ETS-1

CONSOLE OPERATIONS MANUAL

LEAD INSTRUMENTATION ENGINEER
LIE

NTO-T-0005

MASTER

NERVA Test Operations
Nuclear Rocket Development Station
Jackass Flats, Nevada

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CONTROL ROOM CONSOLE LAYOUT

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LIST OF ABBREVIATIONS

A&E	Administration & Engineering Building
AFEL	Assistant Facility Engineer - Left
AFER	Assistant Facility Engineer - Right
ASE	Assistant Stand Engineer
ATE	Assistant Test Engineer
AUTO	Automatic
CAL	Calibration
CDC	Control Data Corporation
CLC	Checklist Commentator
CP	Control Point
CTE	Chief Test Engineer
DDS	Digital Data System
DL	Data Link
DTD	Deputy Test Director
FEL	Facility Engineer - Left
FER	Facility Engineer - Right
GFS	Gas Fill & Service Console
Hz	Hertz (Cycles per Second)
IPS	Inches per Second
KMHz	Kilo-Mega-Hertz (1,000,000,000 cycles per second)
LFE	Lead Facility Engineer
LIE	Lead Instrumentation Engineer
LRE	Lead Reactor Engineer
LSE	Lead Safety Engineer
MCC	Master Control Console
MTR	Magnetic Tape Recorder Panel
RIC	Remote Installation Console
RRO	Remote Recorder Operator's Panel
RTT	Resistance Temperature Transducer
SEL	Systems Engineering Laboratories
S/S	Samples-per-Second

TCB	Test Cell Building
TD	Test Director
TDC	Test Diagnostic Center
TNC	Temporary NES Console
TSE	Test Stand Engineer
TTY	Teletype

I. INTRODUCTION

The Lead Instrumentation Engineer (LIE) console contains the controls and indications necessary to operate the data acquisition system during a test run. The LIE controls the system from controls on the LIE console and by voice commands to operators at the Remote Recorder Operator's Panel (RRO), the Magnetic Tape Recorder Panel (MTR), and the Digital Data System Console (DDS). In addition to relief operation of the LIE console during Test Operations, the alternate LIE operator will be responsible for operation of the ETS-1/A&E Data Link Teletype Console, and setup and operation of the ETS-1 Test Diagnostic Center.

II. PURPOSE

The purpose of this manual is to describe in detail the functions of the controls on the control consoles and panels associated with the Data Acquisition System, the ETS-1/A&E Data Link, and the ETS-1 Test Diagnostic Center. It describes in general the systems being controlled and discusses the system operational philosophy.

An operations manual of this type is subject to constant revision, both to increase the depth of coverage, and later to reflect changes in equipment or operating procedure. Each of the LIE operators who qualify to operate this console will be required to up-date this manual in light of new information.

III. LIE CONSOLE CONTROLS AND INDICATORS

A. Console Controls

The LIE console, shown in Figure III-1, contains five types of controls: calibration controls, calibration mode inhibit/enable switches, strip chart recorder start/stop switch, jump speed selector switch, and console power switch.

1. Calibration Controls. The lower right panel of the LIE console contains controls for placing electrical calibration signals on all measurement channels in the system which are not inhibited. The individual controls and their functions are as follows:

a. Mode Control Switch. This switch selects either the NORMAL or CALIBRATE modes of operation. The NORMAL mode allows all signals to travel from the transducer to the end recording or indicating devices in a normal uninterrupted path. The CALIBRATE mode interrupts this normal signal path at the signal conditioner and interjects circuitry to electrically simulate the output of the transducer at the 0, 25, 50, 75, and 100% of full scale stimulus levels. This switch is a switch light which indicates whether the switch is in the NORMAL or CALIBRATE mode.

b. Calibration Level Selectors. These controls are switch lights which select a given calibration level (0, 25, 50, 75, or 100%) and indicate which level has been selected. These controls are used to manually calibrate the system.

c. Auto Cal Start Switch. This switch energizes circuitry which automatically steps through the five calibration level steps sequentially

from zero to 100%. The switch is a switch light which indicates whether the auto calibration is IN PROCESS or OFF. The lights on the individual calibration level selector switches indicate which step in the sequence is energized during the auto calibration sweep.

2. Calibration Mode Inhibit/Enable Switches. The lower right hand panel contains eleven switch lights which are labeled INHIBIT on top and ENABLE on the bottom as shown below.

Five control consoles in the Control Room also have an inhibit/enable switch. The function of those switches is to prevent groups of channels from calibrating when the data acquisition system is operating in the CALIBRATE mode. There is one switch on the LIE console for each of the control consoles in the CP. The switch on the LIE console is wired in a series permissive circuit with the switch on the corresponding control console. That is, both switches have to be in the ENABLE position before the channels on the control console can calibrate. If either or both switches are in INHIBIT, the console channels cannot calibrate. The light logic on the LIE console inhibit/enable switches is such that the right half of the switch light will indicate the position of the LIE console switch, and the left half will indicate the position of the corresponding control console switch.

3. Strip Chart Recorder Start/Stop Switch. This switch is located in the lower right hand corner of the inhibit/enable switch matrix. Its function is to start and stop all of the eight channel recorders, single channel strip chart recorders, and oscillograph recorders. This switch has three positions: ready, start, and stop. The READY position indicates that the recorders are in the remote position and power is on. The switch must be in the READY position before switching to the START position. It cannot be switched directly from STOP to START. The switch is a switch light which indicates the switch mode.

4. Jump Speed Selector Switch. This switch is located below and to the left of the inhibit/enable switch matrix. Its function is to change the speed of the strip chart and oscillograph recorders from preset low speeds to preset high speeds. With the exception of the eight-channel Beckman recorders G and H, the low and high preset speeds for the various recorders in the recorder room are selected by switches located in the back of the Remote Recorder Panel. The low and high preset speeds for recorders G and H, located in the recorder room, are selected from a panel in the back of the LIE console. The Jump Speed Selector Switch is a switch light which indicates whether the switch is in the LOW or HIGH position.

5. Console Power Switch. This switch has three positions: off, indicator test, and power on. In the OFF position, no power is applied to the console and no indicator lights will be lighted. The INDICATOR TEST position applies power to the indicator lights, and the POWER ON position applies power to the control switch functions.

B. LIE Console Indications

The upper right panel of the LIE console contains indicator lights which show the status of the strip chart, oscillograph, analog tape and digital data system recorders. These indications show whether the system is ready or running. This panel also contains two signal conditioning status indications. The ALL CHANNELS READY light is lit when all of the signal conditioner rack remote/local switches are in the REMOTE calibration mode. This condition must be met before the channel can be calibrated from the LIE console. The CAL. CONTROL ACQUIRED light is lit when the Test Cell Building Master Calibration Panel local/remote switch is in the REMOTE position. This condition must exist before the system can be calibrated from the LIE console. The upper left hand panel of the LIE console contains indicator lights which indicate the status of the timing system. The lower left hand panel of the LIE console contains two communications panels. One of the panels is used to monitor the Operations Net and one is used to monitor the Data Net.

FIGURE III-1

LEAD INSTRUMENTATION ENGINEER CONSOLE

FOR TRAINING USE ONLY

IV. REMOTE RECORDER OPERATOR'S PANEL (RRO)

The RRO panel, shown in Figure IV-1, is located in the recorder room in Rack 10R01. The function of this panel is to locally control the Beckman 8-channel strip chart recorders, the Midwest oscillographs in the recorder room, and the L & N single channel strip chart recorders in the Control Room. For each individual recorder, the panel contains an on/off switch and a running/ready switch. The on/off switch applies power to the recorder, and the running/ready switch starts (Running Position) and stops (Ready Position) the chart drive mechanism. For each group of recorders (i.e. Beckman 8 channel, oscillograph, or L & N single channel) there is a group start/stop switch which will simultaneously start or stop the chart drive mechanism for all recorders in the group which have power applied and are in the READY mode. Also, for each group, there is a group hi/low switch which will simultaneously change the chart speed of all recorders in the group. The high and low speeds are preset for each recorder by switches located on the back of the RRO panel. The panel also contains a master on/off switch which controls power to the panel.

PAPER CHART RECORDER CONTROL TYPE CC-271

PAPER CHART RECORDER
CONTROL PANEL

IV-2

FIGURE IV-1

V. MAGNETIC TAPE RECORDER PANEL (MTR)

The MTR panel, shown in Figure V-1, is located in Rack 10R02 and contains the controls to remotely control the Ampex analog tape recorders. For each tape recorder the panel contains the following switches:

1. Power On/Off Switch - controls ac power to the tape recorder.
2. Record Switch - places the recorder in the RECORD mode.
3. Drive Switch - starts the tape transport drive mechanism and brings it to the preselected recording speed.
4. Fast Forward Switch - drives the tape transport to high speed in the forward direction.
5. Fast Reverse Switch - drives the tape transport to high speed in the reverse direction.
6. Stop Switch - stops the tape transport.

The panel also contains a master record/stop switch which will simultaneously put all recorders in the record mode and drive the tape transports to the preselected recording speed for all recorders with power applied. This panel also contains controls for voice annotating the analog tapes.

MAGNETIC TAPE RECORDER
CONTROL PANEL

FIGURE V-1

VI. EVENTS RECORDER REMOTE CONTROL PANELS

There are two control panels located in 10R01 in the recorder room which remotely control the start/stop and chart speed of the two Brush event strip chart recorders. One of the events remote control panels is shown in Figure VI-1.

The events recorders are operated by the RRO under the direction of the LIE. The chart speed is selected by push-button control and may be changed at any time. There are lights on the panel to indicate the remote/local status of the recorders, the status of the recorder interlock wiring, and whether or not the recorder chart drive mechanism is operating.

FIGURE VI-1

VII. DIGITAL DATA SYSTEM (DDS) MASTER CONTROL CONSOLE (MCC)

The DDS Master Control Console is located in the recorder room and controls the operation of the two digital subsystems. Figure VII-1 shows the front panel layout. The controls and indications on this console are as follows:

1. Recording Mode Controls. There are three modes of recording digital data which are selected by a mode control switch on the MCC. These modes are as follows:

- a. Multiple. With the mode control switch in the MULTIPLE position, the DDS will record the number of frames of digital data selected by the NO. OF FRAMES switch on the DDS and then stop. The number of frames which may be selected by the NO. OF FRAMES switch are 1, 4, 16, and 64.

- b. Continuous. With the mode control switch in the CONTINUOUS position the DDS will record all data inputed to the system continuously.

- c. Periodic. With the mode switch in the PERIODIC position the DDS will record one frame of data at the time intervals selected by the FRAME RATE control on the MCC. The intervals available are 1 second, 10 seconds, and 100 seconds.

FIGURE VII-1

VIII. SYSTEMS DESCRIPTION

A brief description of the systems controlled by the LIE during a test will be given in the following paragraphs.

A. Signal Conditioning System

The signal conditioning system consists of the following major components and subsystems:

1. Passive Signal Conditioners. These conditioners contain excitation power supplies to supply excitation voltage to passive transducers such as strain gage type transducers and RTT's. This module also contains circuitry for bridge completion (if necessary), resistive shunt or substitution calibration, and the necessary zero and ranging controls to set-up the channel.

2. Active Signal Conditioners. These conditioners are used in conjunction with self voltage generating transducers such as thermocouples. The modules contain circuitry for zero offset, and voltage substitution calibration.

3. Amplifiers. The system contains narrow band (DC to 100 Hz) and wide band amplifiers (DC to 10,000Hz) which amplify the signals from the signal conditioners to suitable voltage levels for entry into the data recording systems.

4. Calibration System. The calibration system electrically simulates, in the signal conditioner or signal conditioner - transducer

combination, the 0, 25%, 50%, 75% and 100% of full scale transducer output signal. This system is controlled from three different points as follows:

a. Rack Calibration Panel. Each rack of signal conditioners has a calibration panel which permits the application of any of the five calibration levels to all signal conditioners in the rack. The local/remote switch on this panel must be in the LOCAL position for individual rack operation and in the REMOTE position for operation from either the Test Cell Building Master Calibration Panel or the LIE console. The ALL CHANNELS READY light on the LIE console is lit only when all of the rack calibration panel local/remote switches are in the REMOTE position.

b. Test Cell Building (TCB) Master Calibration Panel. The controls on this panel may be used to either manually or automatically calibrate the entire system from the TCB. The local/remote switch on this panel must be in the LOCAL position to calibrate from the TCB. The local/remote switch on this panel must be in the REMOTE position to permit operation from the LIE console. When this switch is in the REMOTE position, the CAL CONTROL ACQUIRED light on the LIE console is lighted.

B. Digital Data System

This system is controlled by an operator at the DDS Master Control Console, who in turn is directed by voice command from the LIE. The system consists of two 480-channel pulse code modulated digital subsystems. Each subsystem is a sampled system containing two 80-channel 10-samples-per-second (S/S) low level (0-100 millivolt) multiplexers, two 120-channel 10-S/S high level (0-5 volt) multiplexers, one 40-channel 50-S/S high level multiplexer, and two 20-channel 100-S/S high level multiplexers. The signals sampled by the multiplexers are converted from analog-to-digital, assembled into a specific format, and recorded on magnetic tape.

C. Analog Tape Recording System

The Ampex analog tape recording system consists of four 32-track tape recorders and one 14-track tape recorder. These recorders are used primarily to record wide band data. The frequency response for the Analog Tape Recording system is 0-10,000 Hz. The normal signal path for this data is from the transducer to a signal conditioner, then to a wide band amplifier, and finally to the tape recorder. The recording speeds available are 1-7/8 inches per second (ips), 3-3/4 ips, 7-1/2 ips, 15 ips, 30 ips, and 60 ips. This system is controlled by an operator at the Magnetic Tape Recorder Panel who in turn is controlled via voice command from the LIE.

D. Oscillograph Recording System

The Midwestern oscillograph recording system consists of three 50-channel optical oscillographs. These channels are used primarily to record wide band data via the signal path described in Section VIII-C. These recorders are also used to record narrow band data which originates in the transducer, goes to the signal conditioner, to a narrow band amplifier, and to the recorder. The frequency response of the narrow band amplifier is 0-100 Hz. The chart speeds available are 0.1 inches per second (ips), 0.2 ips, 0.4 ips, 0.8 ips, 1 ips, 2 ips, 4 ips, 8 ips, 18 ips, 10 ips, 20 ips, 40 ips, 80 ips, and 180 ips. However at speeds in excess of 40 ips the Midwestern oscillographs tend to have an erratic pull which tears the paper. This system may be controlled by the LIE from a switch on the LIE console or by voice command from the LIE to an operator at the RRO panel.

E. Beckman Eight-Channel Strip Chart Recorders

This system consists of eight 8-channel Beckman recorders used to record narrow band data. The chart speeds available are 0.1 centimeters per second (cm/sec), 0.2 cm/sec., 0.5 cm/sec., 1.0 cm/sec., 2.5 cm/sec., 5.0 cm/sec., 12.5 cm/sec., and 25 cm/sec. The same numbers of speed settings are available in millimeters per second. This system may be controlled by the LIE from a switch on the LIE console or by voice command to an operator at the RRO panel. Frequency response of these recorders is 0 - 100 Hz.

F. I&N Single-Channel Strip Chart Recorders

This system consists of eighteen Leads and Northrup single-channel recorders used to record and monitor critical test data in the Control Room. The chart speeds available are 0.1 inches per second (in/sec) and 0.3 in/sec. Different speeds may be selected by changing gears and motors in the recorder. This system may be controlled either by the LIE from a switch on the LIE console or by voice command to the RRO. The frequency response of these recorders is 0 - 1 Hz.

G. Sanborn Eight-Channel Strip Chart Recorders

This system consists of two 8-Channel Sanborn Recorders used to record narrow band data. The chart speeds available are 0.5 millimeters per second (mm/sec.), 1.0 mm/sec., 2.5 mm/sec., 5.0 mm/sec., 10 mm/sec., 25 mm/sec., and 50 mm/sec. This system is controlled by an operator at the recorders who in turn is commanded via voice from the LIE or from the recording room engineer. Frequency response of these recorders is 0-50 Hz.

IX. LIE CONSOLE OPERATIONAL PROCEDURE

The LIE performs three major functions during a test run. These are: calibration, recorder operation, and malfunction detection. Malfunction detection is included in Section X.

A. Calibration

When the Test Director calls for a system calibration, the following operations must be performed:

1. Switch all Control Consoles to ENABLE.
2. Switch all LIE inhibit/enable switches to ENABLE.
3. Switch the mode switch to the CAL. position.
4. Switch the strip chart and oscillograph recorders ON
HIGH SPEED.
5. Command the RRO and the DDS operators to turn their recorders ON. (DDS to MULTIPLE 64 FRAMES)
6. When the DDS operator indicates that the DDS is ready for calibration, switch the auto calibration start switch to the IN PROCESS position.
7. When the DDS operator indicates that his tapes have stopped and the auto calibration start switch indicates OFF, turn the strip charts to LOW speed and OFF, command the RRO to turn off the analog tape recorders and return the mode switch to the NORMAL position.

CAUTION

IF THE MODE SWITCH IS NOT RETURNED TO THE NORMAL POSITION, ALL DATA WILL BE LOST DURING THE TEST RUN.

8. Return the LIE inhibit/enable switches to the INHIBIT position.
9. Return the Control Consoles to INHIBIT.

B. RECORDERS ON--RECORDERS HIGH--RECORDERS LOW--RECORDERS OFF

When the Test Director gives any of the above commands, the LIE must simultaneously operate the controls on his console for the strip chart and oscillographs and give voice commands to the RRO and DDS operators. Prior to each test the LIE must brief the RRO and DDS operators on the high and low recorder speeds, so that the only voice commands necessary will be RECORDERS HIGH, RECORDERS LOW, RECORDERS ON, and RECORDERS OFF.

X. MALFUNCTION DETECTION

It is the responsibility of the LIE to know the status of the entire data acquisition system at all times, be able to react to any emergency situation in a manner which will preserve the maximum amount of test data, and resolve any system malfunctions or discrepancies in a minimum period of time. This requires a good working knowledge of all data acquisition system subsystems and major components. The following steps are necessary in order to maintain cognizance of the data acquisition system status during a test run:

A. Have the DDS and RRO operators continually monitor their systems for signs of system failure or impending system failure. Have the RRO monitor the strip chart recorders for signs of individual channel discrepancies. Have these operators report the above information to the LIE immediately.

B. It is the LIE's responsibility to inform the Test Director of all data acquisition system discrepancies or failures and the corrective action that has been or should be taken.

XI. ETS-1/A&E DATA LINK AND ETS-1 TEST DIAGNOSTIC CENTER

The ETS-1 A&E Data Link (DL), shown in Figure XI-1, is utilized to provide real time computer data and displays for the A&E Building Multipurpose Room and the ETS-1 Test Diagnostic Center (TDC) during Test Operations.

The SEL coder receives parallel digital data from the SEL-600 Digital Data Formatter units, converts ten selected channels to analog data, and serially codes all channels for transmission via the Data Link microwave (7 KMHz) to the A&E Building. The SEL decoder converts ten selected channels to analog data for meter displays in the A&E Building Multipurpose Room, and interleaves the serial incoming data into a parallel format to appear as a CDC 604 tape transport to the CDC controller unit. In addition to routing data to the CDC 3200 computer for real time data processing, the raw count input data is recorded on digital tapes to provide redundant recording of all digital data collected at ETS-1. The CDC 3200 computer provides outputs of 20 channels of engineering units data and 12 channels of computed data in binary coded parallel format. The real time computer output data is recorded on digital tape and is also routed through the Serial Coder for transmission to the Test Diagnostic Center at ETS-1. Twelve of the output channels are decoded for analog display in the A&E Building Multipurpose Room.

All 32 channels transmitted to ETS-1 via the Data Link are decoded and appear as 0-5 vdc signals at the TDC patchboard. These channels, in addition to 48 channels from the ETS-1 Analog Patch and 12 channels from the ETS-1 Magnetic Tape Patch, are available for patching to various TDC console meters and test equipment as shown in Figures XI-2 through XI-7.

The Teletype System, TTY, shown in Figure XI-1, is used to supplement the TDC meter displays with printed data listing "over limits," real time data summary, and other test data. Also, the TTY is used to initiate changes in the channels selected for display at the TDC, and for data system calibration checks.

The LIE operator not on duty at the LIE console will operate the TDC-TTY console, and upon completion of TDC setup will assist TDC personnel with any operational problems.

In summary, the Data Link provides a means of on line Data System analysis in addition to TDC and A&E Multipurpose Room displays.

DATA LINK BLOCK DIAGRAM
FOR TRAINING USE ONLY

FIGURE XI-1

***NOTE:**

1. PROPOSED 48 CHS. DIRECT FROM ANALOG PATCH TERMINAL BOX.
2. ANALOG COMPUTER REQUIRED FOR ANY CALCULATED CHANNELS.

FIGURE XI-2

ALL METERS ARE WESTON #19217.

XI-7

FIGURE XI-5

STATION TEMPERATURE	CORE SUPPORT PLATE TEMPERATURE	OUTER REFLECTOR TEMPERATURE	INNER REFLECTOR TEMPERATURE
TIE ROD MATERIAL TEMPERATURE		DECAY POWER LOG
T-710 CLUSTER EXIT GAS TEMPERATURE	PUMP DISCHARGE FLOW RATE	THERMAL POWER	DRUM POSITION
T-680			AVE.