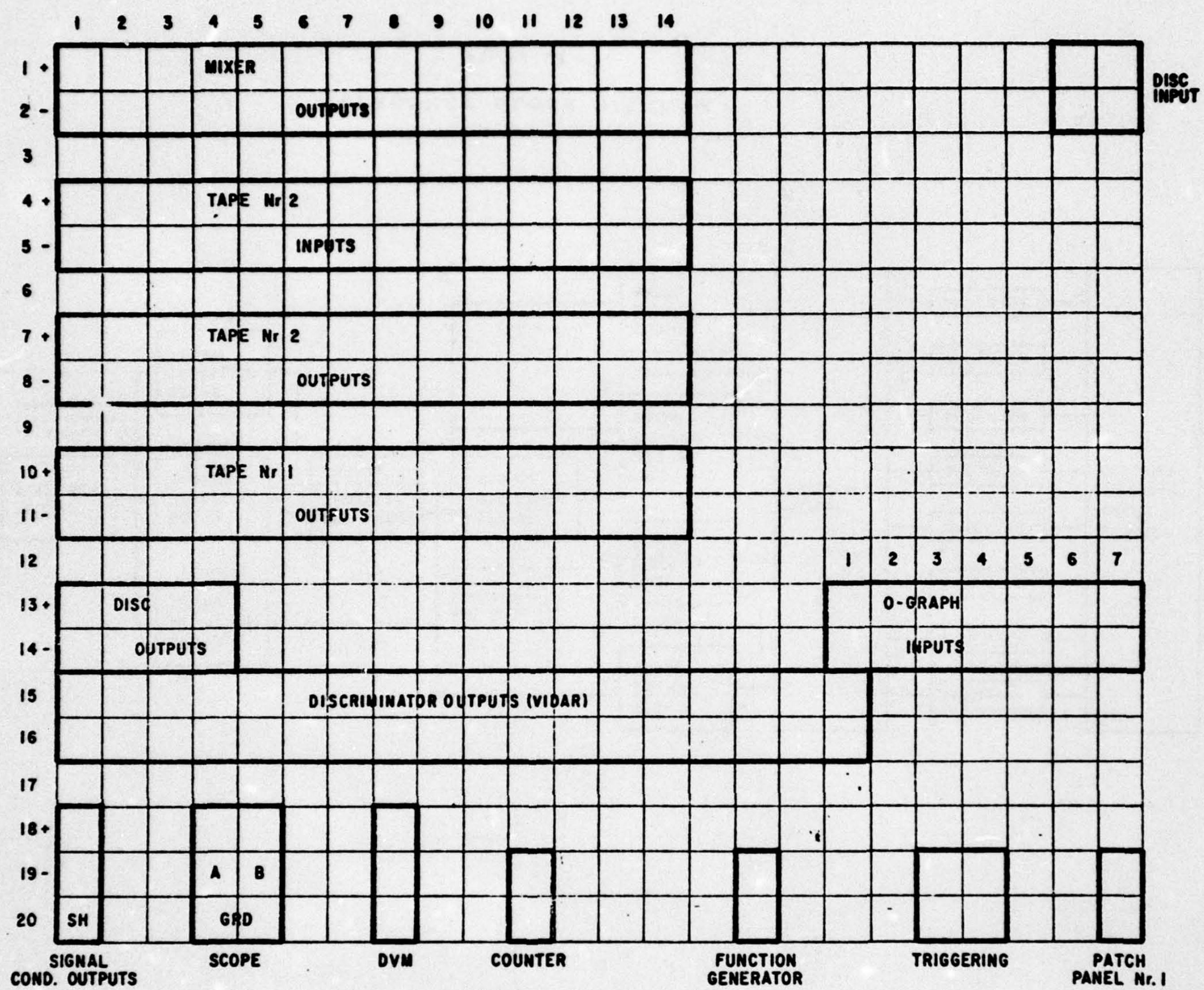
061115





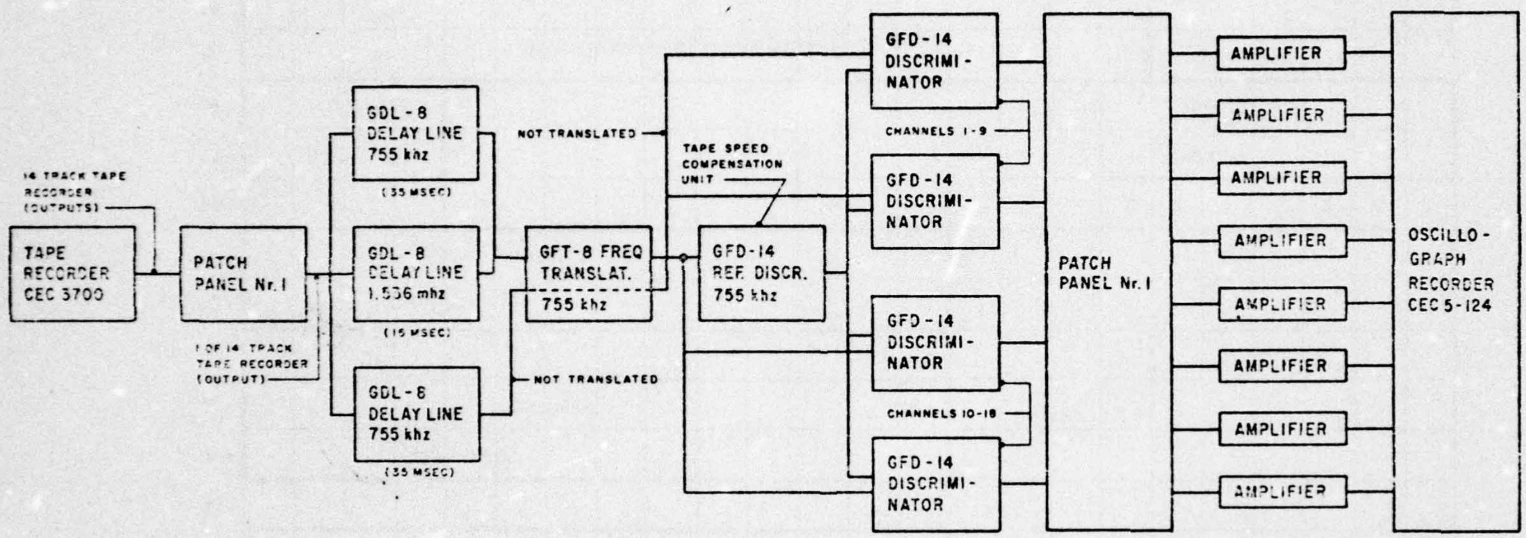
PATCH PANEL #1

Figure 4-5



PATCH PANEL #2

Figure 4-6



REPRODUCE BLOCK DIAGRAM

Figure 4-7

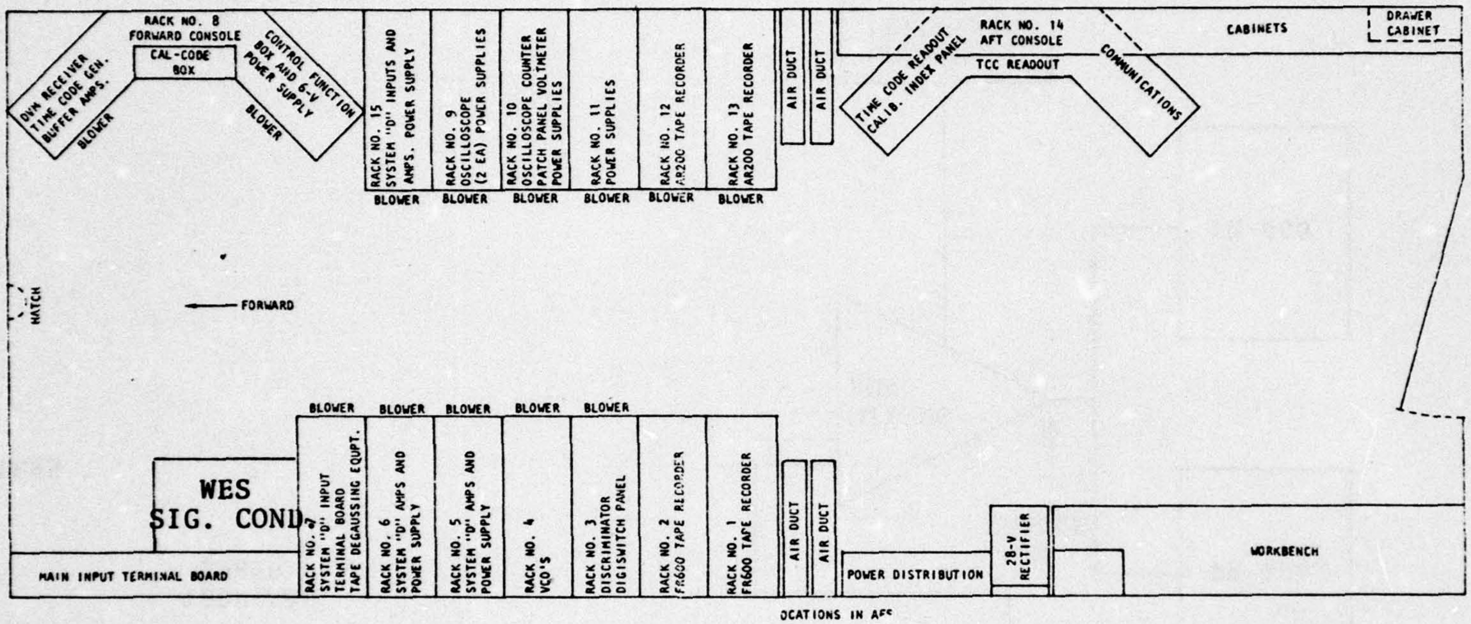


FIGURE 4-8 LOCATION OF EQUIPMENT IN S-IV-4

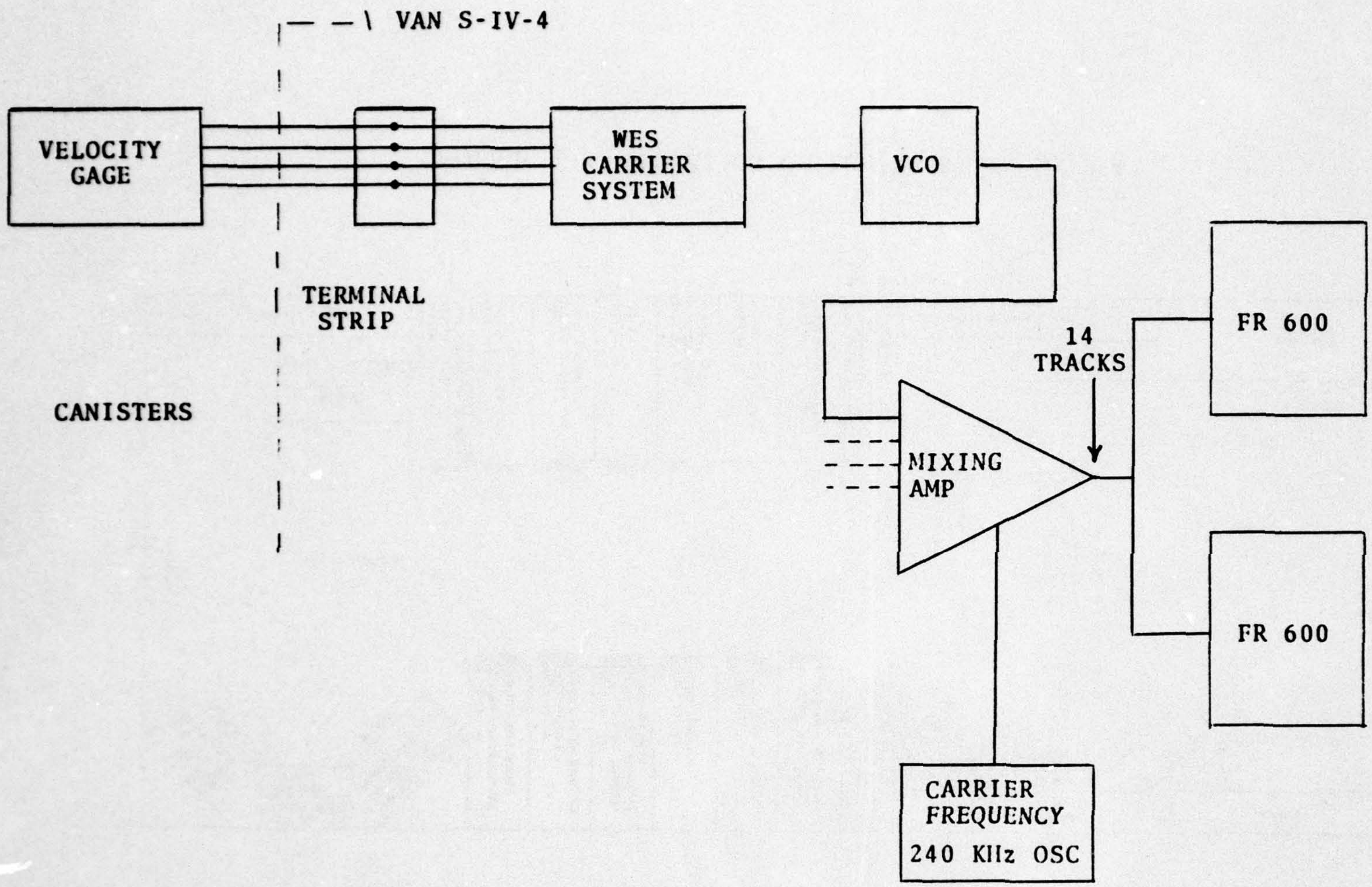


FIGURE 4-9 SIGNAL FLOW CHART TO FR 600 MAGNETIC TAPE RECORDERS

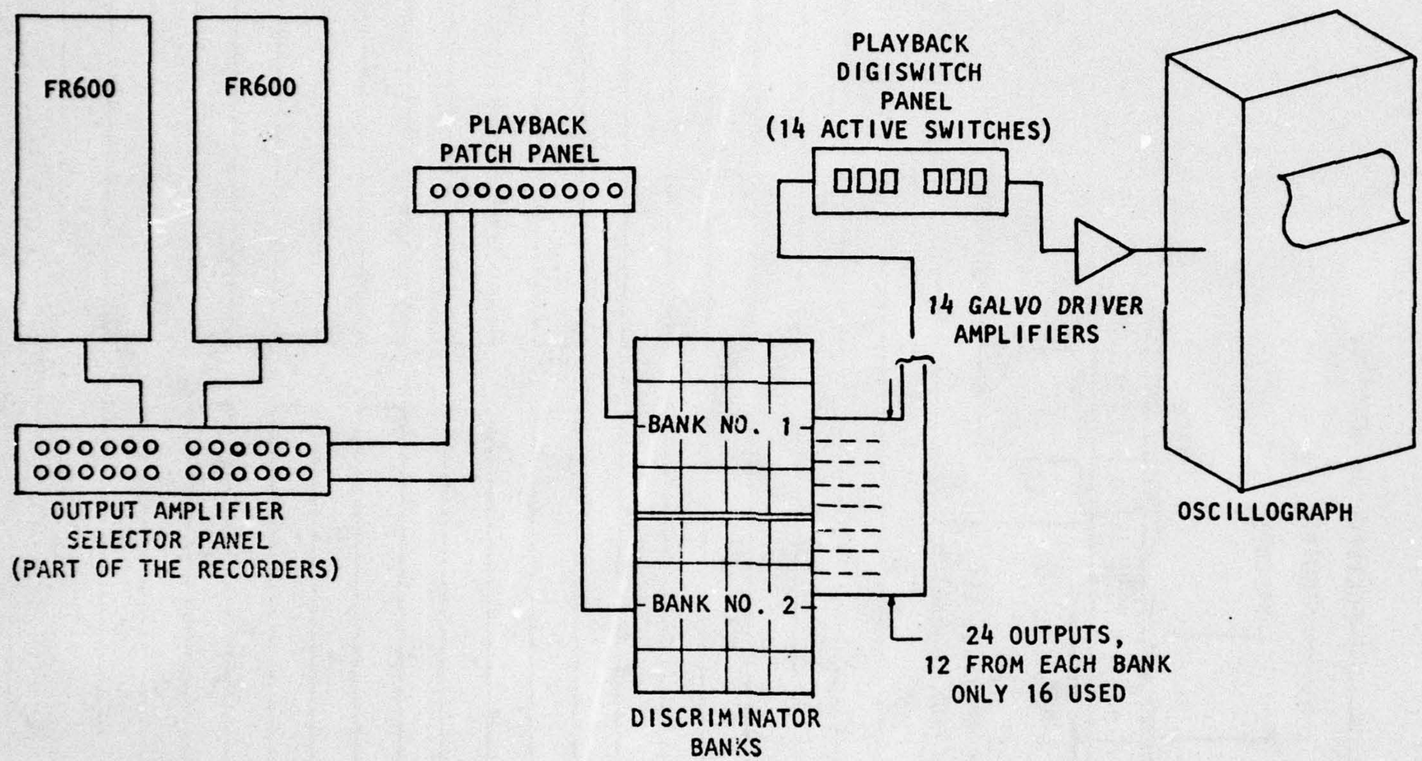


FIGURE 4-10 READOUT SYSTEM OF THE MULTIPLEX RECORDERS IN VAN NO. 4

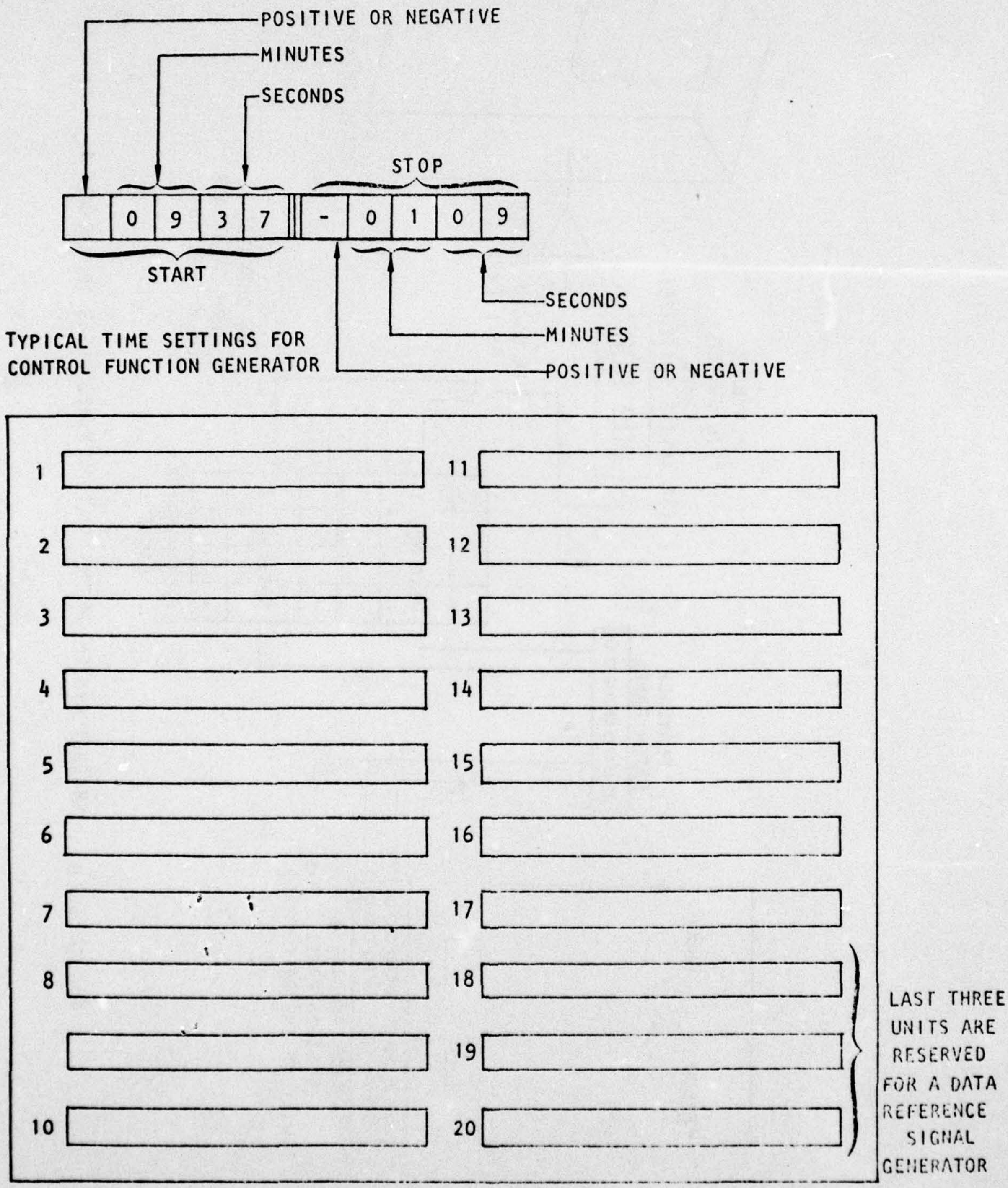


FIGURE 4-11 CONTROL FUNCTION GENERATOR PANEL IN VAN NO. 4

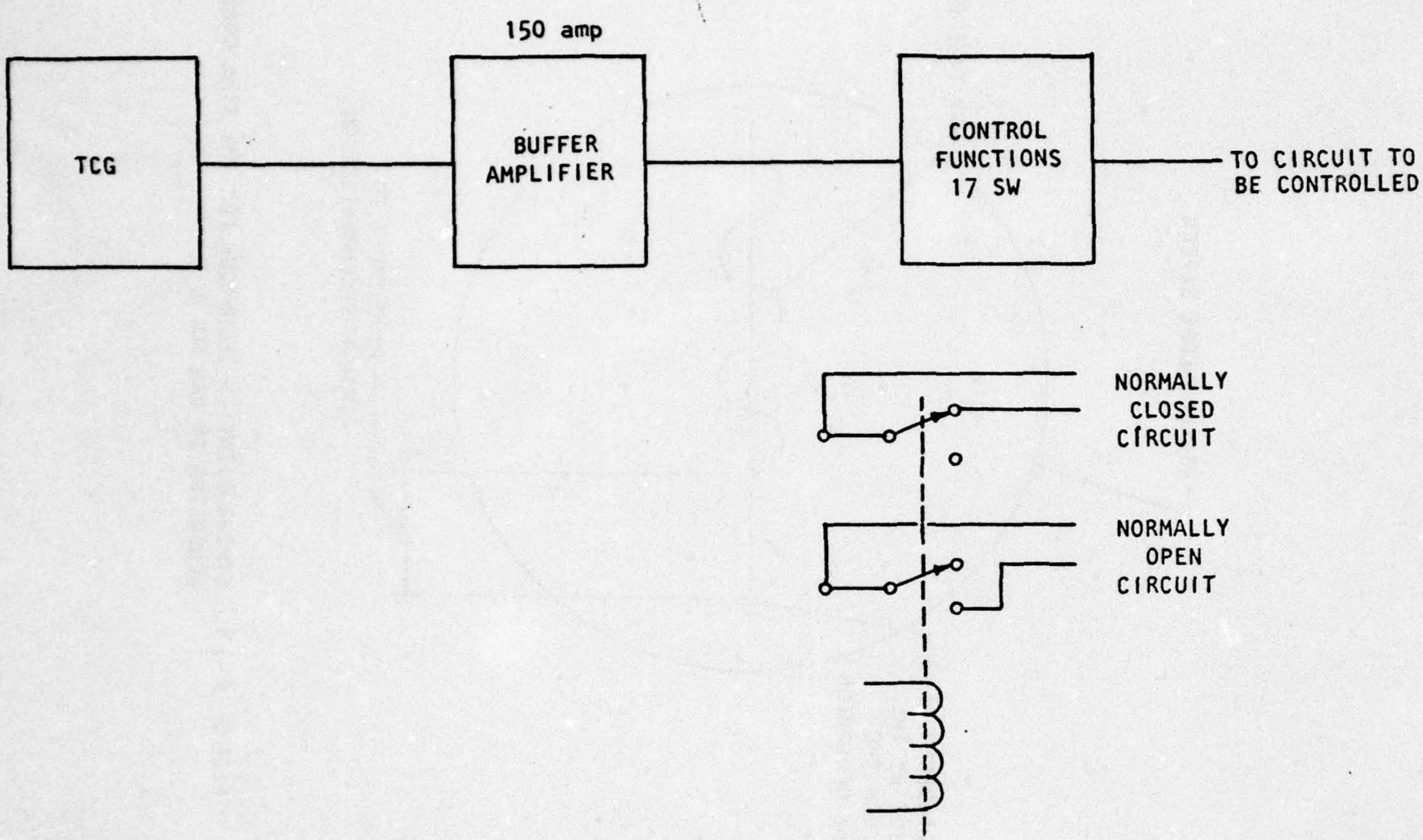
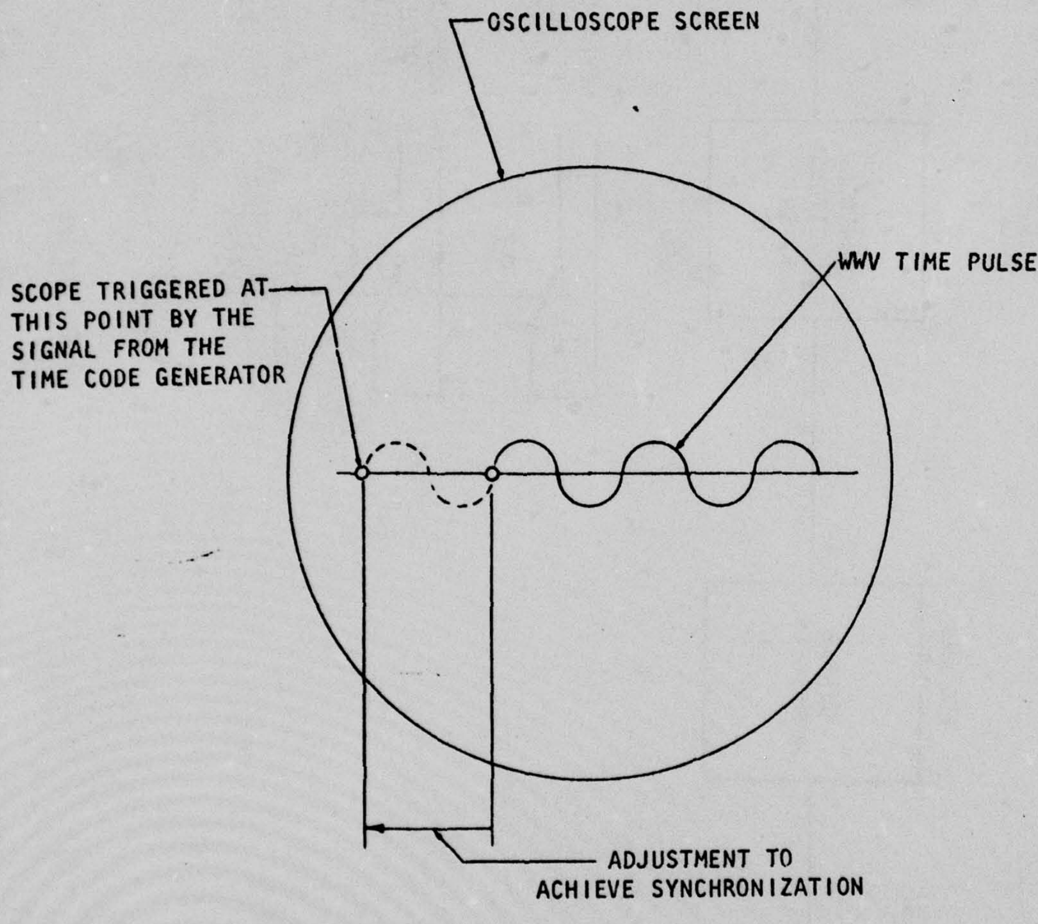


FIGURE 4-12 TIMING CIRCUITRY FOR CONTROL FUNCTION GENERATOR IN VAN NO.4



13 SYNCHRONIZATION TECHNIQUE FOR THE TIME CODE GENERATOR IN VAN NO. 4

SECTION 5.0

DATA REDUCTION PLAN

TABLE OF CONTENTS

5.0

con't

LIST OF TABLES

SECTION 5.0

DATA REDUCTION PLAN

5.1 INTRODUCTION

This plan outlines the recording and playback system which will be used by AFWL and the data reduction system which will be utilized by the Air Force Weapons Laboratory Computational Services Division in the reduction and presentation of Middle Gust ~~IA~~.

5.2 Recording and Data Playback System

5.2.1 General Description

The AFWL Test Vans are instrumented to accept and record a given number of channels of test data depending on the test. A time code generator is used to provide IRIG timing, countdown, and switch closures for various function units from the TCC Van.

Two constant bandwidth modulating systems are employed for multiplexing 225 channels of information into 28 multiplexes, which are recorded on three 14-track tape recorders. Reference pulse, firing pulse, and IRIG-A or IRIG-B timing will be recorded on the magnetic tape recorders.

The Instrumentation Trailers (S-IV-4 and S-IV-3) are equipped with quick-look playback capability consisting of discriminator banks, with galvanometer driver DC amplifiers, to condition the signal for input to an oscillograph.

5.2.1.1 Description of Transducer Signal Recording Process - The conditioned signal from the transducer comes into a Voltage Controlled Oscillator (VCO). From the VCO the signal goes into the mixer which combines the VCO signals (11 in S-IV-4 and 18 in S-IV-3) and forwards the sum to the tape recorders. These 11 or

18 signals are recorded on one of the tracks of the magnetic tape recorders in the respective vans.

5.2.1.2 Description of Playback System - From the recorder, one of the 14 tracks is selected and fed to the discriminators. The discriminators separate the channels of the track and feed each to a galvanometer driver (DC amplifier) which conditions the signals applied to the galvanometers. For quick-look purposes, an expanded scale record of the channel of interest can be oscillographed.

5.2.2 System Components

The voltage controlled oscillator (VCO), crystal, oscillator, mixer-amplifier, and FR-600 and VR-3700 tape recorders are the major components of the data recording system. Depending on the van in question, eleven or eighteen VCO's, a crystal oscillator and a mixer-amplifier are used together to form a multiplex. The recording systems consist of 14 such multiplexes, numbered 1 through 14; the VCO's within each multiplex are numbered 1 through 11 in S-IV-4 and 1 through 18 in S-IV-3 starting with the lowest frequency as number 1 and ascending to the highest frequency as number 18 in S-IV-3, and with the highest frequency as number 1 and descending to the lowest frequency as number 11 in S-IV-4.

The data playback system is composed of the FR-600 and VR-3700 magnetic tape recorders, discriminators, galvanometer driver DC amplifiers, and the oscillograph recorder.

5.2.2.1 Voltage Controlled Oscillator (VCO) - The VCO's used are transistorized units that accept the outputs of various types of transducers and converts them to frequency modulated signals. The VCO's were designed to accept differential data signals to $\pm$ 2.5 volts. Center frequency and deviation from center frequency is determined by a modular plug-in frequency unit. The system in S-IV-4 will be equipped with 154 VCO's and plug-in frequency units as follows:

VCO No.	QUANTITY EACH	CENTER FREQUENCY KHz	DEVIATION KHz	FREQUENCY RESPONSE (KHz) MOD. INDEX OF 2
1	14	192	8	4
2	14	160	8	4
3	14	128	8	4
4	14	96	4	2
5	14	80	4	2
6	14	64	4	2
7	14	48	2	1
8	14	40	2	1
9	14	32	2	1
10	14	24	2	1
11	14	16	2	1
TOTAL	154			

The system in S-IV-3 will be equipped with 336 VCO's and plug-in frequency units as follows:

VCO No.	QUANTITY EACH	CENTER FREQUENCY KHz	DEVIATION KHz	FREQUENCY RESPONSE (KHz) MOD. INDEX OF 2
18	14	1,350	20	10
17	14	1,280	20	10
16	14	1,210	20	10
15	14	1,140	20	10
14	14	1,070	20	10
13	14	1,000	20	10
12	14	930	20	10
11	14	759	29	10
10	14	790	20	10
9	14	720	20	10
8	14	650	20	10
7	14	580	20	10

Con't

VCO No.	QUANTITY EACH	CENTER FREQUENCY KHz	DEVIATION KHz	FREQUENCY RESPONSE (KHz) MOD. INDEX OF 2
6	14	580	20	10
5	14	440	20	10
4	14	370	20	10
3	14	300	20	10
2	14	230	20	10
1	14	160	20	10
TOTAL	252			

5.2.2.2 Crystal Oscillator - The crystal oscillator is a transistorized unit used to provide a reference carrier for tape speed compensation. The frequency of the unit is determined by a plug-in module that provides a 240 KHz sine wave of approximately 200 mv, for tape speed compensation of one complete multiplex.

5.2.2.3 Mixer Amplifier - The mixer amplifier accepts inputs from the VCO's, mixes, amplifies the signals, and forwards the sum to the respective magnetic tape recorder. The amplifier output signal is approximately 2.3 volts peak-to-peak into a 93 ohm line. The output level is shown on the level meter and can be monitored.

5.2.2.4 FR-600 Magnetic Tape Recorder (AMPEX) - The two FR-600's record the data in S-IV-4. These recorders are 14-track record/ playback systems. The reproduce output level is a nominal 1.0 volt rms into 10K ohms.

5.2.2.5 VR-3700 Magnetic Tape Recorder (CEC) - The VR-3700's record the data in S-IV-3. This recorder is a 14-track record playback system. The reproduce output level is a nominal 1.0 volt rms into 75 ohms.

5.2.2.6 Discriminator - The system is equipped with two banks of discriminators that are capable of being patched to any tape tract (multiplex) output at the tape select patch panel. Each bank consists of one reference tuning unit, discriminators and low pass filters. The discriminator is a phase-locked loop FM demodulator that accepts inputs from 2 mv to 2.0 volts rms. Each discriminator is equipped with a low-pass filter plug-in unit that passes only the data frequencies selected.

5.2.2.7 Galvanometer Driver DC Amplifiers - The DC amplifier is a low-gain, wide-band, single-ended power amplifier designed to drive high frequency galvanometers. The amplifier accepts input signals of 0.5 volts to 10 volts.

5.2.2.8 Oscillograph Recorder _ The recording oscillographs are direct-write galvanometers capable of reproducing a phenomenon that can be converted into an analog voltage. The oscillograph has a multi-channel print capability but for this test, printout will be single channel with time markers and grid lines.

5.3 DATA REDUCTION

The primary data recording media for the Middle Gust Program is magnetic tape. These tapes will contain IRIG time A and B. Tapes will have a fiducial signal recorded. Because of limitation in the field equipment, all AFWL tapes will be returned to the AFWL for duplication. The WES thirty-two track tape will be duplicated on fourteen track tape at the test site. (Track assignments on dubbed tape will be made by AFWL.) A thirty-two track dub is also required. The dubbed fourteen track tapes will be used by AFWL, and the dubbed thirty-two track by WES. (AFWL will have control of the original thirty-two track tape.) Each recording channel will be calibrated prior to the test event and immediately following the event where possible. Voltage substitution, voltage insertion, resistance insertion and/or physical calibration methods will be used to calibrate each channel. These calibrations will be digitized and used in the data conversions.

In general the data reduction and conversion system should include the following:

1. Direct, linear conversion using an engineering units constant relative to T-0.

2. First and second integration, differentiation of selected data with a multi-curve graphical data presentation

3. Fourier integration

4. Cross Correlation Techniques.

During data conversion, all data is to be filtered to prevent aliasing. This filter should be a low pass butterworth type with the cutoff frequency set at 1/4 to 1/5 of the sampling rate. The filter cutoff frequency and sampling rate will be specified on the data forms for each gage. The sampling rate will nominally be five times the highest frequency expected for the transducer of interest.

The reduction request form will be used to insure directions for data reduction and presentation are properly recorded and transmitted. This topic is discussed in the last subsection.

The data reduction process to be done by Air Force Weapons Laboratory Computational Division (ADD) is essentially a three step process. These steps include the production of identical copies (dubs) of the original data tapes, quick-look data reduction, and final data reduction by the digitizing, processing, and plotting.

5.3.1 Dry Run Test Tapes

A dry run test tape is a device used by data reduction personnel at ADD to debug the data reduction system and, at the same time, provide an indication of any recording system problems. These tapes are prepared after the recording system is completely ready for the test and should indicate the quality of recording to be expected on test day unless problems are isolated and corrected to improve the quality. These tapes will contain all the serial time data, all calibration data (not to be used for data reduction, however, since gains may be changed), and the "null" excitation levels of all the gages being recorded.

The dry run test tapes will be prepared for each event five working days before test day. These test tapes will be prepared on tapes (not necessarily new) which have been properly degaussed and identified in the same manner as they will be on test day. Since all the equipment will be operating on commercial power, these dry run test tapes will be made simultaneously in an exact duplication of test day conditions so that if any system problems are detected, they can be worked out before the test day. These dry run test tapes will be delivered to ADD on the day that they are prepared and will be accompanied by a complete listing of data channel disignations with their respective calibration information.

Feedback information from ADD indicating apparent problems will be reviewed by the Instrumentation Project Officer with the technicians involved and an investigation will be started to determine if corrective measures are warranted. Any corrective measures deemed necessary will be taken.

5.3.2 Quick-Look Data Reduction

The quick-look data reduction will be rather limited unless some problem develops where the duration of the data is very short. All of the tapes which were delivered to ADD will be run through reproduce electronics and recorded on an oscillograph. These oscillographic records will be reviewed by the Test Conductor and/or his representatives to determine a digitization duration. Unless it is determined that all data has terminated sooner, all data channels shall be digitized for a duration of 4 seconds after time zero. No quantitative work will be done with these oscillographis records.

5.3.3 Formal Data Reduction

Formal data reduction will be accomplished at the Air Force Weapons Laboratory at Kirtland AFB. Formal data reduction will be divided into two phases; analog data reduction and digital data reduction.

5.3.3.1 Analog Data Reduction - Analog tapes 1" by 10-1/2" reels, fourteen track recordings of a constant bandwidth will be recorded at the test site. These tapes will be played back on an Ampex FR-1800H magnetic tape reproduce system at a speed of 60 ips using direct reproduce amplifiers with standard equalizers. The output of the tape machine will be inputted to the discriminators which converts the variations in frequency to variations in voltage. These then provide the input to the analog to digital (A/D) converter. The sampling rate requirements range from 2 KHz to 150 KHz per signal.

The A/D sample rates for the various data will be determined for the various tests depending on the individual gage resonance on fundamental frequency response.

5.3.3.2 Digital Data Reduction - Before a shot, a master calibration tape will be prepared containing:

A. Expected engineering units levels of calibration steps to be recorded on the live data tape.

Using the identifier code (track and carrier) assigned to each file of data on the digitized tape, the appropriate calibration information will be extracted from the master calibrate tape. The set of calibration step values will be read from the digitized tape and coefficients to convert from digits to volts will be determined. The data will then be read, a pre-pulse bias level determined and subtracted from all data points. The result will be fed through the varying degree polynomial using the pre-shot coefficients to convert from volts to engineering units.

5.3.4 Data Presentation Requirements

The general data presentation requirements for each event are shown in Table 5-1. These requirements fall into the following categories.

5.3.4.1 Time Histories - This includes expanded time scale plots (direct and smoothed) of all parameters with engineering units on the ordinate axis. Selected data will require scales of linear-linear, linear-log, and log-log. (Acceleration, Pressure)

5.3.4.2 Integrations and Differentiations - Various parameters must be integrated and/or differentiated to yield parameters of direct interest in analysis. Usually these plots will be made on original data plots with appropriate engineering units to the right of the plot.

5.3.4.3 Power Spectral Density (PSD) & Cross Correlation - This will include log and linear plots of several parameters to investigate frequency spectrum correlation and mechanical impedance variations. (Pressures, Accelerations, Velocity)

TABLE 5.1

MIDDLE GUST IA

EXPECTED DATA PRESENTATION REQUIREMENTS

ANALOG DATA	A-TO-D CONVERSION & REDUCTION	DATA PRESENTATION
AIR BLAST PRESSURE TIME HISTORIES		-Time Histories (Direct) -Time Histories (Smoothed) -Pressure vs. Log Time -Integrated Pressure (Impulse) -Summary -Pressure PSD -TOA Contours -Peak Pressure vs. Range
TOTAL PRESSURE HISTORIES		-Time Histories (Direct) -Time Histories (Smoothed) -Pressure vs. Log Time -Peak Pressure vs. Depth
ACCELERATION TIME HISTORIES		-Time Histories (Direct) -Integrated Accel. (Velocity) -Double-Integrated Accel.(Displ) -Summary -Superimposed traces @ t_o -Acceleration PSD -Peak accel. vs. Depth & Radius
VELOCITY TIME HISTORIES		-Time Histories (Direct) -Integrated Vel (Displ) -Differentiated Vel (Accel) -Summary -Superimposed traces @ t_o -Velocity PSD -Peak Velocities vs. Depth & Radius
SOIL STRESS HISTORIES		-Time History -Summary
HIGH PRESSURE HISTORIES (Manganin, Yterbium, PZT, IMHST, TTT)		-Time History -Summary
PORE PRESSURE		-Time History

5.3.4.4 Depth Plots - Plots are required indicating how peak values of parameters change with depth.

5.3.4.5 Summaries - Data summaries as outlined in Table 5-2 are required for all measured parameters.

5.3.4.5 Special Requests - Special data plots of superimposed traces, side-by-side displays, selected time segments, contour plots, and calculations using the Hugonit equation of state to determine from the pressure time of arrival, the peak value, phase and equivalent yield will be necessary. In addition, the capabilities for determining transducer transfer functions from data and their use in unfolding data may be required.

The quick look reports should include the following data:

PRESSURE	Time Histories & Integration Summary
ACCELERATION	Time Histories & Integration Summary
VELOCITY	Time Histories and Differentials

5.4 REDUCTION REQUEST FORM

The reduction request form will be used to transmit requests from the data analyst to the data reduction staff. A sample form is shown on the following page. This form is to be filled out using the Standard Measurement Designation and Record Code established by the letter of 1 April 1971.

5.5 TRANSDUCER ORIENTATION AND POLARITY

The designation for the physical orientation of Middle Gust transducer packages and the output polarity needs to be standardized so as to prevent misinterpretation of the data.

REDUCTION REQUEST DATE ____________ DATE OUTPUT REQ. ____________ PAGE ____ OF ______

EVENT ______________________________ PB SPEED ____________________ REC SPEED ____________________

TIME CODE ____

CALIBRATION SAMPLE RATE ______________ TIME: START __________________ STOP __________________

____

TIME ZERO ____

STANDARD MEASUREMENT DESIGNATION	STANDARD RECORD CODE	LOW PASS FILTER	DATA			OUTPUT COMMENTS
			SAMPLE RATE	START TIME	STOP TIME	

DATA REDUCTION REQUEST FORM

TABLE 5-2

MIDDLE GUST IA

TYPICAL SUMMARY OF DATA

The following entries should be summarized for all measurements of any one type:

1. MEASUREMENT NUMBER
2. RECORDING CODE (Tape Recorder, Track No, and Channel No.)
3. PEAK PARAMETER VALUE (Direct and Smoothed if applicable)
4. TIME OF ARRIVAL
5. TIME TO PEAK
6. DURATION
7. INTEGRATED PEAK(S)
8. DIFFERENTIATED PEAK(S)
9. REMARKS

The following designations and polarities will be observed throughout the instrumentation design, fabrication, wiring, and installation.

a. Pressure Measurements (Soil, Total, Pore, High):

Polarity: Plus (+) for increasing pressure.

b. Vertical Acceleration, Velocity Measurements:

Polarity: Plus (+) down for direction of wave propagation.

Arrow Orientation: Down for direction of wave propagation.

c. Horizontal Acceleration, Velocity Measurements:

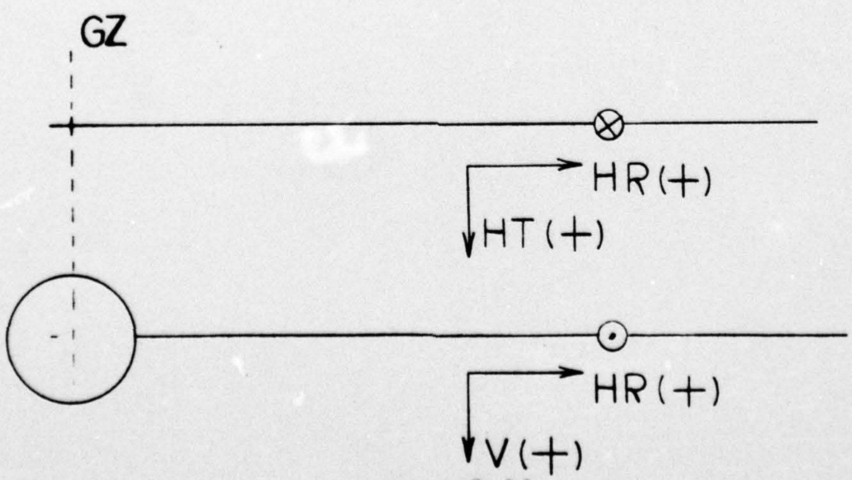
Polarity: Plus (+) in direction of horizontal wave propagation.

Horizontal Transverse: From centerline of test bed.

Arrow Orientation: In direction of horizontal wave propagation.

d. Soil Stress:

Polarity: Plus (+): Compression



SECTION 6.0

TIMING AND FIRING PLAN

MIDDLE GUST

TABLE OF CONTENTS

6.0

LIST OF ILLUSTRATIONS

SECTION 6.0

TIMING AND FIRING SYSTEM

6.1 INTRODUCTION

This plan outlines the timing and firing systems to be utilized on the Middle Gust events. The timing system provides the necessary sequential functions to control the instrumentation. The firing system provides the necessary signals and controls to insure the explosive is properly and safely detonated.

6.2 TIMING CONTROL SYSTEM (Ref. Figure 6-1)

The S-IV-3 Van can serve as a master timing control station and also provide the time reference signals for all the test recording systems, if the TCC van is not available. The principal components of the timing control system of the #3 Van are the time code generator and the sequencer panel. A diagram of the timing components is shown in Figure 6-1.

6.2.1 Time Code Generator

The time code generator (TCG) is a precision timing system that generates a time-coded signal for driving the countdown sequencer, providing IRIG A and B time signals, and driving real-time displays.

The TCG control panel has controls for presetting the starting time to synchronize it to the WWV time signal. The TCG is started by presetting the desired start time on the real-time display. On the WWV signal, the operator pushes the start button. The starting circuitry allows the operator a leeway of one second before the starting time. Thus, if the start button is depressed within this interval, the time signals of the TCG will be synchronized with WWV. Fine synchronization is then obtained with the advance-retard synchronization controls.

6.2.2 WWV Receiver

The WWV receiver is a standard type of unit, which receives time signals from the Bureau of Standards Station WWV in Fort Collins, Colorado. This receiver has a channel selector for the various WWV channels, but it does not have a tuner. Generally, it has high-sensitivity with good noise-filtering characteristics. The WWV receiver is hard-wired to the TCG.

6.2.3 Automatic Function Drawer

Van 3 has an automatic function drawer that is able to control ten functions, i.e. to close and open automatically ten circuits during and after countdown. These control functions will be used to perform the countdown operations that must be sequenced with countdown, such as starting and stopping recorders. An eleventh function is available but is normally used to activate the countdown clock at some real time. Refer to the Automatic Function Drawer Manual for operation and maintenance information.

6.2.4 Fiducial Generation

The countdown sequencer furnishes a zero time closure to the firing relay. The firing relay initiates the discharge of the TC 130A X-unit. The discharge explodes the bridgewire detonators connected to the load ring. The same load ring signal is sent to the SG-72 FIDU generator. The SG-72 regenerates FIDU and provides a distribution point for all zero time recording requirements.

6.3 TCC VAN TIMING CONTROL SYSTEM (Ref - Figure 6-2)

The Test Control and Communication (TCC) Van, as built is presented in Figure 6-2. The equipment layout in the van is shown in Figure 6-2.

6.3.1 General

The TCC Van serves as the center of operational control of the test. Its primary functions are:

A. Test control
B. Test monitoring
C. Communications center
D. Ordnance control

All of these functions are controlled from the test conductor's panel, which thus serves as the master control center for the principal test activities. The test conductor's panel is shown in Figure 6-2 and is described in the following section.

6.3.2 <u>Test Conductor's Panel</u>

The test conductor's panel contains control and monitoring equipment for the principal functions of concern to the Test Conductor: time, communications, and ordnance. The principal sections of the panel, and their functions, are described below.

6.3.2.1 <u>Acquisition Panel</u> - The acquisition panel monitors the operation of the key instruments in the test instrumentation, such as cameras and recorders. This panel also allows the Test Conductor to operate these instruments independently of the programmed control. For each instrument, a light-switch combination serves as monitor light and control switch. The light display indicates whether the instrument is on or off, and the switch (push-type integral with the light display) provides direct control of the instrument through parallel circuitry that overrides the sequencer. The Test Conductor can, at will, start or stop each of the instruments monitored on the panel.

6.3.2.2 <u>Time Displays</u> - The test conductor's panel has real-time and countdown-time displays. These displays represent the master time references. The timing systems in all of the recording vans are synchronized to the TCC Van. The master time displays in all of the recording vans operate from the same time signals that operate these displays. These signals are generated in the time code generator and countdown sequencer in the TCC Van, as shown in Figure 6-3.

6.3.2.3 Sequencer Panel Control - The activating control for the sequencer panel is located in the test conductor's panel. This control also activates the countdown sequence, which will be started at T - 6 hours.

6.3.2.4 Master Ordnance Panel - The master ordnance panel, in the center of the test conductor's panel, contains the master arming switch (a key switch) and display lights to indicate the three conditions of the firing system: safe, arm, and ignition.

6.3.2.5 Communications Section - The communications section has stations for the following communications systems.

Intercom system
Field radio network
Public Address system
Party line nets
Aircraft radio (UHF 225 MC to 425 MC)
Citizens band radio
Emergency warning system
Commercial telephone

6.3.2.6 Monitor Systems - The Test area can be monitored with a closed-circuit black-and-white television system. The test conductor's panel has an 8-in. monitor screen for this system. The system also includes a two-track video tape recorder for recording the test event. Part of the video control panel in the TCC Van is a remote control for camera aiming. The Test Conductor is, therefore, able to rotate the camera ± 180 deg and to tilt it ± 20 deg.

The test conductor's panel also includes a four-track audio recorder. The countdown is recorded on one of the tracks of this recorder.

6.3.3 Timing Control System

The TCC Van not only serves as a master timing control station, but also provides all the time reference signals for all of the test recording systems. These time reference signals and their use are described in Section 6.2.1. The principal components of the timing control system of the TCC Van are the time code generator and the sequencer panel. A diagram of the timing components is shown in Figure 6-3.

6.3.3.1 Time Code Generator - The time code generator (TCG) is a precision timing system that generates a time-coded signal for driving the countdown sequencer, providing IRIG A and B time signals, and driving real-time displays. The TCG is synchronized to WWV to within ±5 microseconds.

6.3.4 Ordnance Control

In addition to the master ordnance panel in the test conductor's panel, the TCC Van has an ordnance panel for both Primacord and overburden arming by the Ordnance Engineer. The final arming sequence is described in Section 6.5. The firing pulse recorded by all the instrument vans is generated by transformers in the battery power lines to the firing circuit. There is one transformer for each recording van.

6.3.5 Support Equipment

The only support equipment installed in the TCC van is air conditioning equipment and power control equipment, which is described in the following paragraphs.

6.3.5.1 Air Conditioning - Two separate and independent all-weather air conditioning systems are used in the TCC Van, one for the personnel areas and one for the equipment. The control panel for the air conditioning systems is located in the aft section of the van, as shown in Figure 6-2.

The input of the personnel air conditioning system is ducted to the ceiling of the van, where it enters the personnel area. The air is exhausted through ducts at the aft section of the van. Conditioned air for the equipment is ducted in through the top of the equipment racks, and is exhausted through the bottom of the racks. Both systems have thermostat controls, which are normally set at 70°F for the personnel system and at 60°F for the equipment system.

6.3.5.2 Power System - The power distribution system in the TCC Van is similar to those used in the AFWL instrument vans. An auxiliary gasoline generator supplies power for some of the lights and some of the communications.

6.4 FIRING SYSTEM DESCRIPTION

The firing system for Middle Gust is depicted in Figure . The system is basically of the capacitive discharge type and was designed to initiate exploding bridgewire (EBW) detonators, such as the SE-1 detonator of Mound Laboratories and the RP-1 of Reynolds Industries. The components and their configuration as shown, are known to be reliable and this system has been used successfully on numerous field tests.

The control unit is basically a system of switches and relays designed to control the operation of the overall system. It incorporates interlock features to assure reliable operation and to prevent system malfunction.

The TC-369 is a single channel high voltage transverter designed for charging field test firing system capacitors. It incorporates a high voltage interlock circuit which provides relay contact transfer when a predetermined voltage is obtained. Both the output voltage and the interlock sensing level are externally adjustable in the field to the specific output requirements between 1900 and 3000 volts. (3000 volts will be used for Middle

Gust). The TC-369 operates in a current regulation mode while charging field test firing system capacitors and then in a voltage regulation mode once the capacitor system is fully charged to the set output voltage.

The TC-130A field-X unit is basically a capacitor discharge firing unit. It employs a 7 f capacitor which is charged to 30000V. To fire the unit a signal of about 28-30 volts will be applied to trigger connectors on the unit causing a spark gap switch to trigger. When this happens the energy on the 7 f capacitor will be dumped through a load ring and hence into firing lines and EBW detonators, causing initiation of the explosives.

The TC-185 is a pulse transformer that provides a step-down of approximately 300 to 1.

The SG 72 fiducial generator is a dual input channel system that provides ten identical isolated outputs. Dual inputs provide redundancy in triggering the generator. The outputs represent zero time (fiducial) for the particular events that are used to trigger them. The functioning time (trigger to output) is typically a few nanoseconds.

6.5 FIRING SYSTEM OPERATION

The first step in operation of the firing system will be to turn on two key switches. This applies 30 VDC to the control unit and enables the pre-arm operation.

A toggle switch will then be turned on to initiate the pre-arm operation. During this stage of the operation the TC-369 will be charging the capacitor in the TC-130A X-unit to 3000V. This voltage will be monitored on a meter at the control panel. The interlock voltage in the TC-369 will be set to about 2900 volts. When the X-unit reaches the pre-set interlock voltage a relay closure in the TC-369 will take place and this will actuate relays in the control unit which complete the circuitry necessary to enable the arm function. Completion of the pre-arm function is indicated by lights on the control unit.

The arm function is initiated by throwing a toggle switch. This closes relays and completes the circuitry necessary to provide a trigger pulse to the TC-130A. Completion of this function is indicated by lights on the control panel.

To fire the system a relay closure will be provided by the timing system at zero time. This will actuate mercury relays in the firing system control unit which will send 30V down the TC-130A trigger lines, causing it to actuate.

The output of the TC-130 will fire the EBW detonator and will also be used to provide a fiducial signal to be recorded as zero time on the data tapes. The TC-130A output will be coupled to the recording vans through a TC-185 step-down pulse transformer, an SG-72 fiducial generator.

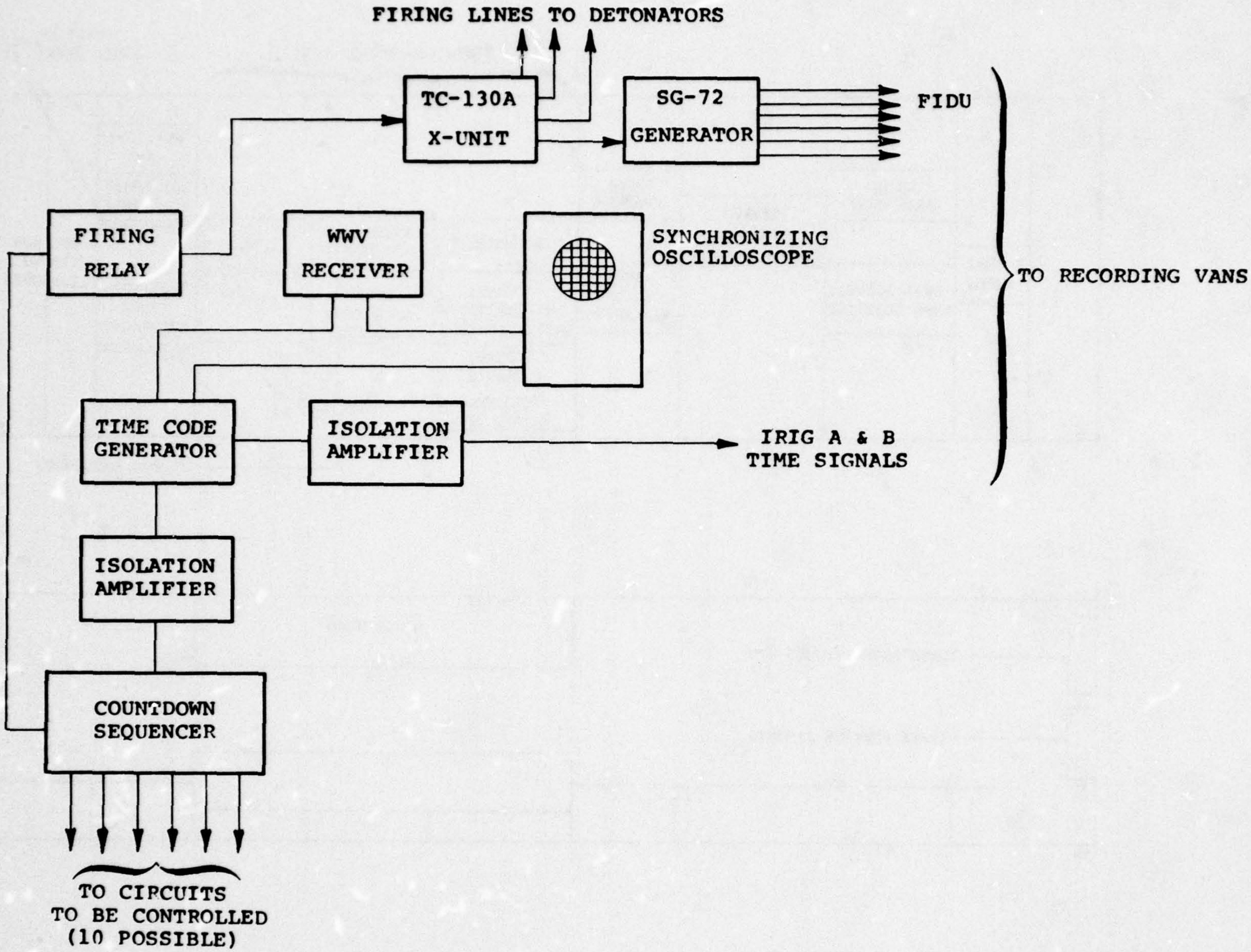


FIGURE 6-1 TIMING CONTROL SYSTEM FOR S-IV-3 VAN

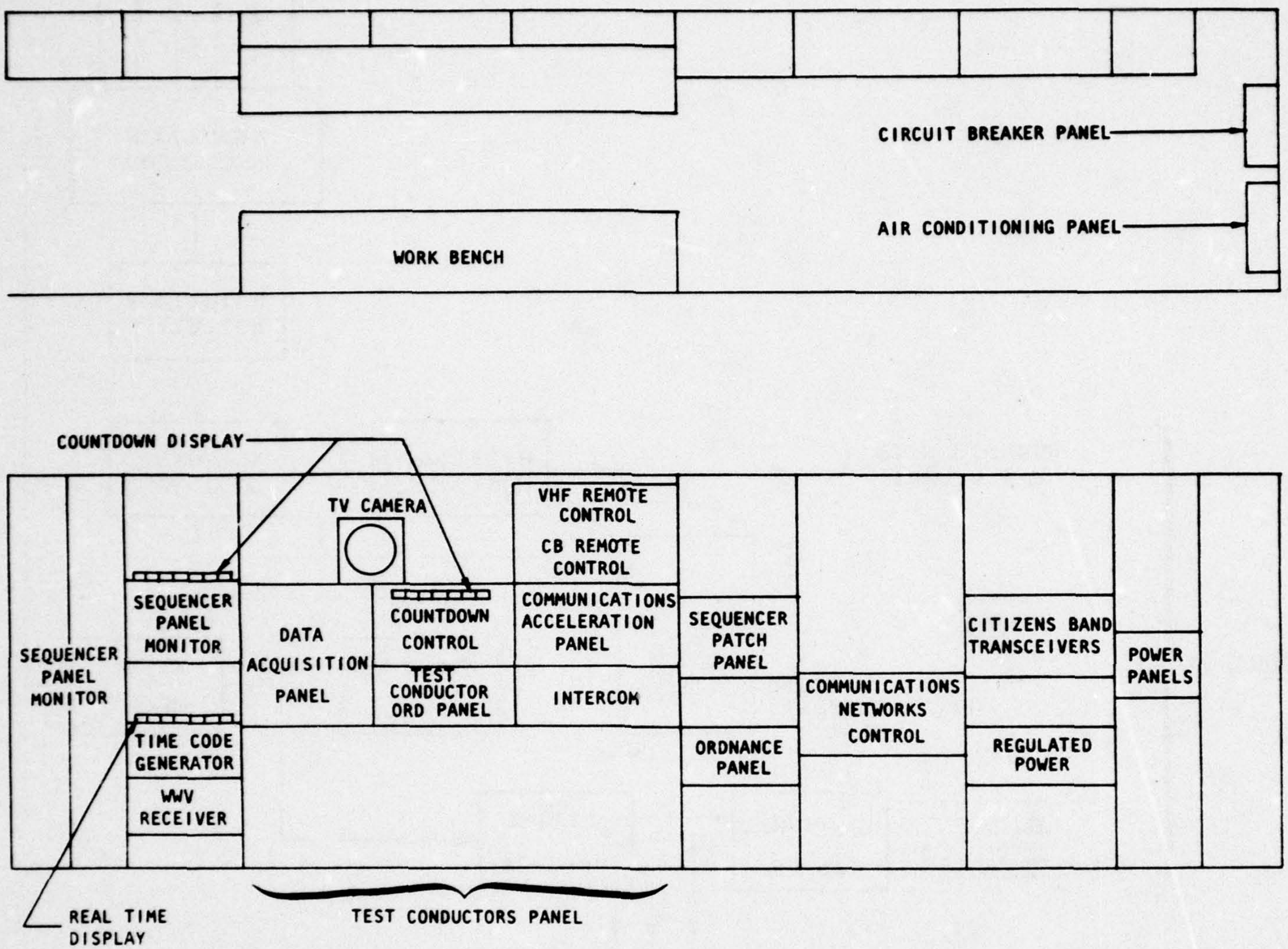


FIGURE 6-2 LOCATION OF EQUIPMENT IN TEST CONTROL COMMUNICATIONS VAN

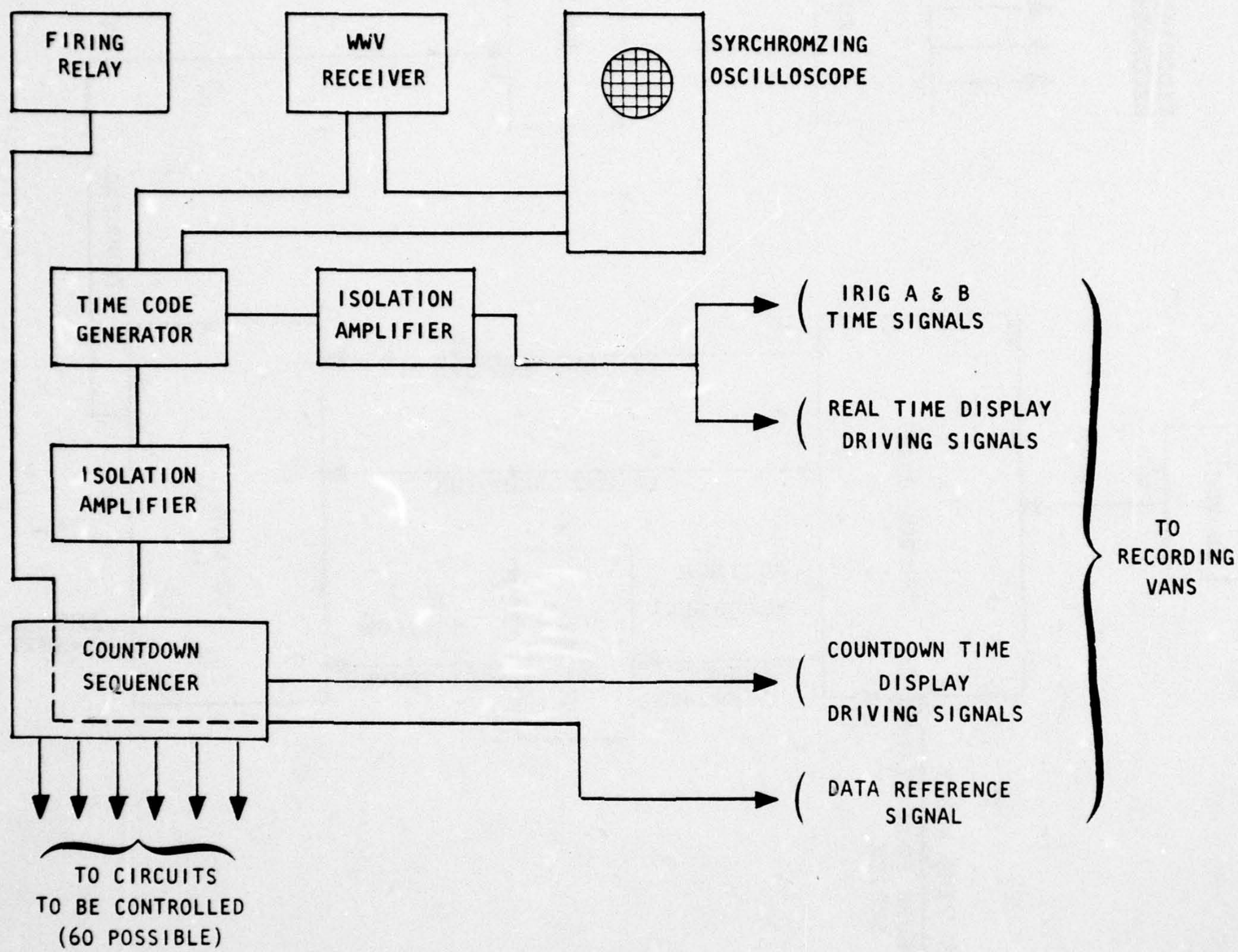


FIGURE 6-3 TIMING CONTROL SYSTEM FOR TCC VAN

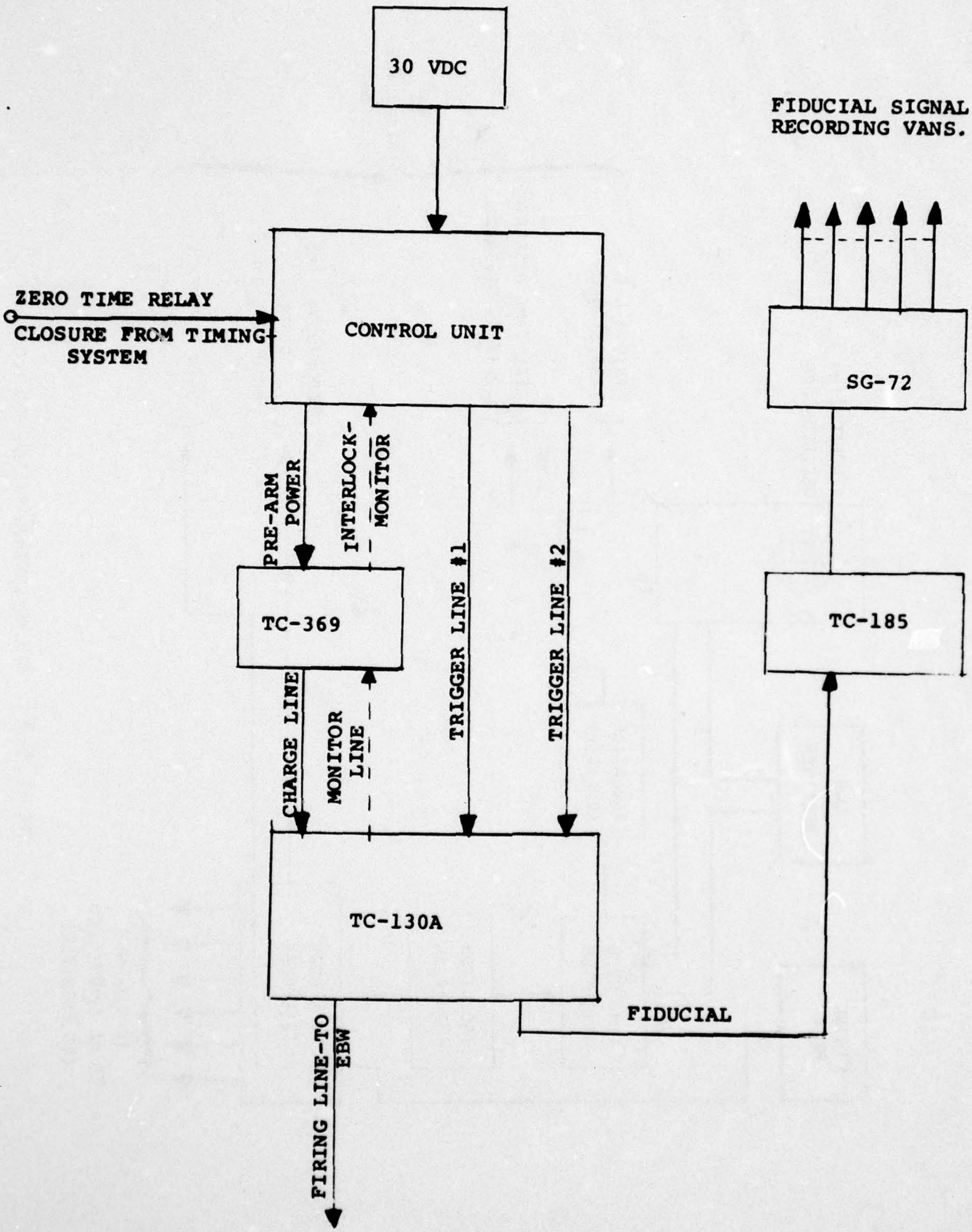


FIGURE 6-4. MIDDLE GUST FIRING SYSTEM - SCHEMATIC

SECTION 7.0

POWER SYSTEM

TABLE OF CONTENTS

7.0

LIST OF ILLUSTRATIONS

7.0 POWER SYSTEM

7.1 INTRODUCTION

The 60 HZ power required to supply the needs of MIDDLE GUST will be supplied by the Southeast Colorado Power Association. The construction of the secondary power system will be completed by BOMUR ELECTRIC COMPANY under subcontract. Practices and procedures within the applicable sections of the National Electrical Code will govern the installation and hook-up of the system to ensure adequate safety and protection. Figure 7-1 is a schematic of the entire system.

7.2 PRIMARY SYSTEM

The primary power system will be installed by the Southwest Colorado Power Association. The installation will include the conversion of 2-3/4 miles of existing line and the construction of approximately 3/4 mile of new line. They will also construct two platforms for the 150 KVA and 300 KVA transformer banks (see Figure 7-2). These platforms will be guyed and the transformers will be rigidly fixed to the platform to help prevent loss of electrical power during the test. The primary voltage will be 7200/12470Y and the lines will be routed to the transformer platforms approximately 120 feet from the trailer shelter (see Figure 7-3).

7.3 SECONDARY SYSTEM

The secondary system will supply the trailer shelter and the auxiliary vans with 480 volt-Δ, 60 HZ, 3 Ø, 4 W service (see Figure 7-2). The trailer shelter shall be supplied from the 300 KVA bank with a 480 volt -Δ , 400 amp service to panel 'A' (see Figures 7.3 and 7.4). Each instrumentation trailer will then be supplied from panel 'A'. An additional transformer with outlets will be used to supply electrical power for work inside the shelter.

The auxiliary van area will be supplied from the 150 KVA bank. Two 45 KVA, 480 Δ- 208/120Y, transformers will step down the voltage for use in the vans and for other auxiliary circuits (see Figure 7-5). The power connections for the trailers and lights will be temporary connections to allow removal of the vans at test time. Motor generator sets will be used to supply power to remote camera stations.

7.4 GROUNDING SYSTEM

The grounding system in the trailer shelter will consist of a counterpoise (see Figure 7-4) buried to a depth of 2½ feet. Every 40 feet of the counterpoise will be treated with 100-pounds of Copper Sulfide ($CuSO_4$) to decrease the resistance to ground as much as possible. Six ground rods will be driven and connected to the counterpoise. Each ground rod will be 10'x3/4" and will be treated with 100 lbs. of $CuSO_4$.

Each corner of the shelter will be connected to the counterpoise, as shown. The ground resistance will be tested to ensure that it is less than 1 ohm. If the grounding has a resistance greater than 5 ohms, it will be necessary to take further action. Specific corrective measures will be determined at that time.

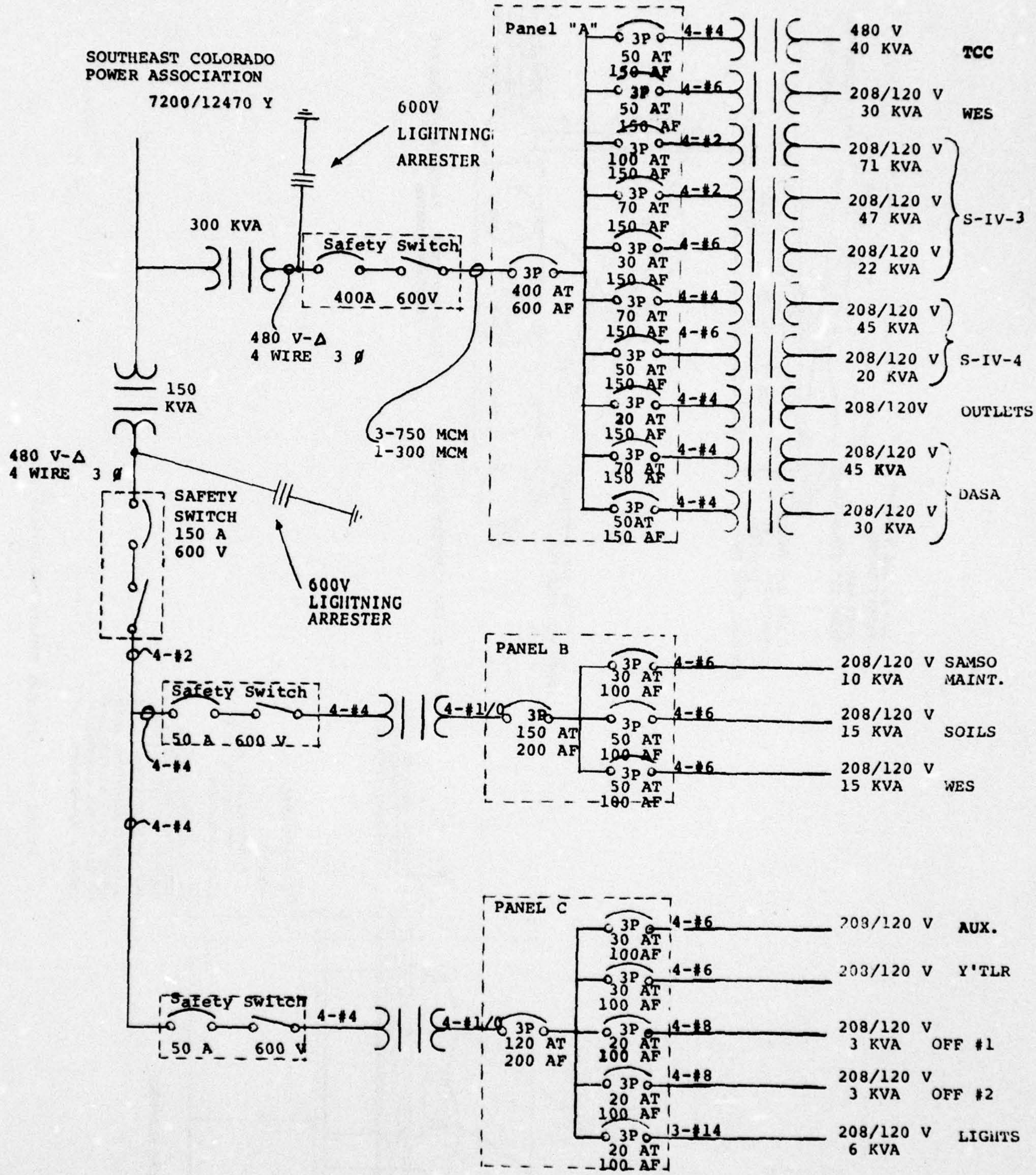


FIGURE 7-1. MIDDLE GUST POWER DISTRIBUTION SCHEMATIC

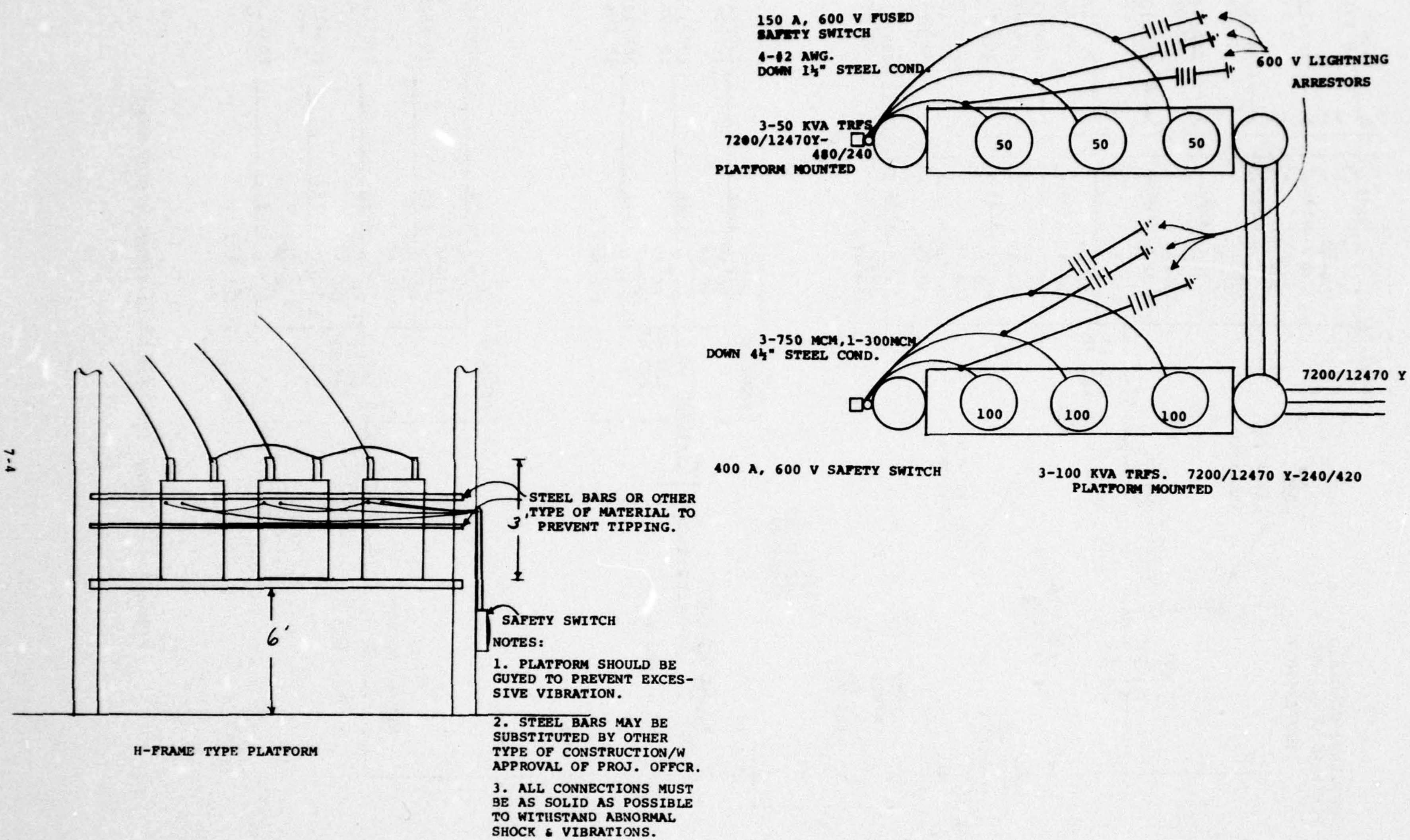


FIGURE 7-2. PRIMARY TRANSFORMER DETAILS

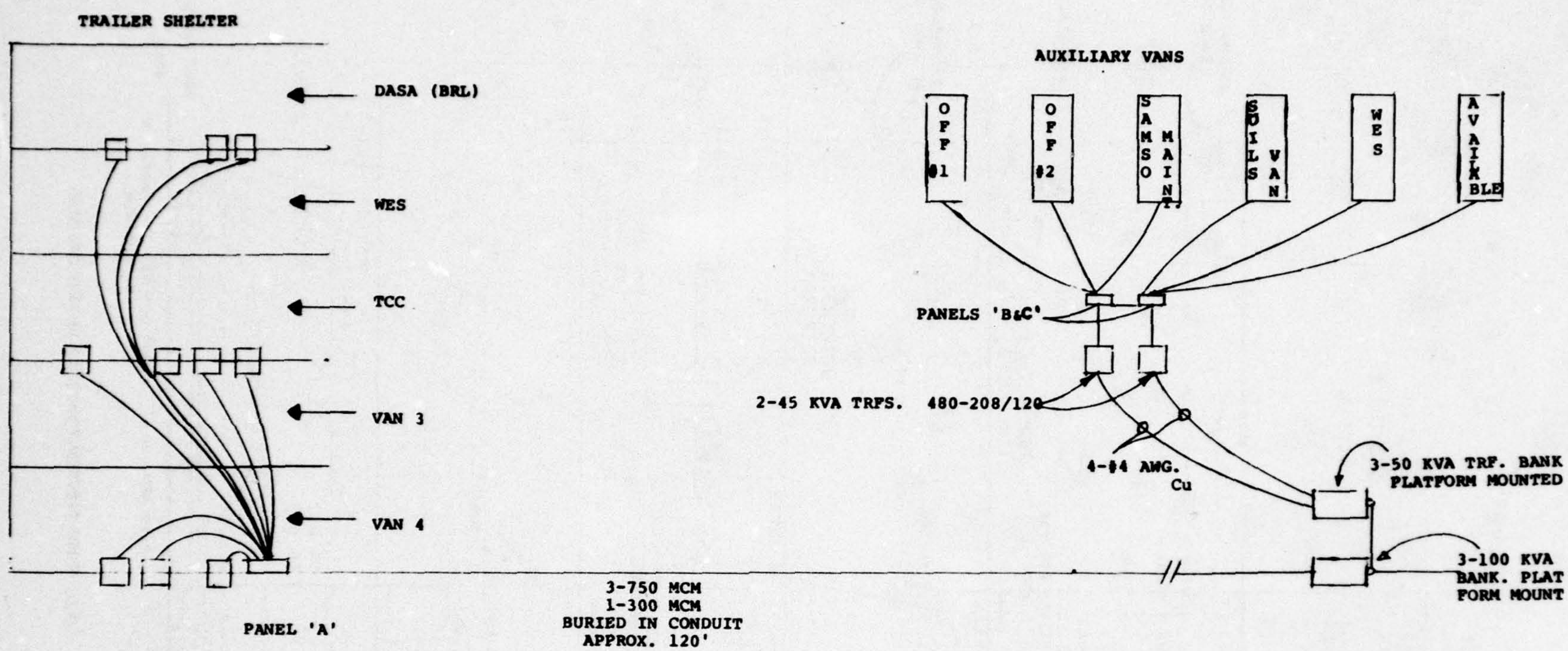


FIGURE 7-3. POWER DISTRIBUTION SYSTEM - PROJECT MIDDLE GUST - TRAILER SHELTER AREA

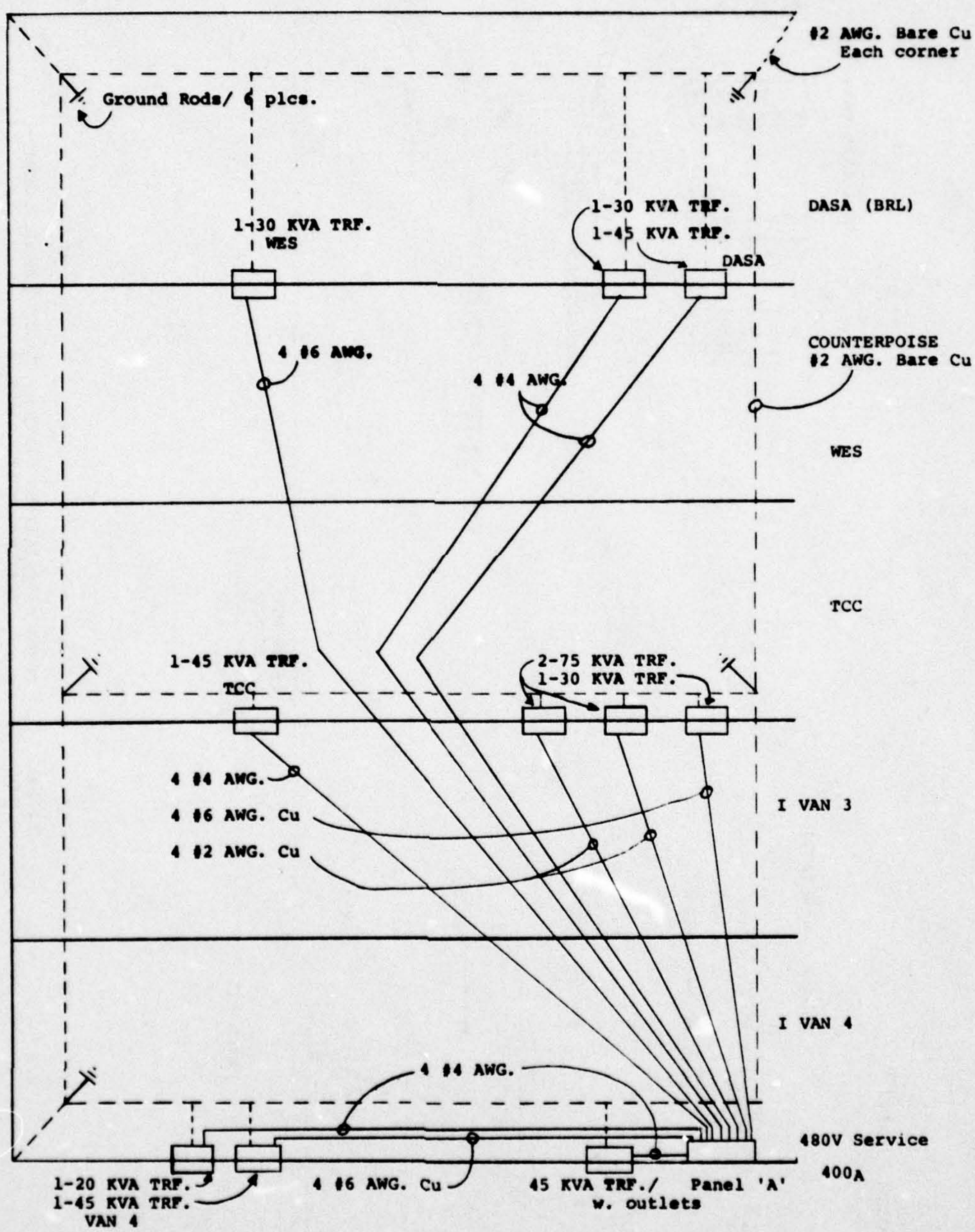


FIGURE 7-4. POWER DISTRIBUTION TRAILER SHELTER AREA

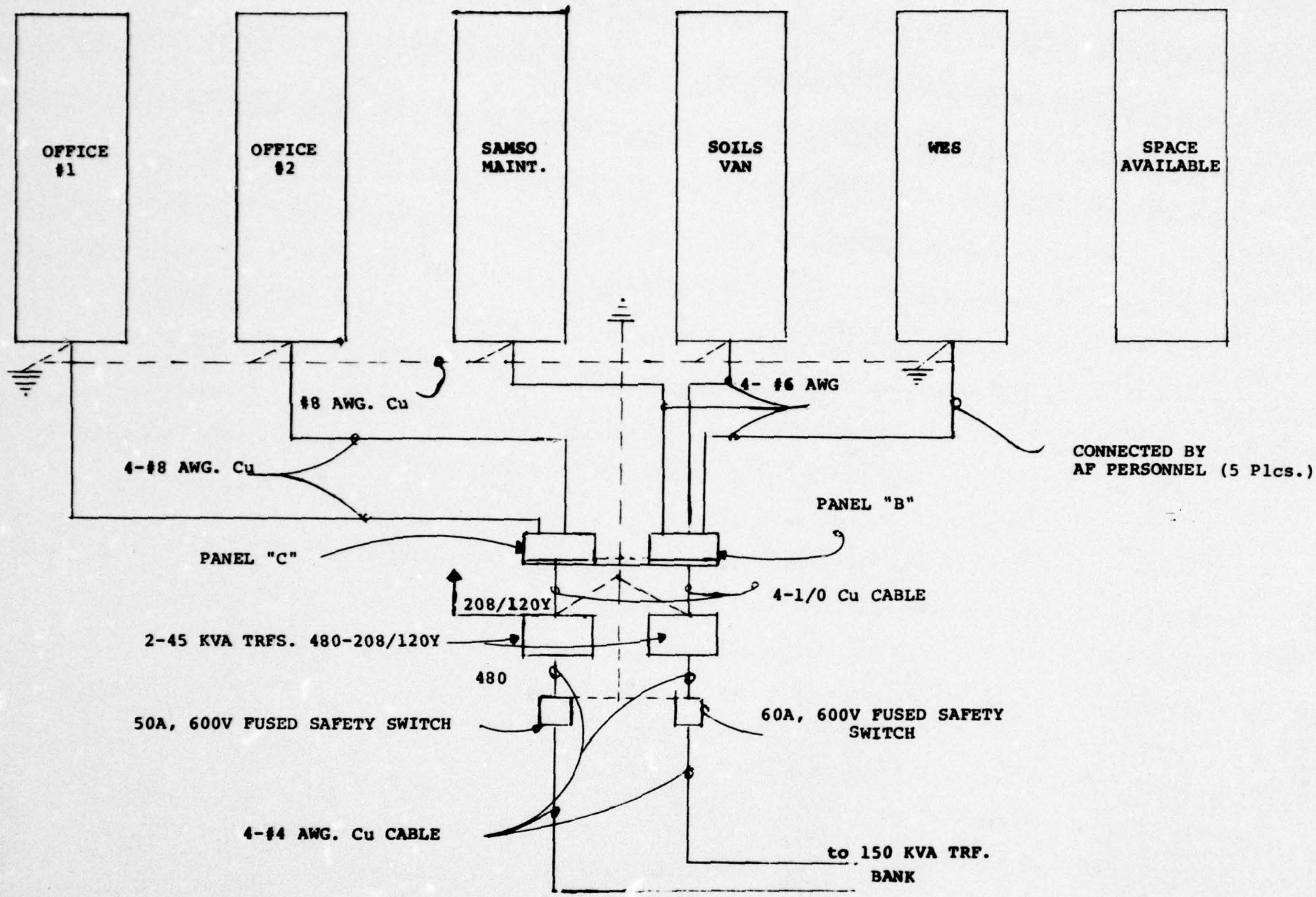


FIGURE 7-5. POWER DISTRIBUTION AUXILIARY VAN AREA

SECTION 8.0

QUALITY CONTROL
AND
DOCUMENTATION UPDATING
PROCEDURES

TABLE OF CONTENTS

8.0

LIST OF ILLUSTRATIONS

SECTION 8.0

QUALITY CONTROL AND DOCUMENTATION UPDATING PROCEDURES

8.1 AFWL QUALITY CONTROL CHECKLISTS

To insure that adequate control is maintained in the installation in Middle Gust, a system of quality control has been established. The aim is to produce high-quality data and insure the maximum return of data.

Specific personnel have been assigned to the quality-control function. Their function, briefly, is to insure that the written instructions for instrumentation installations (this plan) are followed. To assist them, a series of quality control sheets have been developed. For each particular type of gage or set of installation procedures, a separate sheet has been prepared. The sheets outline, step-by-step, in sequence of installation, the checks that the quality control personnel are required to make. Table 10-1 lists the quality control sheets which have been prepared or are under preparation.

TABLE 8-1

Title	For Use In Conjunction With Section	Figure No. Of Sample Sheet
Assembly of Free Field Motion Canisters		10.1
Transducer History		10.2
Downhole Installation of Free Field Canisters		10.3
Active Measurement Status		10.4

8.2 WES QUALITY CONTROL CHECK LISTS

Quality control procedures of WES implemented channels shall be affected by WES.

Note: Additional quality control checklist may be developed in the field as required.

FIGURE 8-1

QUALITY CONTROL SHEET

ASSEMBLY OF FREE FIELD MOTION CANISTERS

I. GAGE INFORMATION

	Measurement No.	Serial No. of Installed Gage
1. Accelerometer #1:		
2. Accelerometer #2:		
3. Accelerometer #3:		
4. Velocity Gage #1:		
5. Velocity Gage #2:		
6. Velocity Gage #3:		
7. Temperature		

A. Accelerometer

1. Verify cable connection to gage and that all shields are floating: ________ (Initial)

2. Verify proper gage orientation when placed in canister: ________ (Initial)

3. Verify 18-20 inch-pounds torque applied to accelerometer mounting screw ________(Initial)

4. Verify residual imbalance after torqueing: ________ (Initial)

5. Verify gage lead wire stress relieved: ________ (Initial)

6. Verify gage cable measurement designation: ________ (Initial)

B. Velocity

1. Verify top of gage clean and free of all oil and dirt: ________ (Initial)

2. Verify cable connections to gage and that all shields are floating: ________ (Initial)

3. Verify proper gage orientation when placed in canister: ________ (Initial)

4. Verify gage securely clamped into canister and gage lead wire stress relieved: ________ (Initial)

5. Verify gage operating properly: ________ (Initial)

6. Verify gage properly sealed: ________ (Initial)

7. Verify canister properly marked for orientation and measurement designation: ________ (Initial)

8. Verify gage cable measurement designation: ________ (Initial)

C. Thermocouple

1. Verify that thermocouple properly installed: ________ (Initial)

2. Verify thermocouple resistance: ________ (Initial)

D. Verify that the canister is sealed: ________ (Initial

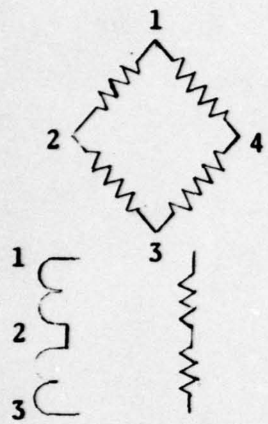
E. Remarks:

FIGURE 8-2
TRANSDUCER HISTORY

Measurement No.________ VCO#________ Gage Type________

Calibration		Comments
Gage Assembly		Comments
Gage Placement		Comments

R Cal Value________ Excitation________ Excitation Current________



Note: Show active arms on sketch. Show arm Cal R is put across.

Resistance	Date	Date	Date	Date	Date
1 - 2 =					
2 - 3 =					
3 - 4 =					
4 - 1 =					
1 - 3 =					
2 - 4 =					
Shield - 1					
Shield - 2					
Shield - 3					
Shield - 4					
Shield - ⏚					
Cal V =					
Ex V =					
Ex I =					
Noise PP =					
Comments					

FIGURE 8-3

Downhole Installation of Free-Field Canisters

Hole No.__________________ Measurement No.__________________

1. Verify hole vertical within 1/2 hole diameter throughout its entire depth.

2. Verify hole depth.

3. Verify hole cleaned; remove drillers mud; flush with fresh water.

4. Verify gage cable properly connected.

5. Level gage canister on level table.

6. Null velocity checkout box. Record offset.

7. Check accelerometer residual imbalance. Record offset.

8. Place gage canister in hole. Verify orientation and depth.

9. Verify canister is vertical. Checkout box will indicate null determined in step #6. Determine allowable offset from calibration sheets.

10. Verify canister is grouted.

11. Verify checkout box maintains null after release of canister.

12. Verify canister cable properly connected to landline.
    Accel._________ Vel.__________

13. Verify recording equipment balances.
    Accel._________ Vel.__________

FIGURE 8-4

INSTRUMENTATION VAN

ACTIVE MEASUREMENT STATUS

Meas. No.	Type Gage	Checked Out			Remarks
		Yes		No	
		Good	Bad	Questionable	

SECTION 9.0

MIDDLE GUST

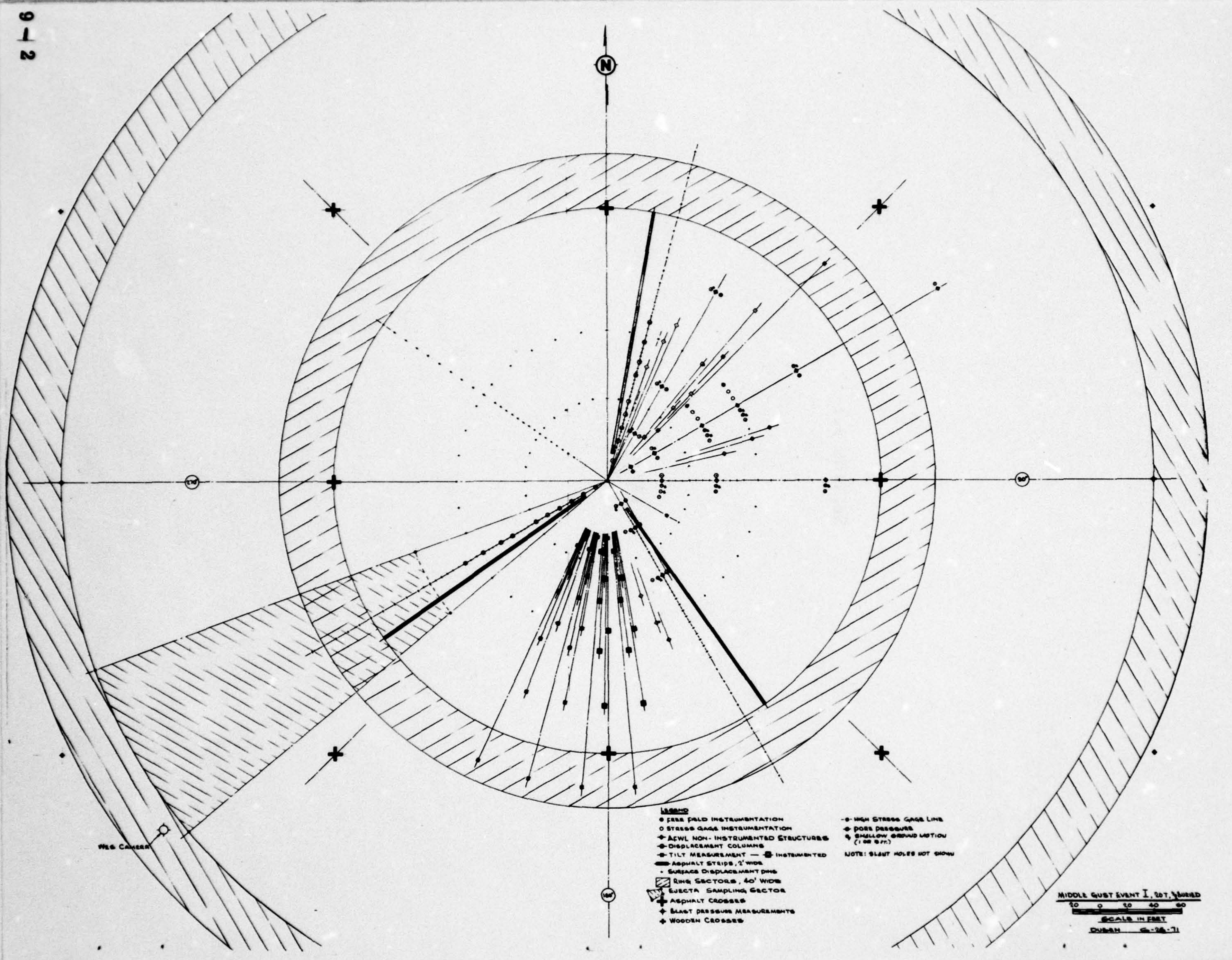
EVENT I

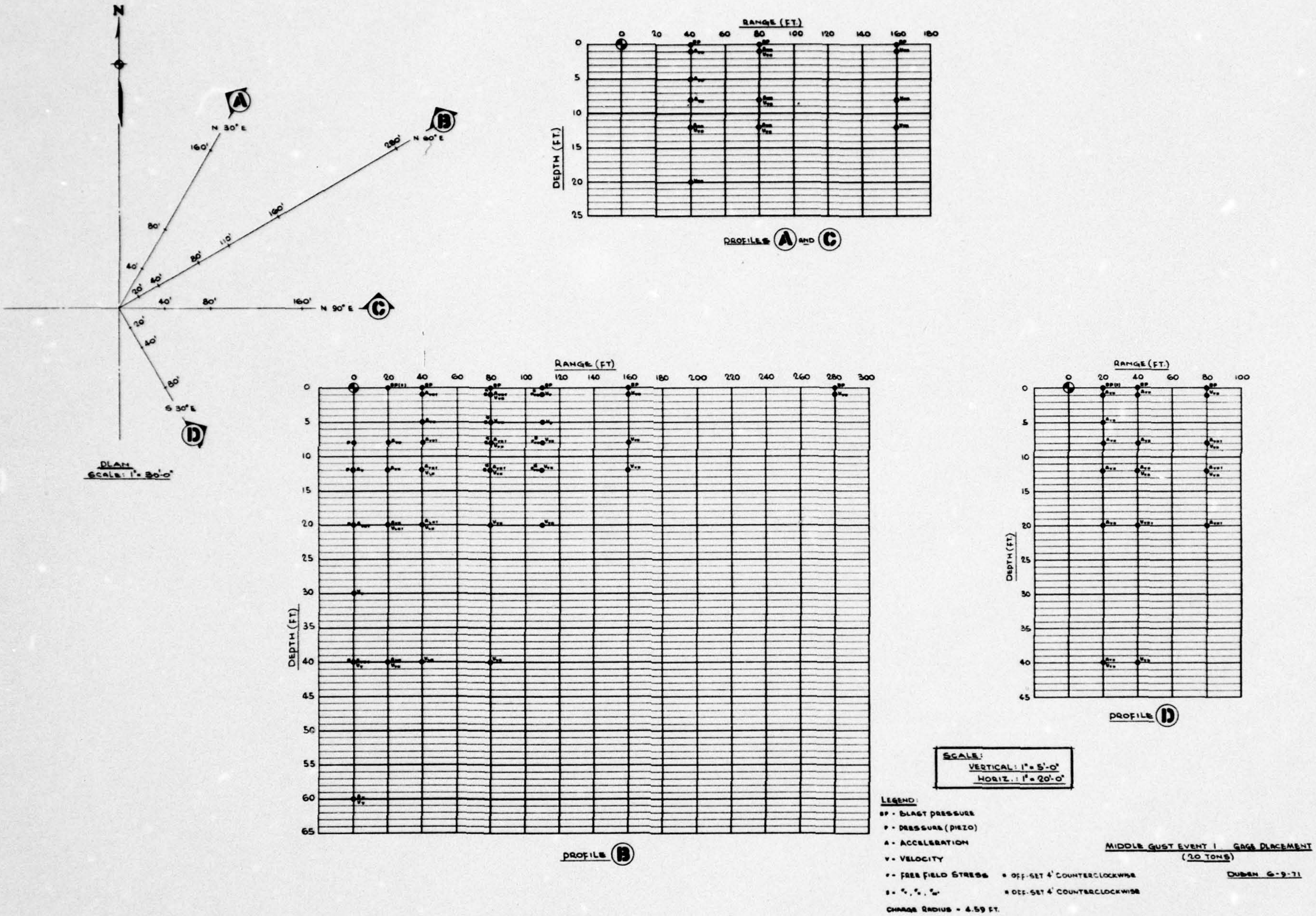
20 TON HALF-BURIED SPHERE

TABLE OF CONTENTS

SECTION 9.1

LAY-OUT


N
WES CAMERA
LEGEND
• FREE FIELD INSTRUMENTATION
○ STRESS GAGE INSTRUMENTATION
AFWL NON-INSTRUMENTED STRUCTURES
DISPLACEMENT COLUMNS
TILT MEASUREMENT — INSTRUMENTED
ASPHALT STRIPS, 2' WIDE
· SURFACE DISPLACEMENT PINS
RING SECTORS, 40' WIDE
EJECTA SAMPLING SECTOR
ASPHALT CROSSES
BLAST PRESSURE MEASUREMENTS
WOODEN CROSSES
HIGH STRESS GAGE LINE
PORE PRESSURE
SHALLOW GROUND MOTION (1 OR 3 FT.)
NOTE: SLANT HOLES NOT SHOWN
MIDDLE GUST EVENT I, 20T, ⅓ BURIED
20 0 20 40 60
SCALE IN FEET
DUBAH 6-26-71


PLAN
SCALE: 1" = 30'-0"
PROFILES A AND C
PROFILE B
PROFILE D
RANGE (FT.)
DEPTH (FT.)
SCALE:
VERTICAL: 1" = 5'-0"
HORIZ.: 1" = 20'-0"
LEGEND:
BP - BLAST PRESSURE
P - PRESSURE (PIEZO)
A - ACCELERATION
V - VELOCITY
* - OFF-SET 4' COUNTERCLOCKWISE
CHARGE RADIUS = 4.59 FT.
MIDDLE GUST EVENT I GAGE PLACEMENT
(20 TONS)
DUBEN 6-9-71

SECTION 9.2

MEASUREMENT LISTS

Measurement Number Assignments

Measurement Number	Description
1-100	AFWL Recorded Free Field Velocity Gages
101-200	WES Recorded Free Field Velocity Gages
201-275	AFWL Recorded Free Field Accelerometer Gages
276-350	WES Recorded Free Field Accelerometer Gages
351-400	AFWL Recorded Free Field Air Pressure
401-425	WES Recorded Free Field Total Pressure
426-475	WES Recorded Free Field Stress Gages
476-500	AFWL Recorded Free Field Pore Pressure
501-510	AFWL Recorded High Stress Gages
511-515	AFWL Recorded T^3 Gages
516-520	WES Recorded Manganin Gages
521-530	WES Recorded Ytterbium
531-535	AFWL Recorded PZT Gages
536-585	AFWL Recorded Cable Noise Measurements

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
351	F-E-L01-0.0-030-40-BP-V	2000 psi	351	J-2-1	351	S-IV-3
201	F-E-L01-01-030-40-A-V	2261CA-10K	201	J-2-18	201	S-IV-3
202	F-E-L01-01-030-40-A-H	2261CA-10K	202	J-2-19	202	S-IV-3
203	F-E-L01-05-030-40-A-V	2261CA-10K	203	J-2-20	203	S-IV-3
204	F-E-L01-05-030-40-A-H	2261CA-10K	204	J-2-21	204	S-IV-3
205	F-E-L01-08-030-40-A-V	2261CA-10K	205	J-2-22	205	S-IV-3
206	F-E-L01-08-030-40-A-H	2261CA-10K	206	J-2-23	206	S-IV-3
207	F-E-L01-12-030-40-A-V	2261CA-10K	207	J-2-24	207	S-IV-3
208	F-E-L01-12-030-40-A-H	2261CA-10K	208	J-2-25	208	S-IV-3
1	F-E-L01-12-030-40-V-V	601 MV	1	J-1-1	1	S-IV-4
2	F-E-L01-12-030-40-V-H	601 MV	2	J-1-2	2	S-IV-4
3	F-E-L01-20-030-40-V-V	601 MV	3	J-1-3	3	S-IV-4
4	F-E-L01-20-030-40-V-H	601 MV	4	J-1-4	4	S-IV-4
352	F-E-L02-0.0-030-80-BP-V	500 psi	352	J-2-2	352	S-IV-3
209	F-E-L02-01-030-80-A-V	2261CA-2500	209	J-2-26	209	S-IV-3
210	F-E-L02-01-030-80-A-H	2261CA-2500	210	J-2-27	210	S-IV-3
5	F-E-L02-01-030-80-V-V	601 VV	5	J-1-5	5	S-IV-4
6	F-E-L02-01-030-80-V-H	601 VH	6	J-1-6	6	S-IV-4
211	F-E-L02-08-030-80-A-V	2261CA-2500	211	J-2-28	211	S-IV-3
212	F-E-L02-08-030-80-A-H	2261CA-2500	212	J-2-29	212	S-IV-3
7	F-E-L02-08-030-80-V-V	601 VV	7	J-1-7	7	S-IV-4
8	F-E-L02-08-030-80-V-H	601 VH	8	J-1-8	8	S-IV-4
213	F-E-L02-12-030-80-A-V	2261CA-2500	213	J-2-30	213	S-IV-3
214	F-E-L02-12-030-80-A-H	2261CA-2500	214	J-2-31	214	S-IV-3

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
9	F-E-L02-12-030-80-V-V	601 VV	9	J-1-9	9	S-IV-4
10	F-E-L02-12-030-80-V-H	601 VH	10	J-1-10	10	S-IV-4
353	F-E-L03-0. 0-030-160-BP-V	500 psi	353	J-2-3	353	S-IV-3
11	F-E-L03-01-030-160-V-V	601 VV	11	J-1-11	11	S-IV-4
12	F-E-L03-01-030-160-V-H	601 VH	12	J-1-12	12	S-IV-4
13	F-E-L03-08-030-160-V-V	601 VV	13	J-1-13	13	S-IV-4
14	F-E-L03-08-030-160-V-H	601 VH	14	J-1-14	14	S-IV-4
15	F-E-L03-12-030-160-V-V	601 VV	15	J-1-15	15	S-IV-4
16	F-E-L03-12-030-160-V-H	601 VH	16	J-1-16	16	S-IV-4
401	F-E-L04-08-000-00-P-V					WES
402	F-E-L04-12-000-00-P-V					WES
276	F-E-L04-12-000-00-A-V	2264-30K				WES
403	F-E-L04-20-000-00-P-V					WES
277	F-E-L04-20-000-00-A-V	2264-30K				WES
278	F-E-L04-20-000-00-A-H	2261CA-10K				WES
279	F-E-L04-20-000-00-A-T	2261CA-10K				WES
101	F-E-L04-30-000-00-V-V	601 MV				WES
404	F-E-L04-40-000-00-P-V					WES
280	F-E-L04-40-000-00-A-V	2261CA-10K				WES
281	F-E-L04-40-000-00-A-H	2261CA-10K				WES
282	F-E-L04-40-000-00-A-T	2261CA-2500				WES
102	F-E-L04-40-000-00-V-V	601 MV				WES
283	F-E-L04-60-000-00-A-V	2261CA-10K				WES
103	F-E-L04-60-000-00-V-V	601 MV				WES

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
109	F-E-L06-12-060-40-V-V	601 MV				WES
110	F-E-L06-12-060-40-V-H	601 MH				WES
303	F-E-L06-20-060-40-A-V	2261CA-10K				WES
304	F-E-L06-20-060-40-A-H	2261CA-10K				WES
305	F-E-L06-20-060-40-A-T	2261CA-2.5K				WES
111	F-E-L06-20-060-40-V-V	601 MV				WES
112	F-E-L06-20-060-40-V-H	601 MH				WES
113	F-E-L06-40-060-40-V-V	601 MV				WES
114	F-E-L06-40-060-40-V-H	601 MH				WES
357	F-E-L07-00-060-80-BP-V	500 psi	357	J-2-7	357	S-IV-3
306	F-E-L07-01-060-80-A-V	2261CA-2.5K				WES
307	F-E-L07-01-060-80-A-H	2261CA-2.5K				WES
308	F-E-L07-01-060-80-A-T	2261CA-2.5K				WES
115	F-E-L07-01-060-80-V-V	601 VV				WES
116	F-E-L07-01-060-80-V-H	601 VH				WES
117	F-E-L07-05-060-80-V-V	601 VV				WES
118	F-E-L07-05-060-80-V-H	601 VH				WES
309	F-E-L07-08-060-80-A-V	2261CA-2.5K				WES
310	F-E-L07-08-060-80-A-H	2261CA-2.5K				WES
311	F-E-L07-08-060-80-A-T	2261CA-2.5K				WES
119	F-E-L07-08-060-80-V-V	601 VV				WES
120	F-E-L07-08-060-80-V-H	601 VH				WES
312	F-E-L07-12-060-80-A-V	2261CA-2.5K				WES
313	F-E-L07-12-060-80-A-H	2261CA-2.5K				WES
314	F-E-L07-12-060-80-A-T	2261CA-2.5K				WES
121	F-E-L07-12-060-80-V-V	601 VV				WES
122	F-E-L07-12-060-80-V-H	601 VH				WES

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
354	F-E-L05-0.0-060-20-BP-V	2000 psi	354	J-2-4	354	S-IV-3
355	F-E-L05-0.0-060-20-BP-V	5000 psi	355	J-2-5	355	S-IV-3
284	F-E-L05-08-060-20-A-V	2261CA-10K				WES
285	F-E-L05-08-060-20-A-H	2261CA-10K				WES
286	F-E-L05-12-060-20-A-V	2261CA-10K				WES
287	F-E-L05-12-060-20-A-H	2261CA-10K				WES
288	F-E-L05-20-060-20-A-V	2261CA-10K				WES
289	F-E-L05-20-060-20-A-H	2261CA-10K				WES
104	F-E-L05-20-060-20-V-V	601 MV				WES
105	F-E-L05-20-060-20-V-H	601 MH				WES
106	F-E-L05-20-060-20-V-T	601 MA				WES
290	F-E-L05-40-060-20-A-V	2261CA-10K				WES
291	F-E-L05-40-060-20-A-H	2261CA-10K				WES
107	F-E-L05-40-060-20-V-V	601 MV				WES
108	F-E-L05-40-060-20-V-H	601 MH				WES
356	F-E-L06-0.0-060-40-BP-V	1000 psi	356	J-2-6	356	S-IV-3
292	F-E-L06-01-060-40-A-V	2261CA-10K				WES
293	F-E-L06-01-060-40-A-H	2261CA-10K				WES
294	F-E-L06-01-060-40-A-T	2261CA-2500				WES
295	F-E-L06-05-060-40-A-V	2261CA-10K				WES
296	F-E-L06-05-060-40-A-H	2261CA-10K				WES
297	F-E-L06-08-060-40-A-V	2261CA-10K				WES
298	F-E-L06-08-060-40-A-H	2261CA-10K				WES
299	F-E-L06-08-060-40-A-T	2261CA-2500				WES
300	F-E-L06-12-060-40-A-V	2261CA-10K				WES
301	F-E-L06-12-060-40-A-H	2261CA-10K				WES
302	F-E-L06-12-060-40-A-T	2261CA-2500				WES

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
123	F-E-L07-20-060-80-V-V	601 VV				WES
124	F-E-L07-20-060-80-V-H	601 VH				WES
125	F-E-L07-40-060-80-V-V	601 VV				WES
126	F-E-L07-40-060-80-V-H	601 VH				WES
358	F-E-L08-00-060-110-BP-V	500 psi	358	J-2-8	358	S-IV-3
127	F-E-L08-01-060-110-V-V	601 VV				WES
128	F-E-L08-05-060-110-V-V	601 VH				WES
129	F-E-L08-08-060-110-V-V	601 VV				WES
130	F-E-L08-08-060-110-V-H	601 VH				WES
131	F-E-L08-12-060-110-V-V	601 VV				WES
132	F-E-L08-12-060-110-V-H	601 VH				WES
133	F-E-L08-20-060-110-V-V	601 VV				WES
134	F-E-L08-20-060-110-V-H	601 VH				WES
359	F-E-L09-00-060-160-BP-V	500 psi	359	J-2-9	359	S-IV-3
135	F-E-L09-01-060-160-V-V	601 VV				WES
136	F-E-L09-01-060-160-V-H	601 VH				WES
137	F-E-L09-08-060-160-V-V	601 VV				WES
138	F-E-L09-08-060-160-V-H	601 VH				WES
139	F-E-L09-12-060-160-V-V	601 VV				WES
140	F-E-L09-12-060-160-V-H	601 VH				WES
360	F-E-L10-00-060-280-BP-V		360	J-2-10	360	S-IV-3
141	F-E-L10-01-060-280-V-V	601 VV				WES
142	F-E-L10-01-060-280-V-H	601 VH				WES
426	F-E-L07-01-060-80-FS-V					WES
427	F-E-L07-01-060-80-FS-H					WES
476	F-E-L07-01-060-80-Pp					S-IV-3
477	F-E-L07-05-060-80-Pp					S-IV-3
478	F-E-L07-08-060-80-Pp					S-IV-3
479	F-E-L07-12-060-80-Pp					S-IV-3

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
480	F-E-L08-01-060-110-Pp					S-IV-3
481	F-E-L08-05-060-110-Pp					S-IV-3
482	F-E-L08-08-060-110-Pp					S-IV-3
483	F-E-L08-12-060-110-Pp					S-IV-3
428	F-E-L07-01-060-80-FS-45°					WES
429	F-E-L07-05-060-80-FS-V					WES
430	F-E-L07-05-060-80-FS-H					WES
431	F-E-L07-05-060-80-FS-45°					WES
432	F-E-L07-08-060-80-FS-V					WES
433	F-E-L07-08-060-80-FS-H					WES
434	F-E-L07-08-060-80-FS-45°					WES
435	F-E-L07-12-060-80-FS-V					WES
436	F-E-L07-12-060-80-FS-H					WES
437	F-E-L07-12-060-80-FS-45°					WES
438	F-E-L08-01-060-110-FS-V					WES
439	F-E-L08-01-060-110-FS-H					WES
440	F-E-L08-08-060-110-FS-V					WES
441	F-E-L08-08-060-110-FS-H					WES
442	F-E-L08-12-060-110-FS-V					WES
443	F-E-L08-12-060-110-FS-H					WES
361	F-E-L11-00-090-40-BP-V	1000 psi	361	J-2-11	361	S-IV-3
215	F-E-L11-01-090-40-A-V	2261CA-10K	215	J-2-32	215	S-IV-3
216	F-E-L11-01-090-40-A-H	2261CA-10K	216	J-2-33	216	S-IV-3
217	F-E-L11-05-090-40-A-V	2261CA-10K	217	J-2-34	217	S-IV-3
218	F-E-L11-05-090-40-A-H	2261CA-10K	218	J-2-35	218	S-IV-3
219	F-E-L11-08-090-40-A-V	2261CA-10K	219	J-2-36	219	S-IV-3
220	F-E-L11-08-090-40-A-H	2261CA-10K	220	J-2-37	220	S-IV-3
221	F-E-L11-12-090-40-A-V	2261CA-10K	221	J-2-38	221	S-IV-3
222	F-E-L11-12-090-40-A-H	2261CA-10K	222	J-2-39	222	S-IV-3
17	F-E-L11-12-090-40-V-V	601 MV	17	J-1-17	17	S-IV-4
18	F-E-L11-12-090-40-V-H	601 MH	18	J-1-18	18	S-IV-4

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
19	F-E-L11-20-090-40-V-V	601 MV	19	J-1-19	19	S-IV-4
20	F-E-L11-20-090-40-V-H	601 MH	20	J-1-20	20	S-IV-4
362	F-E-L12-00-090-80-BP-V	500 psi	362	J-2-12	362	S-IV-3
21	F-E-L12-01-090-80-V-V	601 VV	21	J-1-21	21	S-IV-4
22	F-E-L12-01-090-80-V-H	601 VH	22	J-1-22	22	S-IV-4
223	F-E-L12-01-090-80-A-V	2261CA-2.5K	223	J-2-40	223	S-IV-3
224	F-E-L12-01-090-80-A-H	2261CA-2.5K	224	J-2-41	224	S-IV-3
225	F-E-L12-08-090-80-A-V	2261CA-2.5K	225	J-2-42	225	S-IV-3
226	F-E-L12-08-090-80-A-H	2261CA-2.5K	226	J-2-43	226	S-IV-3
23	F-E-L12-08-090-80-V-V	601 VV	23	J-1-23	23	S-IV-4
24	F-E-L12-08-090-80-V-H	601 VH	24	J-1-24	24	S-IV-4
227	F-E-L12-12-090-80-A-V	2261CA-2.5K	227	J-2-44	227	S-IV-3
228	F-E-L12-12-090-80-A-H	2261CA-2.5K	228	J-2-45	228	S-IV-3
25	F-E-L12-12-090-80-V-V	601 VV	25	J-1-25	25	S-IV-4
26	F-E-L12-12-090-80-V-H	601 VH	26	J-1-26	26	S-IV-4
363	F-E-L13-00-090-160-BP-V	500 psi	363	J-2-13	363	S-IV-3
27	F-E-L13-01-090-160-V-V	601 VV	27	J-1-27	27	S-IV-4
28	F-E-L13-01-090-160-V-H	601 VH	28	J-1-28	28	S-IV-4
29	F-E-L13-08-090-160-V-V	601 VV	29	J-1-29	29	S-IV-4
30	F-E-L13-08-090-160-V-H	601 VH	30	J-1-30	30	S-IV-4
31	F-E-L13-12-090-160-V-V	601 VV	31	J-1-31	31	S-IV-4
32	F-E-L13-12-090-160-V-H	601 VH	32	J-1-32	32	S-IV-4
364	F-E-L14-00-150-20-BP-V	2000 psi	364	J-2-14	364	S-IV-3
365	F-E-L14-01-150-20-BP-V	2261CA-2000 psi	365	J-2-15	365	S-IV-3
254	F-E-L14-01-150-20-A-V	2261CA-10K	254	J-2-71	254	S-IV-3
255	F-E-L14-01-150-20-A-H	2261CA-10K	255	J-2-72	255	S-IV-3
229	F-E-L14-05-150-20-A-V	2261CA-10K	229	J-2-46	229	S-IV-3
230	F-E-L14-05-150-20-A-H	2261CA-10K	230	J-2-47	230	S-IV-3

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
231	F-E-L14-08-150-20-A-V	2261CA-10K	231	J-2-48	231	S-IV-3
232	F-E-L14-08-150-20-A-H	2261CA-10K	232	J-2-49	232	S-IV-3
233	F-E-L14-12-150-20-A-V	2261CA-10K	233	J-2-50	233	S-IV-3
234	F-E-L14-12-150-20-A-H	2261CA-10K	234	J-2-51	234	S-IV-3
235	F-E-L14-20-150-20-A-V	2261CA-10K	235	J-2-52	235	S-IV-3
236	F-E-L14-20-150-20-A-H	2261CA-10K	236	J-2-53	236	S-IV-3
237	F-E-L14-40-150-20-A-V	2261CA-10K	237	J-2-54	237	S-IV-3
238	F-E-L14-40-150-20-A-H	2261CA-10K	238	J-2-55	238	S-IV-3
33	F-E-L14-40-150-20-V-V	601 MV	33	J-1-33	33	S-IV-4
34	F-E-L14-40-150-20-V-H	601 MH	34	J-1-34	34	S-IV-4
366	F-E-L15-00-150-40-BP-V	1000 psi	366	J-2-16	366	S-IV-3
239	F-E-L15-01-150-40-A-V	2261CA-10K	239	J-2-56	239	S-IV-3
240	F-E-L15-01-150-40-A-H	2261CA-10K	240	J-2-57	240	S-IV-3
241	F-E-L15-08-150-40-A-V	2261CA-10K	241	J-2-58	241	S-IV-3
242	F-E-L15-08-150-40-A-H	2261CA-10K	242	J-2-59	242	S-IV-3
243	F-E-L15-12-150-40-A-V	2261CA-10K	243	J-2-60	243	S-IV-3
244	F-E-L15-12-150-40-A-H	2261CA-10K	244	J-2-61	244	S-IV-3
35	F-E-L15-12-150-40-V-V	601 MV	35	J-1-35	35	S-IV-4
36	F-E-L15-12-150-40-V-H	601 MH	36	J-1-36	36	S-IV-4
37	F-E-L15-20-150-40-V-V	601 MV	37	J-1-37	37	S-IV-4
38	F-E-L15-20-150-40-V-H	601 MH	38	J-1-38	38	S-IV-4
39	F-E-L15-20-150-40-V-T	601 MH	39	J-1-39	39	S-IV-4
40	F-E-L15-40-150-40-V-V	601 MV	40	J-1-40	40	S-IV-4
41	F-E-L15-40-150-40-V-H	601 MH	41	J-1-41	41	S-IV-4

Measurement Number	Measurement Designation	Gage Type	Cable No. Xducer J-Box	J-Box	Cable No. J-Box Van	Trailer Number
367	F-E-L16-00-150-80-BP-V	500 psi	367	J-2-17	367	S-IV-3
42	F-E-L16-01-150-80-V-V	601 VV	42	J-1-42	42	S-IV-4
43	F-E-L16-01-150-80-V-H	601 VH	43	J-1-43	43	S-IV-4
245	F-E-L16-08-150-80-A-V	2261CA-2. 5K	245	J-2-62	245	S-IV-3
246	F-E-L16-08-150-80-A-H	2261CA-2. 5K	246	J-2-63	246	S-IV-3
247	F-E-L16-08-150-80-A-T	2261CA-2. 5K	247	J-2-64	247	S-IV-3
44	F-E-L16-08-150-80-V-V	601 VV	44	J-1-44	44	S-IV-4
45	F-E-L16-08-150-80-V-H	601 VH	45	J-1-45	45	S-IV-4
248	F-E-L16-12-150-80-A-V	2261CA-2. 5K	248	J-2-65	248	S-IV-3
249	F-E-L16-12-150-80-A-H	2261CA-2. 5K	249	J-2-66	249	S-IV-3
250	F-E-L16-12-150-80-A-T	2261CA-2. 5K	250	J-2-67	250	S-IV-3
46	F-E-L16-12-150-80-V-V	601 VV	46	J-1-46	46	S-IV-4
47	F-E-L16-12-150-80-V-H	601 VH	47	J-1-47	47	S-IV-4
251	F-E-L16-20-150-80-A-V	2261CA-2. 5K	251	J-2-68	251	S-IV-3
252	F-E-L16-20-150-80-A-H	2261CA-2. 5K	252	J-2-69	252	S-IV-3
253	F-E-L16-20-150-80-A-T	2261CA-2. 5K	253	J-2-70	253	S-IV-3
501	F-E-L17-00-120-04-HS	IMHST				S-IV-3
502	F-E-L17-00-120-04-HS	IMHST				S-IV-3
503	F-E-L17-00-120-04-HS	IMHST				S-IV-3
504	F-E-L17-00-120-04- HS	IMHST				S-IV-3
511	F-E-L17-00-120-04-TTT	TTT				S-IV-3
512	F-E-L17-00-120-04-TTT	TTT				S-IV-3
516	F-E-L17-00-120-04-M	Manganin				WES
521	F-E-L17-00-120-04-Y	Ytterbium				WES
522	F-E-L17-00-120-04-Y	Ytterbium				WES
523	F-E-L17-00-120-04-Y	Ytterbium				WES
524	F-E-L17-00-120-04-Y	Ytterbium				WES
525	F-E-L17-00-120-04-Y	Ytterbium				WES
531	F-E-L17-00-120-04-P2T	PZT				S-IV-3
532	F-E-L17-00-120-04-P2T	PZT				S-IV-3

SECTION 9.3

SET-UP TABLES

RCDR 1 VR3700	VCO-1	VCO-2	VCO-3	VCO-4	VCO-5	VCO-6	VCO-7	VCO-8	VCO-9	VCO-10	VCO-11	VCO-12	VCO-13	VCO-14	VCO-15	VCO-16	VCO-17	VCO-18
Trk 1							High Stress 1 MHz Time Base											
Trk 2							High Stress Coded Signal #1											
Trk 3	206		207		208		209		210									
Trk 4							High Stress Coded Signal #2											
Trk 5	211		212		213		214		215									
Trk 6							High Stress Coded Signal #3											
Trk 7	Data Ref		Fidu		IRIG B		216		217									
Trk 8							High Stress Coded Signal #4											
Trk 9	218		219		220		221		222									
Trk 10							High Stress Coded Signal #5											
Trk 11	223		224		225		226		227									
Trk 12							High Stress Mixed Signal											
Trk 13	228		229		230		231		232									
Trk 14	IRIG A		201		202		203		204									

DATA RECORDING CHART FOR S-IV-3

RCDR 2 VR3700	VCO-1	VCO-2	VCO-3	VCO-4	VCO-5	VCO-6	VCO-7	VCO-8	VCO-9	VCO-10	VCO-11	VCO-12	VCO-13	VCO-14	VCO-15	VCO-16	VCO-17	VCO-18
Trk 1	233		234		235		236		237		531		532		514		512	
Trk 2	238		239		240		241		242									
Trk 3	243		244		245		246		247		531		532		514			
Trk 4	248		249		250		251		252									
Trk 5	253		254		255		351		352									
Trk 6	353		354		355		356		357									
Trk 7	Data Ref		Fidu		IRIG B		358		359									
Trk 8	360		361		362		363		364									
Trk 9	365		366		367		205											
Trk 10																		
Trk 11											← 512 →							
Trk 12																		
Trk 13																		
Trk 14	IRIG A																	

DATA RECORDING CHART FOR S-IV-3

RCDR-1A FR600	VCO-1	VCO-2	VCO-3	VCO-4	VCO-5	VCO-6	VCO-7	VCO-8	VCO-9	VCO-10	VCO-11
Trk 1				1	2	3	5	6	7	8	9
Trk 2				4	17	18	10	11	12	13	14
Trk 3				19	20	33	15	16	21	22	23
Trk 4				34	35	36	24	25	26	27	28
Trk 5				37	38	39	29	30	31	32	42
Trk 6				40	41	--	43	44	45	46	47
Trk 7	Data Ref		Fidu		IRIG B						
Trk 8											
Trk 9											
Trk 10											
Trk 11											
Trk 12											
Trk 13											
Trk 14					IRIG A*						
AR-200					Not Scheduled 6/12						
AR-200					Not Scheduled 6/12						

* Trk 14 0 to 20 kc FM Timing Channel

DATA RECORDING CHART FOR S-IV-4

VELOCITY ARRAY

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge		Bridge Completion			Cal Data			Max Bridge Output (MV)	Vcc Set.
			Excitation	Sensitivity	Resistor value	ohm	Trim Pot	Cal ohms	MV	%...		
1	F-E-L01-12-030-40-V-V	4-1A-1-4										
2	F-E-L01-12-030-40-V-H	4-1A-1-5										
3	F-E-L01-20-030-40-V-V	4-1A-1-6										
4	F-E-L01-20-030-40-V-H	4-1A-2-4										
5	F-E-L02-01-030-80-V-V	4-1A-1-7										
6	F-E-L02-01-030-80-V-H	4-1A-1-8										
7	F-E-L02-08-030-80-V-V	4-1A-1-9										
8	F-E-L02-08-030-80-V-H	4-1A-1-10										
9	F-E-L02-12-030-80-V-V	4-1A-1-11										
10	F-E-L02-12-030-80-V-H	4-1A-2-7										
11	F-E-L03-01-030-160-V-V	4-1A-2-8										
12	F-E-L03-01-030-160-V-H	4-1A-2-9										
13	F-E-L03-08-030-160-V-V	4-1A-2-10										
14	F-E-L03-08-030-160-V-H	4-1A-2-11										
15	F-E-L03-12-030-160-V-V	4-1A-3-7										
16	F-E-L03-12-030-160-V-H	4-1A-3-8										
17	F-E-L11-12-090-40-V-V	4-1A-2-5										
18	F-E-L11-12-090-40-V-H	4-1A-2-6										
19	F-E-L11-20-090-40-V-V	4-1A-3-4										
20	F-E-L11-20-090-40-V-H	4-1A-3-5										
21	F-E-L12-01-090-80-V-V	4-1A-3-9										
22	F-E-L12-01-090-80-V-H	4-1A-3-10										
23	F-E-L12-08-090-80-V-V	4-1A-3-11										
24	F-E-L12-08-090-80-V-H	4-1A-4-7										
25	F-E-L12-12-090-80-V-V	4-1A-4-8										
26	F-E-L12-12-090-80-V-H	4-1A-4-9										
27	F-E-L13-01-090-160-V-V	4-1A-4-10										
28	F-E-L13-01-090-160-V-H	4-1A-4-11										
29	F-E-L13-08-090-160-V-V	4-1A-5-7										
30	F-E-L13-08-090-160-V-H	4-1A-5-8										
31	F-E-L13-12-090-160-V-V	4-1A-5-9										
32	F-E-L13-12-090-160-V-H	4-1A-5-10										
33	F-E-L14-40-150-20-V-V	4-1A-3-6										
34.	F-E-L14-40-150-20-V-H	4-1A-4-4										
35	F-E-L15-12-150-40-V-V	4-1A-4-5										
36	F-E-L15-12-150-40-V-H	4-1A-4-6										
37	F-E-L15-20-150-40-V-V	4-1A-5-4										
38	F-E-L15-20-150-40-V-H	4-1A-5-5										
39	F-E-L15-20-150-40-V-T	4-1A-5-6										
40	F-E-L15-40-150-40-V-V	4-1A-6-4										

VELOCITY [illegible]

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge Excitation	Transducer/Bridge Sensitivity	Bridge Completion Resistor ohm	Bridge Completion Resistor ohm	Bridge Completion Trim Pot	Cal Data Peak ohms	Cal Data Peak [illegible]	Cal Data Peak [illegible]	Max Bridge Output (MV)	Acc Set.
41	FE-L15-10-150-40 VH	4-1A-6-5										
42	FE-L16-01-150 80 V-V	4-1A-5-11										
43	FE-L16-01-150 80 VH	4-1A-6-7										
44	FE-L16 08 150-80 V-V	4-1A-6 8										
45	FE-L16 08 150 80 VH	4-1A-6-9										
46	FE-L16-12-150-80 VV	4-1A-6-10										
47	FE-L16-12-150-80 VH	4-1A-6-11										

[illegible]

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge: Excitation	Transducer/Bridge: Sensitivity	Bridge Completion: Resistor ohm	Bridge Completion: Resistor ckt	Bridge Completion: Trim-Pot	Cal Data, Real: ohms	Cal Data, Real: mV	Cal Data, Real: E.U.	Max Bridge Output (mV)	Att Set
351	F-E-L01-00-050-40 BPV	3-2-5-7										
352	F-E-L02-00-050-80 BPV	3-2-5-9										
353	F-E-L03-00-050-160 BPV	3-2-6-1										
354	F-E-L05-00-060-20 BPV	3-2-6-3										
355	F-E-L05-00-060-20 BPV	3-2-6-5										
356	F-E-L06-00-060-40 BPV	3-2-6-7										
357	F-E-L07-00-060-80 BPV	3-2-6-9										
358	F-E-L08-00-060-110 BPV	3-2-7-7										
359	F-E-L09-00-060-160 BPV	3-2-7-9										
360	F-E-L10-00-060-280 BPV	3-2-8-1										
361	F-E-L11-00-090-40 BPV	3-2-8-3										
362	F-E-L12-00-090-80 BPV	3-2-8-5										
363	F-E-L13-00-090-160 BPV	3-2-8-7										
364	F-E-L14-00-150-20 BPV	3-2-8-9										
365	F-E-L14-01-150-20 BPV	3-2-9-1										
366	F-E-L15-00-150-40 BPV	3-2-9-3										
367	F-E-L16-00-150-80 BPV	3-2-9-5										

ACCELERATION AT WL

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge Excitation	Transducer/Bridge Sensitivity	Bridge Completion Resistor ohm	Bridge Completion Resistor ohm	Bridge Completion Trim-Pot	Cal Data Real ohms	Cal Data Real MV	Cal Data Real E.U.	Max Bridge Output (MV)	VCO Set.
201	F-E-L01-01-030-40-A-V	3-1-14-3										
202	F-E-L01-01-030-40-A-H	3-1-14-5										
203	F-E-L01-05-030-40-A-V	3-1-14-7										
204	F-E-L01-05-030-40-A-H	3-1-14-9										
205	F-E-L01-08-030-40-A-V	3-2-9-7										
206	F-E-L01-08-030-40-A-H	3-1-7-1										
207	F-E-L01-12-030-40-A-V	3-1-3-3										
208	F-E-L01-12-030-40-A-H	3-1-3-5										
209	F-E-L02-01-030-80-A-V	3-1-3-7										
210	F-E-L02-01-030-80-A-H	3-1-3-9										
211	F-E-L02-08-030-80-A-V	3-1-5-1										
212	F-E-L02-08-030-80-A-H	3-1-5-3										
213	F-E-L02-12-030-80-A-V	3-1-5-5										
214	F-E-L02-12-030-80-A-H	3-1-5-7										
215	F-E-L11-01-090-40-A-V	3-1-5-9										
216	F-E-L11-01-090-40-A-H	3-1-7-7										
217	F-E-L11-05-090-40-A-V	3-1-7-9										
218	F-E-L11-05-090-40-A-H	3-1-9-1										
219	F-E-L11-08-090-40-A-V	3-1-9-3										
220	F-E-L11-08-090-40-A-H	3-1-9-5										
221	F-E-L11-12-090-40-A-V	3-1-9-7										
222	F-E-L11-12-090-40-A-H	3-1-9-9										
223	F-E-L12-01-090-80-A-V	3-1-11-1										
224	F-E-L12-01-090-80-A-H	3-1-11-3										
225	F-E-L12-08-090-80-A-V	3-1-11-5										
226	F-E-L12-08-090-80-A-H	3-1-11-7										
227	F-E-L12-12-090-80-A-V	3-1-11-9										
228	F-E-L12-12-090-80-A-H	3-1-13-1										
229	F-E-L14-05-150-20-A-V	3-1-13-3										
230	F-E-L14-05-150-20-A-H	3-1-13-5										
231	F-E-L14-08-150-20-A-V	3-1-13-7										
232	F-E-L14-08-150-20-A-H	3-1-13-9										
233	F-E-L14-12-150-20-A-V	3-2-1-1										
234	F-E-L14-12-150-20-A-H	3-2-1-3										
235	F-E-L14-20-150-20-A-V	3-2-1-5										
236	F-E-L14-20-150-20-A-H	3-2-1-7										
237	F-E-L14-40-150-20-A-V	3-2-1-9										
238	F-E-L14-40-150-20-A-H	3-2-2-1										
239	F-E-L15-01-150-40-A-V	3-2-2-3										
240	F-E-L15-01-150-40-A-H	3-2-2-5										

ACCELERATION N-W

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge		Bridge Completion			Cal Data			Max Bridge Output (MV)	VCO Set.
					Resistor		Trim-Pot	Real				
			Excitation	Sensitivity	ohm	ohm		ohms	2V	[illegible]		
241	F-E-L15-08-150-40-A-V	3-2-2-7										
242	F-E-L15-08-150-40-A-H	3-2-2-9										
243	F-E-L15-12-150-40-A-V	3-2-3-1										
244	F-E-L15-12-150-40-A-H	3-2-3-3										
245	F-E-L16-08-150-80-A-V	3-2-3-5										
246	F-E-L16-08-150-80-A-H	3-2-3-7										
247	F-E-L16-08-150-80-A-T	3-2-3-9										
248	F-E-L16-12-150-80-A-V	3-2-4-1										
249	F-E-L16-12-150-80-A-H	3-2-4-3										
250	F-E-L16-12-150-80-A-T	3-2-4-5										
251	F-E-L16-20-150-80-A-V	3-2-4-7										
252	F-E-L16-20-150-80-A-H	3-2-4-9										
253	F-E-L16-20-150-80-A-T	3-2-5-1										
254	F-E-L14-01-150-20-A-V	3-2-5-3										
255	F-E-L14-01-150-20-A-H	3-2-5-5										

ACCELERATION WFES

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge Excitation	Transducer/Bridge Sensitivity	Bridge Completion Resistor ohm	Bridge Completion Resistor ohm	Bridge Completion Trim-Pot	Cal Data Real ohms	Cal Data Real mV	Cal Data Real E.U.	Max Bridge Output (MV)	VCO Set.
276	F-E-L04-12-000-00-A-V											
277	F-E-L04-20-000-00-A-V											
278	F-E-L04-20-000-00-A-H											
279	F-E-L04-20-000-00-A-T											
280	F-E-L04-40-000-00-A-V											
281	F-E-L04-40-000-00-A-H											
282	F-E-L04-40-000-00-A-T											
283	F-E-L04-60-000-00-A-V											
284	F-E-L05-08-060-20-A-V											
285	F-E-L05-08-060-20-A-H											
286	F-E-L05-12-060-20-A-V											
287	F-E-L05-12-060-20-A-H											
288	F-E-L05-20-060-20-A-V											
289	F-E-L05-20-060-20-A-H											
290	F-E-L05-40-060-20-A-V											
291	F-E-L05-40-060-20-A-H											
292	F-E-L06-01-060-40-A-V											
293	F-E-L06-01-060-40-A-H											
294	F-E-L06-01-060-40-A-T											
295	F-E-L06-05-060-40-A-V											
296	F-E-L06-05-060-40-A-H											
297	F-E-L06-08-060-40-A-V											
298	F-E-L06-08-060-40-A-H											
299	F-E-L06-08-060-40-A-T											
300	F-E-L06-12-060-40-A-V											
301	F-E-L06-12-060-40-A-H											
302	F-E-L06-12-060-40-A-T											
303	F-E-L06-20-060-40-A-V											
304	F-E-L06-20-060-40-A-H											
305	F-E-L06-20-060-40-A-T											
306	F-E-L07-01-060-80-A-V											
307	F-E-L07-01-060-80-A-H											
308	F-E-L07-01-060-80-A-T											
309	F-E-L07-08-060-80-A-V											
310	F-E-L07-08-060-80-A-H											
311	F-E-L07-08-060-80-A-T											
312	F-E-L07-12-060-80-A-V											
313	F-E-L07-12-060-80-A-H											
314	F-E-L07-12-060-80-A-T											

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge Excitation	Transducer/Bridge Sensitivity	Bridge Completion Resistor ohm	Bridge Completion Resistor ohm	Bridge Completion Trim Pot	Cal Data Real ohms	Cal Data Real MV	Cal Data Real % F.S.	Max Bridge Output (MV)	VCO Set.
401	F-E-L0A-[illegible]-000-00-P-V											
402	F-E-L0A-12-000-00-P-V											
403	F-E-L0A-20-000-00-P-V											
404	F-E-L0A-40-000-00-P-V											

[illegible]

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge		Bridge Completion			Cal Data			Max Bridge Output (MV)	VCO Set.
					Resistor		Trim-Pot	Cal				
			Excitation	Sensitivity	ohm	ohm		ohms	MV	[illegible]		
426	F-E-L07-01-060(4)-E0-FS-V											
427	F-E-L07-01-060(4)-E0-FS-H											
428	F-E-L07-01-060(4)-E0-FS-45°											
429	F-E-L07-05-060(4)-E0-FS-V											
430	F-E-L07-05-060(4)-E0-FS-H											
431	F-E-L07-05-060(4)-E0-FS-45°											
432	F-E-L07-08-060(4)-E0-FS-V											
433	F-E-L07-08-060(4)-E0-FS-H											
434	F-E-L07-08-060(4)-E0-FS-45°											
435	F-E-L07-12-060(4)-E0-FS-V											
436	F-E-L07-12-060(4)-E0-FS-H											
437	F-E-L07-12-060(4)-E0-FS-45°											
438	F-E-L08-01-060-110-FS-V											
439	F-E-L08-01-060-110-FS-H											
440	F-E-L08-08-060-110-FS-V											
441	F-E-L08-08-060-110-FS-H											
442	F-E-L08-12-060-110-FS-V											
443	F-E-L08-12-060-110-FS-H											

VELOCITY 1/2-S

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge: Excitation	Transducer/Bridge: Sensitivity	Bridge Completion: Resistor ohm	Bridge Completion: Resistor ohm	Bridge Completion: Trim-Pot	Cal Data: Rcal ohms	Cal Data: Rcal 2R	Cal Data: Rcal E.U.	Max Bridge Output (MV)	VCO Set.
101	F-E-L04-30-000-00-V-V											
102	F-E-L04-40-000-00-V-V											
103	F-E-L04-60-000-00-V-V											
104	F-E-L05-20-060-20-V-V											
105	F-E-L05-20-060-20-V-H											
106	F-E-L05-20-060-20-V-T											
107	F-E-L05-40-060-20-V-V											
108	F-E-L05-40-060-20-V-H											
109	F-E-L06-12-060-40-V-V											
110	F-E-L06-12-060-40-V-H											
111	F-E-L06-20-060-40-V-V											
112	F-E-L06-20-060-40-V-H											
113	F-E-L06-40-060-40-V-V											
114	F-E-L06-40-060-40-V-H											
115	F-E-L07-01-060-80-V-V											
116	F-E-L07-01-060-80-V-H											
117	F-E-L07-05-060-80-V-V											
118	F-E-L07-05-060-80-V-H											
119	F-E-L07-08-060-80-V-V											
120	F-E-L07-08-060-80-V-H											
121	F-E-L07-12-060-80-V-V											
122	F-E-L07-12-060-80-V-H											
123	F-E-L07-20-060-80-V-V											
124	F-E-L07-20-060-80-V-H											
125	F-E-L07-40-060-80-V-V											
126	F-E-L07-40-060-80-V-H											
127	F-E-L08-01-060-110-V-V											
128	F-E-L08-05-060-110-V-V											
129	F-E-L08-08-060-110-V-V											
130	F-E-L08-08-060-110-V-H											
131	F-E-L08-12-060-110-V-V											
132	F-E-L08-12-060-110-V-H											
133	F-E-L08-20-060-110-V-V											
134	F-E-L08-20-060-110-V-H											
135	F-E-L09-01-060-140-V-V											
136	F-E-L09-01-060-140-V-H											
137	F-E-L09-08-060-140-V-V											
138	F-E-L09-08-060-140-V-H											
139	F-E-L09-12-060-140-V-V											
140	F-E-L09-12-060-140-V-H											

VELOCITY WFS

Measurement Number	Measurement Designation	Record Code	Transducer/Bridge		Bridge Completion			Cal Data			Max Bridge Output (MV)	Acc Set.
					Resistor		Trim-Pot	Real				
			Excitation	Sensitivity	ohm	ohm		ohms	MV	E.U.		
141	F-E-L10-01-060-280-VV											
142	F-E-L10-01-060-280-VH											

SECTION 9.4

CABLE LAY-OUT

SECTION 9.5

DATA REDUCTION

9.5 DATA PRESENTATION REQUIREMENTS

Because Middle Gust Event I is first of a series of events, the feedback from its test results is very important. The present test schedule makes schedule of report shown in Table 9-1, a rigid time table. A list of transducer types and numbers are shown in Table 9-2.

The general data presentation requirements for Middle Gust Event I are shown in Table 9-3. Data reduction request form is shown in Figure 9-5.1

9.5.1 Summaries

Data summaries as outlined in Table 9-4 are required for all measured parameters.

TABLE 9-1

MIDDLE GUST EVENT I

SCHEDULE OF REPORTS

REPORT		PLACE
TEST EVENT	26 AUGUST 1971	SITE
30-DAY PRELIMINARY REPORT OF RESULTS	27 SEPTEMBER 1971	KAFB
120-DAY FINAL REPORT OF RESULTS	2 DECEMBER 1971	KAFB

TABLE 9-2

MIDDLE GUST EVENT I

TRANSDUCERS

MEASUREMENT	NUMBER
AIR BLAST PRESSURE	16
TOTAL PRESSURE	4
ACCELERATION	94 + (10)
VELOCITY	89
SOIL STRESS	25
PORE PRESSURE	8
IMHST	4
MANGANIN	1
YTTERBIUM	5
THERMOPILE THERMOELECTRIC TRANSDUCER	2
PZT	2
TOTAL	250 (260)

TABLE 9.3

MIDDLE GUST IA

EXPECTED DATA PRESENTATION REQUIREMENTS

ANALOG DATA	A-TO-D CONVERSION & REDUCTION	DATA PRESENTATION
AIR BLAST PRESSURE TIME HISTORIES	———	-Time Histories (Direct) -Time Histories (Smoothed) -Pressure vs. Log Time -Integrated Pressure (Impulse) -Summary -Pressure PSD -TOA Contours -Peak Pressure vs. Range
TOTAL PRESSURE HISTORIES	———	-Time Histories (Direct) -Time Histories (Smoothed) -Pressure vs. Log Time -Peak Pressure vs. Depth
ACCELERATION TIME HISTORIES	———	-Time Histories (Direct) -Integrated Accel. (Velocity) -Double-Integrated Accel.(Displ) -Summary -Superimposed traces @ t_o -Acceleration PSD -Peak accel. vs. Depth & Radius
VELOCITY TIME HISTORIES	———	-Time Histories (Direct) -Integrated Vel (Displ) -Differentiated Vel (Accel) -Summary -Superimposed traces @ t_o -Velocity PSD -Peak Velocities vs. Depth & Radius
SOIL STRESS HISTORIES	———	-Time History -Summary
HIGH PRESSURE HISTORIES (Manganin, Yterbium, PZT, IMIST, TTT)	———	-Time History -Summary
PORE PRESSURE	———	-Time History

REDUCTION REQUEST DATE__________ DATE OUTPUT REQ.__________ PAGE____ OF______

EVENT______________________________ PB SPEED________________ REC SPEED________________

TIME CODE____

CALIBRATION SAMPLE RATE____________ TIME: START______________ STOP________________

____

TIME ZERO____

STANDARD MEASUREMENT DESIGNATION	STANDARD RECORD CODE	LOW PASS FILTER	DATA			OUTPUT COMMENTS
			SAMPLE RATE	START TIME	STOP TIME	

Figure 9-5.1 DATA REDUCTION REQUEST FORM

TABLE 9-4

MIDDLE GUST EVENT I

TYPICAL SUMMARY OF DATA

The following entries should be summarized for all measurements of any one type:

1. Measurement Number
2. Recording Code (Tape Recorder, Track No., and Channel No.)
3. Peak Parameter Value (Direct and Smoothed if applicable)
4. Time of Arrival
5. Time to Peak
6. Duration
7. Integrated Peak(s)
9. Remarks

AD-A061 115 AIR FORCE WEAPONS LAB KIRTLAND AFB N MEX F/G 18/3
MIDDLE GUST INSTRUMENTATION PLAN.(U)
JUL 71

UNCLASSIFIED SBIE-AD-E200 209 NL

3 OF 3
ADA
061115

END
DATE
FILMED
2 79
DDC

SECTION 9-6

TIMING AND FIRING

9.6 MIDDLE GUST EVENT I TIMING REQUIREMENTS

Figures 9.6.2 indicates the timing requirements for Event I. The event times will be furnished in the form of an isolated closure from the S-IV-3 Instrumentation Van countdown sequencer. Fiducial and IRIG timing will also be distributed from Van S-IV-3.

EVENT TIME		MAIN CAMERA STATION	SAMSO VAN #3	SAMSO VAN #4	WES VAN	WEST CAMERA STATION	EAST CAMERA STATION
INITIATE	DROP						
-3 Min	T-0	X					
-30 Sec			X	X	X		
-2 Sec					X	X	X
-1 Sec					X		
FIDU		X	X	X	X		
+1:30 Sec			X	X			
IRIG A			X	X	X		
IRIG B			X	X	X		

*Voice count provided to all instrument trailers.

Figure 9-6.1 EVENT I TIMING REQUIREMENTS

SECTION 9.7

EXPERIMENTS

9.7.1 DRI: Dynamic Ejecta Investigations

DRI will record using optical instrumentation, and will analyze early, intermediate, and late time fireball and explosive phenomena. This will include fireball and shock wave expansion, time resolved spectra, time-integrated spectra, and cloud formation and rise.

There are to be five camera positions:

1. Main Camera Position (MCP)
2. East Camera Position (ECP)
3. West Camera Position (WCP)
4. Technical Observation Point (TOP)
5. Cloud Observation Point (COP)

Camera Locations:

A. The MCP will be located approximately 3,000 feet from ground zero (G_z), southeast. Approximately 13 cameras will be located at this station. This station will be as near perpendicular to the Waterways Ejecta Ribbons (Southwest for Event 1).

B. The ECP will be located approximately 3,000 feet from G_z, near perpendicular to line-of-sight of MCP. One camera will be located at this station.

C. The WCP will be located approximately 3,000 feet from G_z, near 180 degrees from ECP. One camera will be located at this station.

D. The TOP should be positioned approximately 10,000 feet from G_z to the southeast. Four cameras will be located at this station.

E. The COP should be positioned approximately 10,000 feet from G_z at 120° to the wouthwest from TOP. One camera will be located at this station.

9.7.2 AFWL/DEV-S: Structural Investigations

A need exists for testing the motion response of Minuteman type structures in a layered medium of clay-over-shade. For Event I, launch tubes of approximately 1/4 scale and with no instrumentation will be tested. These structures will be located as shown in the Test Bed Drawing in Section 9.1.

The 1/4 scale launch tubes will be constructed of concrete culvert pipes, having an inside diameter of 3 feet and a nominal length of 14 feet.

9.7.3 BOEING: Postshot Relaxation Measurements

This experiment is intended to supplement the basic field experimental program of permanent tilt measurements on the Middle Gust test event I with an active instrumentation system. This instrumentation system consists of gages that will measure the postshot relaxation of selected structures as a function of time. Monitoring of the gages will begin immediately after the detonation. The system will be operating at the time of the test and the first recording of all gage outputs will have been completed within (3) minutes after zero time. In addition to tilt data to be obtained in locations inaccessible to passive surveying techniques at early times. Tilt measurements will be made on the instrumented structures which are located as shown in the Test Bed Drawing in Section 9-1.

Data resulting from this technique will provide information not otherwise obtainable. The early-time relaxation data will provide tilt measurements from gages at different depths. Active tilt gage measurements in vents PRAIRIE FLAT, MINE ORE, and MINERAL ROCK indicated that there can be a significant change in tilt the first few minutes after an event. Results from these events indicate that relaxation magnitudes represent up to 50 percent of the maximum recorded permanent tilt, even in a hard rock medium.

The operation of this active system is independent of the passive measurements and would not interfere in any way with the conduct of the basic program.

The object of this program is to actively measure the postshot relaxation of vertical rigid structures emplaced in the geological medium of the MIDDLE GUST test series. Angular relaxation of selected structures will be monitored as a function of time, beginning immediately after detonation and continuing for at least 48 hours.

9.7.4 AFWL CABLE TESTS

The purpose of conducting cable tests on this event is to determine the requirements for a low noise, and economical cable that will survive the environment of tests such as Middle Gust.

The objective of the cable test on Event I is to determine which cable of five different types selected is the best to use in the Middle Gust environment. The five types of cable to be tested are: 1) Belden 8434, 4 conductor; 2) Sandia white 4 conductor; 3) Rivere 4 conductor; 4) Belden 8777, 6 conductor; and 5) Rivere 7 conductor.

The cables under test will be run in and out of the test bed area as shown in Figure 9.7.1 The reason for routing the cable in this manner is to have the 350 ohm bridge circuit outside of the test bed area, which will cause the cable to be exposed to the shock wave first.

The test cables will be placed in existing cable trenches and instrumentation holes. The cable routing plans are detailed in Figures 9.7.2, 3, 4, and 5.

The bridge circuit configuration on all four conductor cables will be a four arm 350 ohm bridge, connected as shown in Figure 9.7.6. The six and seven conductor cables are also connected to a four arm 350 ohm bridge circuit as shown in Figures 9.7.7 and 8. The seven conductor cable, has an extra line attached to the output leg, which should help reduce noise generated on one of the cal leads. Signal conditioning and recording of cable noise data will be in van S-IV-3. A block diagram of the instrumentation system S-IV-3 is shown in Figure 9.7.9.

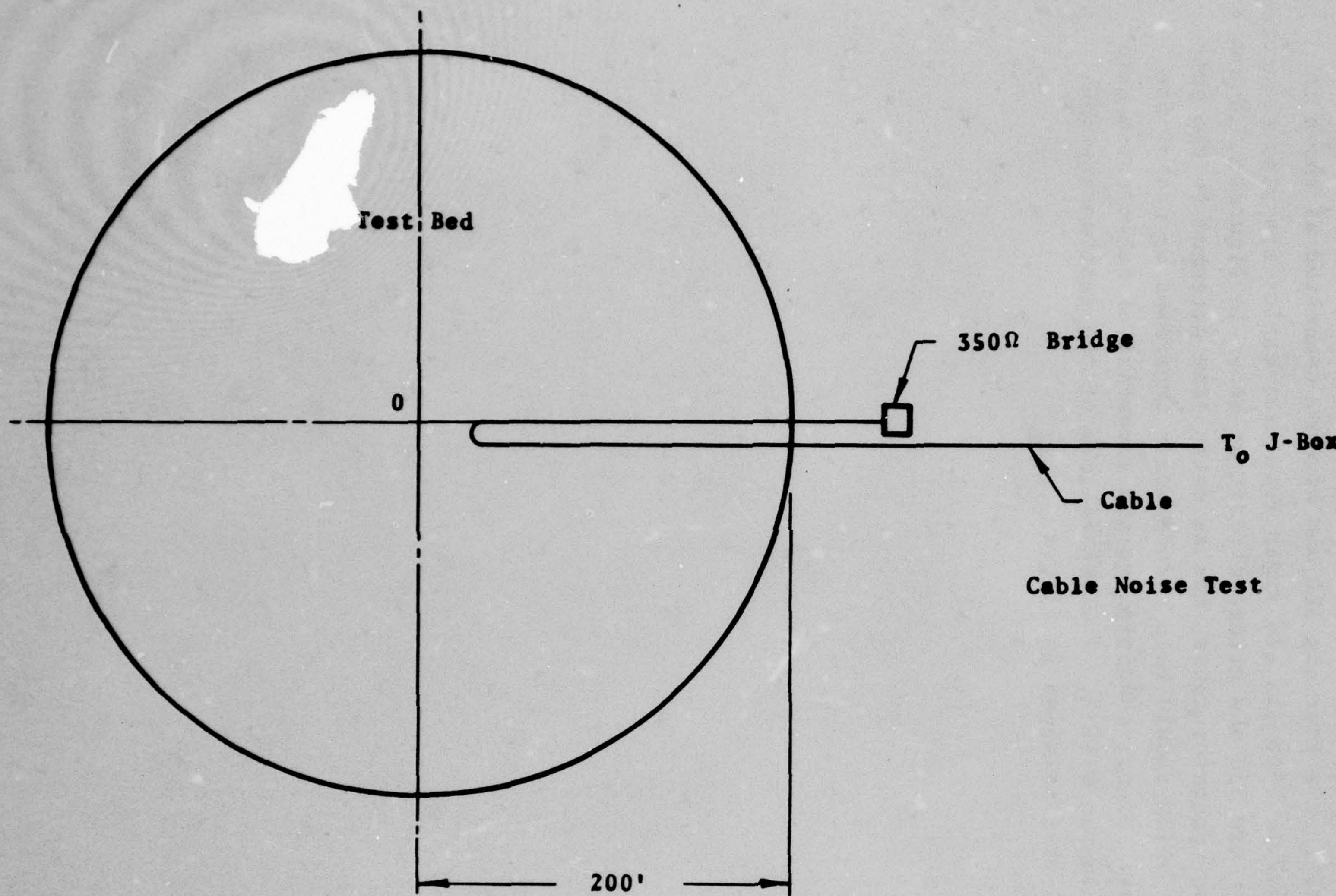


Figure 9.7.1 CABLE ROUTING IN TEST BED AREA

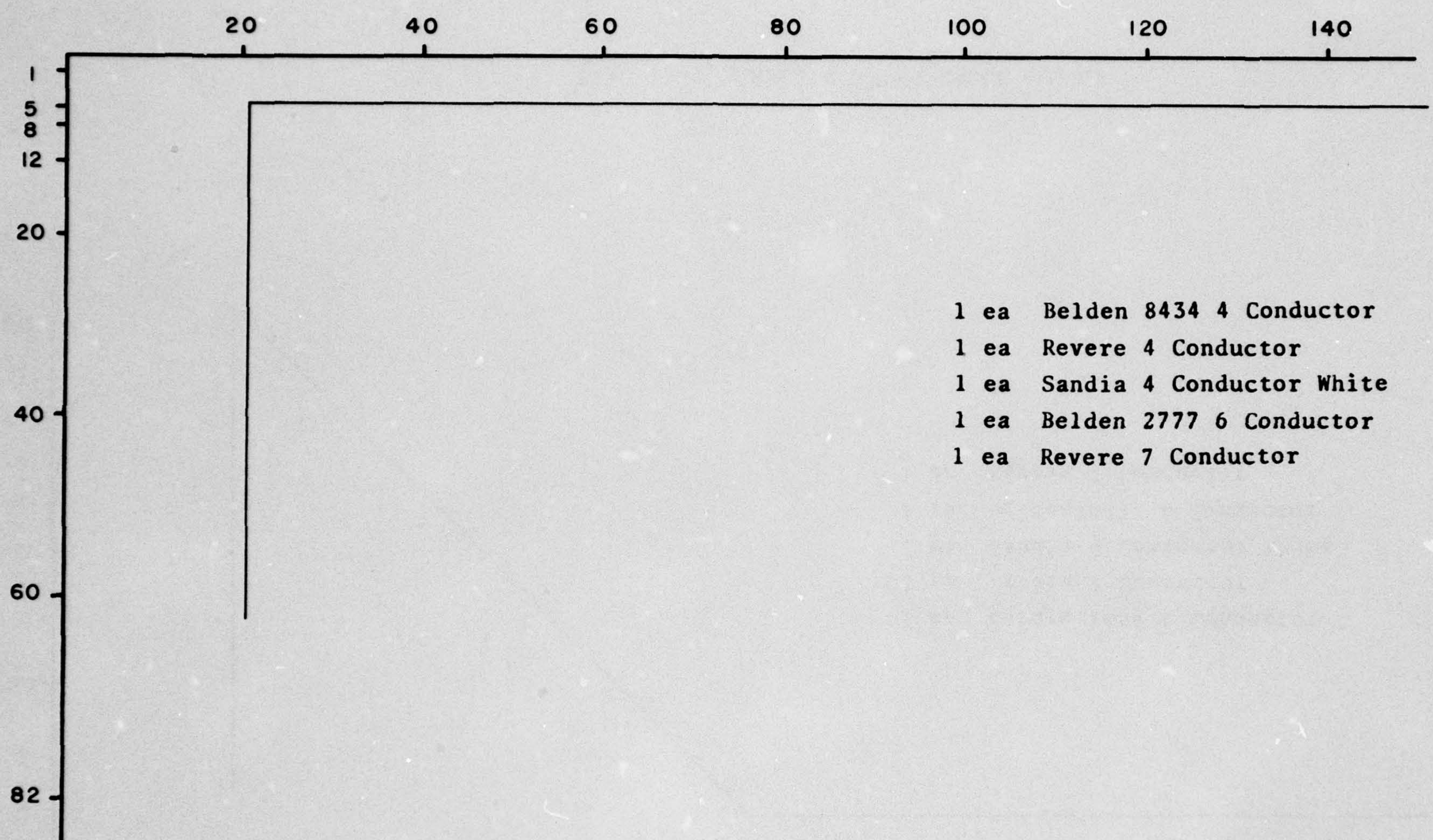


Figure 9.7.2 CABLE ROUTING CABLE NOISE

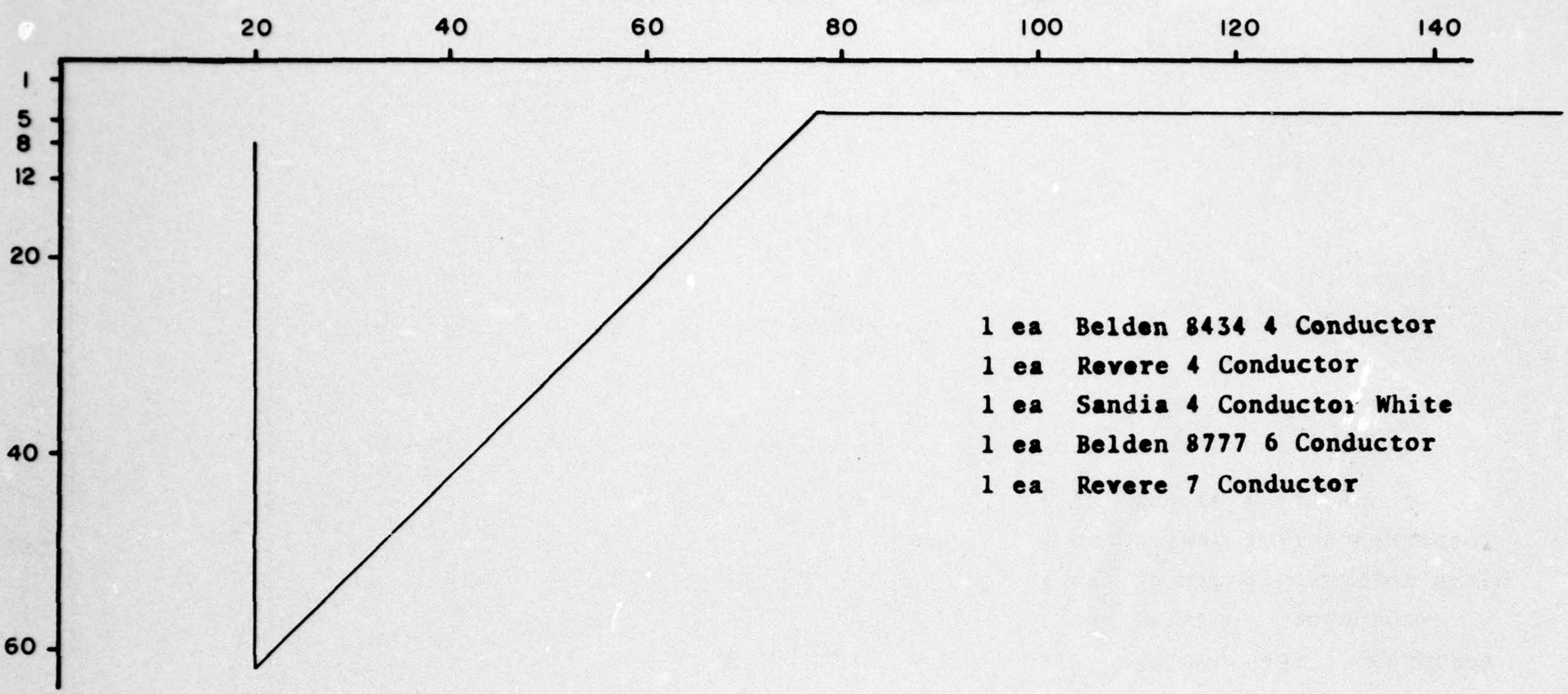


Figure 9.7.3 CABLE ROUTING CABLE NOISE

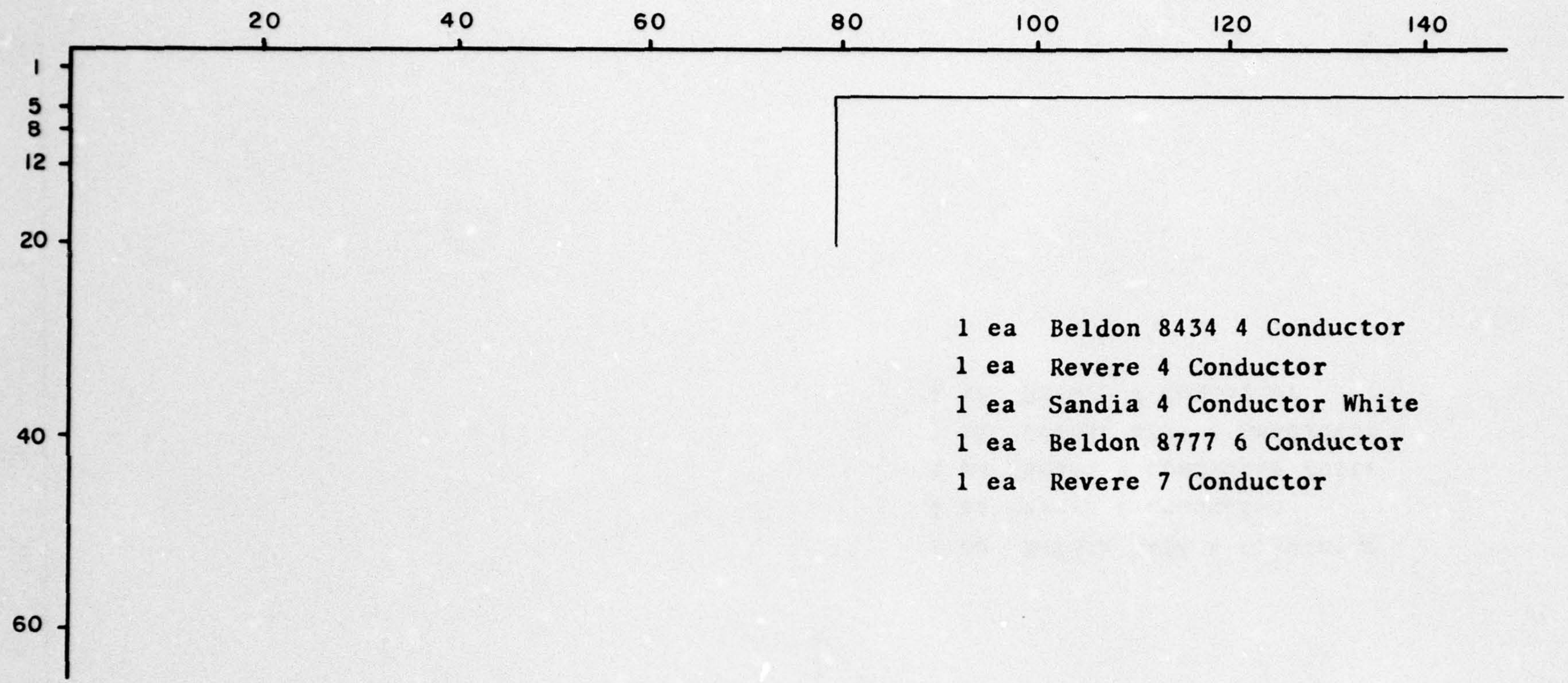


Figure 9.7.4 CABLE ROUTING CABLE NOISE

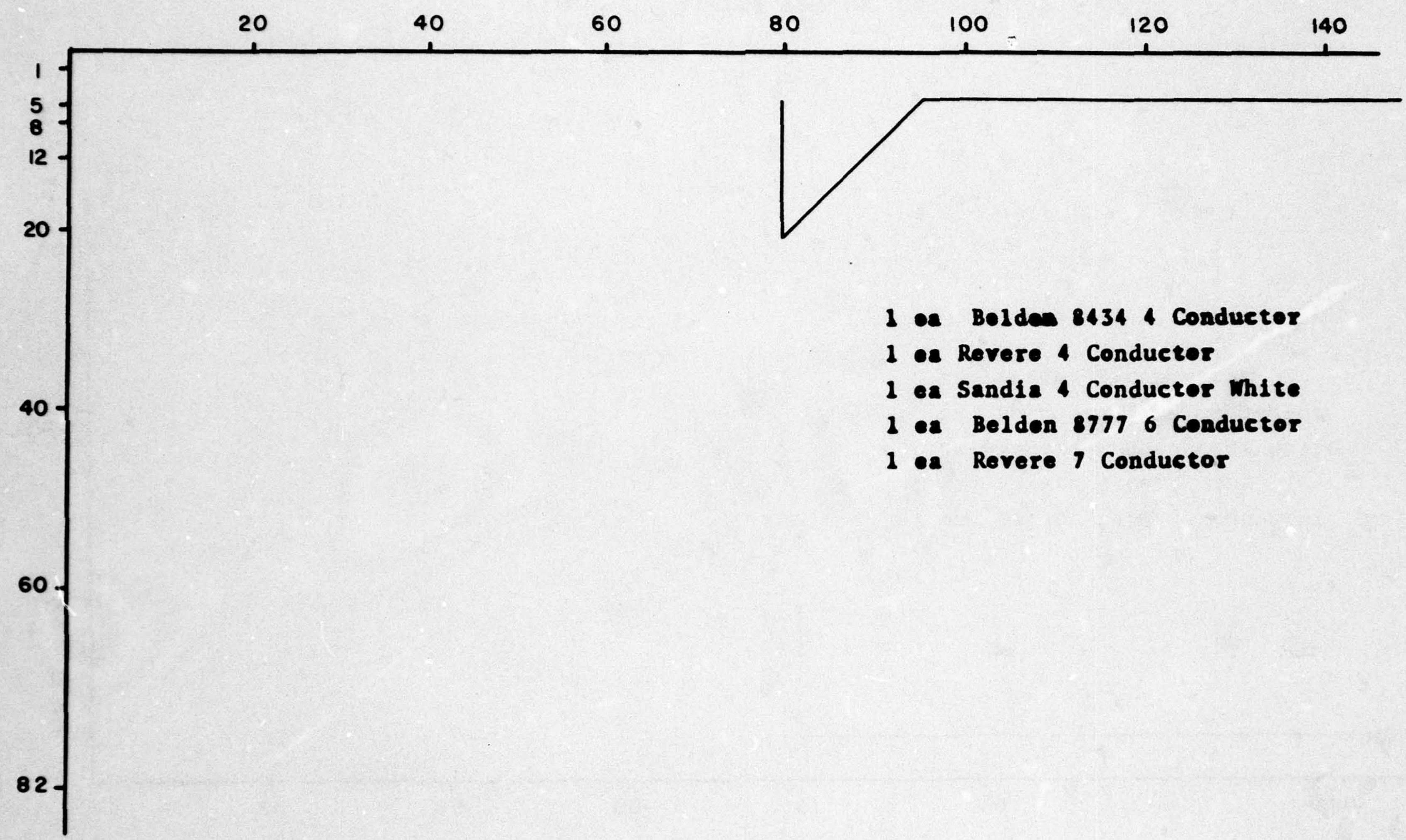


Figure 9.7.5 CABLE ROUTING CABLE NOISE

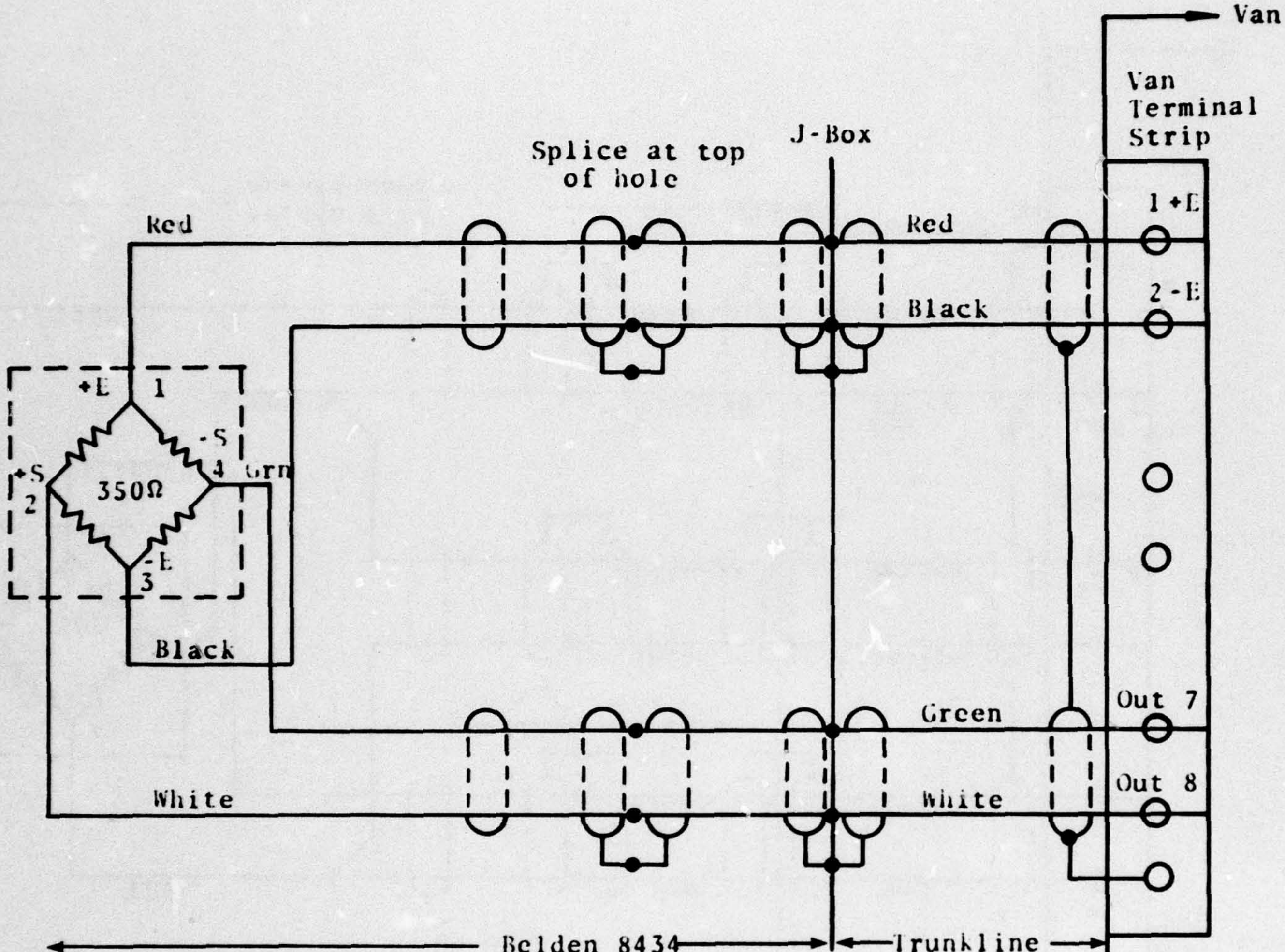


Figure 9.7.6 SANDIA WHITE 4 CONDUCTOR
REVERE 4 CONDUCTOR

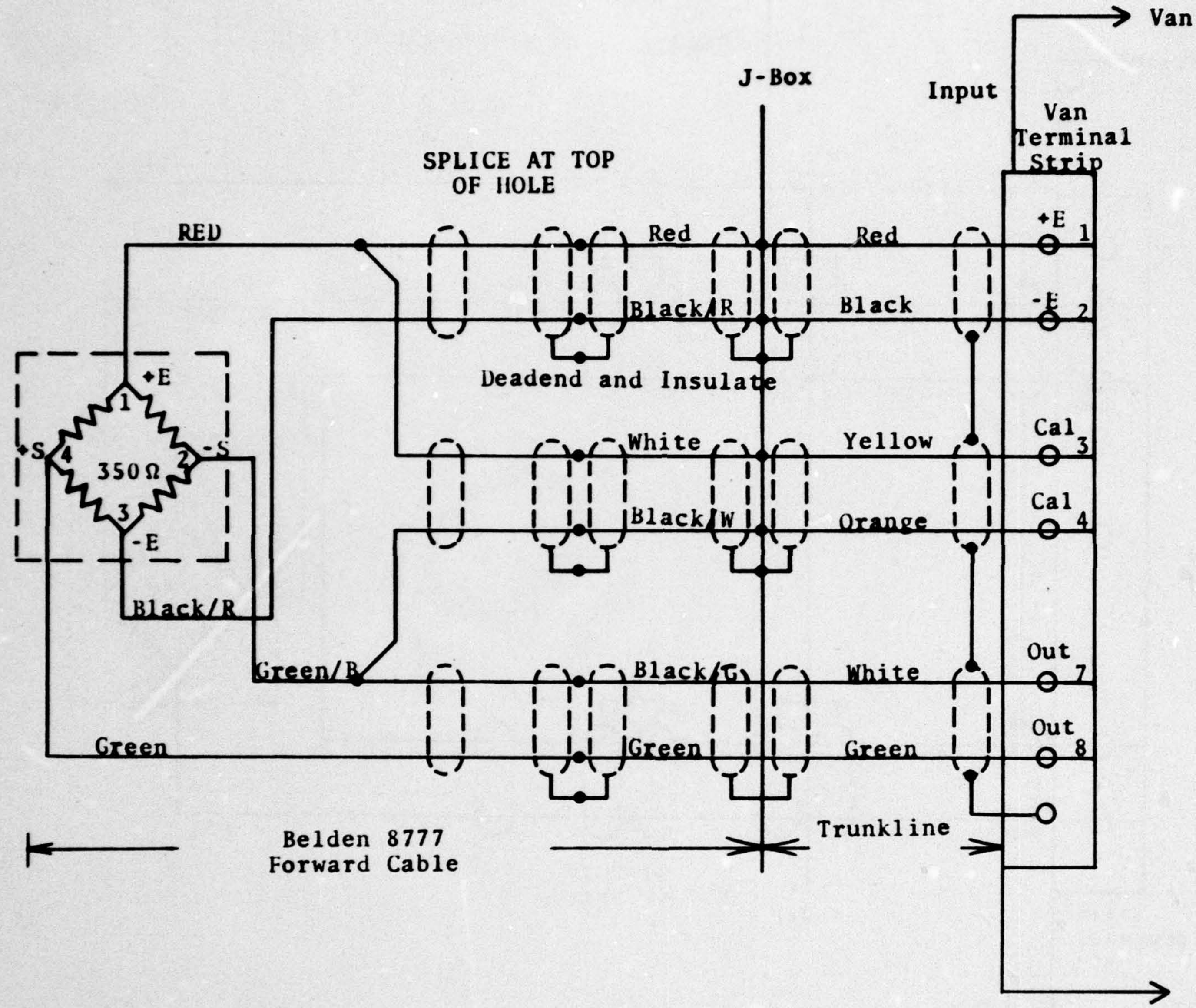


Figure 9.7.7 Belden 8777, 6 Conductor Cable

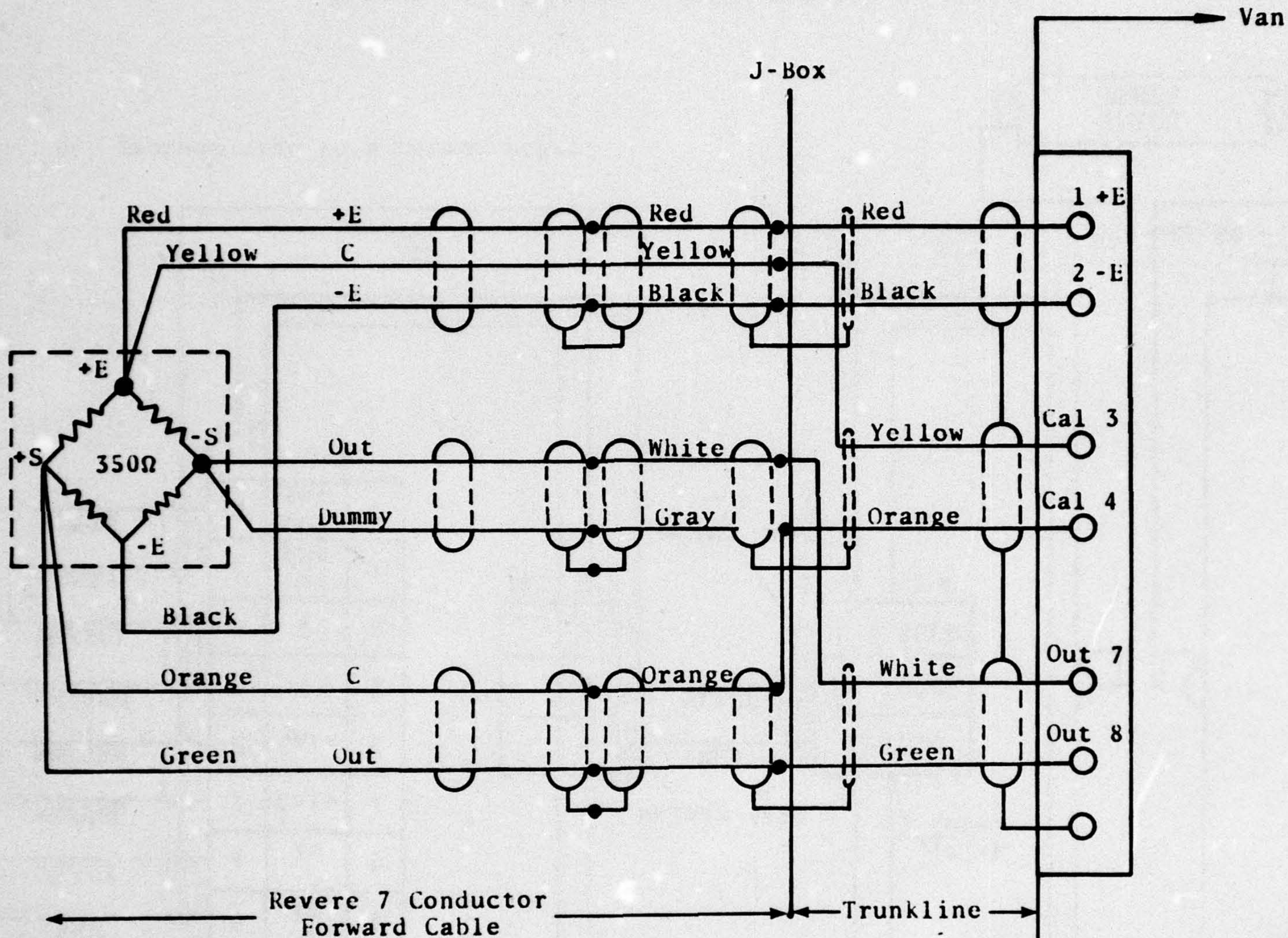
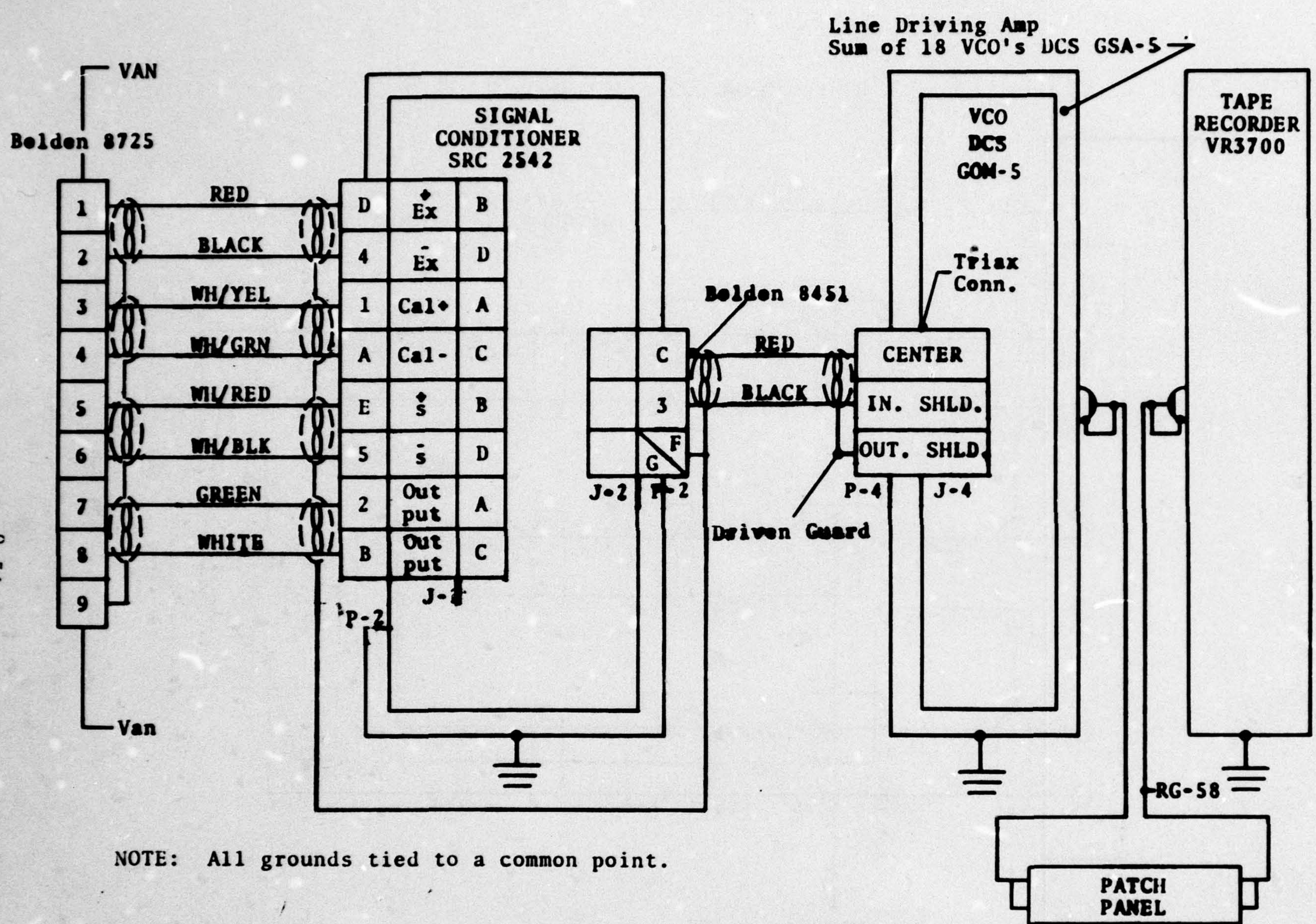


Figure 9.7.8 REVERE 7 CONDUCTOR CABLE



NOTE: All grounds tied to a common point.

Figure 9.7.9 INSTRUMENTATION DIAGRAM (8 WIRE)