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SEISMOGRAPHS

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OPERATING MANUAL

NS 5400

SEISMOGRAPH

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THE NS 5400 DIGITAL SEISMOGRAPH

USER'S MANUAL

NOMIS Seismographs

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1. INTRODUCTION

The NS 5400 is a state-of-the-art computerized seismic and sound recording instrument. The unit is capable of operating for prolonged periods of time on internal batteries under adverse environmental conditions. The instrument is contained within an "unbreakable" high-impact thermal polymer case which incorporates a rubber foam gasket between the lid and base to ensure good resistance to dust and water intrusion. The outside case connections are water resistant and should protect against water intrusion in most situations. A rubber gasket is incorporated around the keyboard panel and printer door to reduce dust and water hazards. All accessories are stored within the unit, making it completely self-contained and highly portable.

This instrument was designed to be "user friendly", allowing the majority of users to operate the unit without even reading the Operating Instructions. Upon turning the unit ON, the user is prompted with a series of setup questions. At the end of each question, in parenthesis, is the response format and/or range of acceptable parameters to further simplify use. The NCSC 5400 retains all user entered data, even if the unit is turned OFF (though the batteries must remain connected).

The NS 5400 operates in two different modes, the Self-Triggering Mode and the Continuous Monitor Mode. In the Self-Triggering Mode the unit records 2, 3, 5, 10 or 15 seconds of seismic/sound activity upon being triggered. Triggering occurs when the instrument detects a seismic/sound level equal to or greater than the user specified trigger level. One half second of pre-trigger information is retained as part of the record. After the data is recorded to memory, a detailed numeric and graphical report is generated.

The Continuous Monitor Mode allows the unit to continuously monitor its inputs and generate a report, summarizing activity which occurs over a specified time period. The Continuous Monitor report presents the peak values seen in numeric and bar chart form. This mode is ideal for monitoring pile driving activities, environmental background activity, and certain noise studies.

The printer asks the operator for input and also prints the graphs and analytical results when required. This is a super fast thermal printer with an integrated paper take up. Because the printer uses the most power in the unit, we suggest using the LCD and memory storage when long term operation on the internal battery is required. The large 8 line x 40 column LCD is present to display all results and reduce printer time.

The storage of the events in memory depends on the character of the individual wave form. The compression routine in memory can reduce some data better than others. These events can be retrieved from memory and printed by the seismograph or down loaded into a computer for storage or printing.

When using the NS5400 the LCD may appear to be slightly cloudy at times. This is due to the fact that a special conductive layer of plastic is located over the LCD display. This conductive layer helps to shield against harmful radio frequencies which can corrupt data and cause false triggers.

A special feature has been programmed into the NS5400 which allows the printer to turn off automatically once the voltage drops to a level below that to operate the printer. This allows all events to continue to be stored in memory and the results displayed on the LCD. This will allow for extended operation of the unit, long after the batteries should have been charged. (See Page 7 on how to turn the printer back on)

The concept behind the NS 5400 is for this unit to be very simple and straight forward in its operation. Therefore, the operator need only answer the questions asked to operate the unit. The AUTO ON feature adds to that by programming the unit prior to leaving the office and simply having the operator turn the unit on in the field. It will automatically go into scanning. Equally as important, the experienced operator can go to higher levels by using the various NCI commands. Therefore, our instrument can be as simple as you want or as detailed as you need.

2. BASIC OPERATION AND SET-UP

2.1. GENERAL

The NS 5400 is a self-triggering, user friendly instrument capable of recording highly accurate information during a blast. In the Self-Triggering Mode, this information is recorded for periods of 2, 3, 5, 10 or 15 seconds when the seismic or sound level meets or exceeds the selected trigger value. The collected data is processed to determine the following: peak particle velocities; peak displacement; peak particle acceleration, frequency at the peak velocity; resultant peak particle velocity or vector sum; peak sound; sound frequency at peak values; and time interval in milliseconds from start to peak velocity reading. This information is then stored and printed out (if desired).

Following the Results is the Frequency Plot (if selected) - either the USBM/OSMRE log plot of peak particle velocity versus frequency, the DIN 4150, or other selected plots. A particle velocity versus time graph is printed after the Frequency Plot. The printing of either graph can be enabled or disabled at the user's discretion. In fact the entire record can be modified by the operator to eliminate any parts of the record not desired.

Once the unit has finished printing or the LCD displays the results, it then returns to the scanning mode.

In the Continuous Monitor mode, the unit continuously monitors inputs, even while printing, and produces a bar chart representing the activity seen during a user specified interval. The bar interval can range from 1 bar/sec to 1 bar/min. A numeric report may be selected from every 0.1 hours up to every 99.0 hours or only on demand. The report will show peak or resultant values, as selected.

In either mode, the unit will operate on a single charge and with a full roll of paper for up to 20 days.

2.2. SETTING UP THE NS 5400

A small fold-out pocket guide is provided with the unit to simplify understanding and setup of the unit, and is an excellent quick-reference, especially in the field.

To use your NS 5400 open the unit and proceed as follows:

1. Ensure that there is enough paper in the printer and check that it is feeding through the mechanism properly. When transporting the NOMIS 5400 the supply roll may become lodged and cause the printer to not print properly. Therefore, always check paper before setup. Refer to page 54, Changing the Paper, for further information.

2. Remove the transducer from its compartment and plug the cable into the socket marked "Seismic". This cable connector must be turned in the socket connector until it fits into the slotted guides. The cable connector should then be pushed into place and the locking nut turned ¼ turn.

3. Remove the microphone and place it in the mast support mounted on the side or use the pointed rod to secure the microphone in the ground. Also, note that the pointed rod will fit into the microphone bracket on the side. The microphone mast can be extended to a maximum of 3 feet (approx. 1 meter) by using the extensions provided. Any part of the microphone mast will fit inside the microphone housing hole. Plug the cable into the socket marked "Sound". Remember to twist the cable connector until it fits in the slotted socket. Be sure to slide the foam windscreen over the microphone.

4. Position the transducer (leveling it first) and the microphone appropriately for the blast. The transducer should be within 20° of the horizon for the unit to record properly. The arrow on top of the transducer block should point toward the blast. This positions the longitudinal trace in the correct direction. The microphone reads correctly when pointing AT the blast. For proper placement of the transducer block please see section 8.1.

5. Switch on the unit. Note that the ON is a simple push while the OFF requires the user to hold down this key for 2 seconds. (This will prevent the user from turning the unit off accidentally.) Upon power up the red LED is lighted and the NS 5400 enters into a self-check mode and is automatically in the self trigger mode. (The continuous monitoring mode is entered through the HELP menu.) After approximately 8 seconds the unit prints an introductory message. The printer now turns off (automatically) and waits for the user to answer the prompt set up questions on the LCD only. The printer can be turned on at any time by going into the NCI mode and typing "PRI ON" and ENTER. The last question on the set up menu is "PRINTER (Y/N) Y". This question automatically defaults to yes such that the printer will turn on automatically before going into scanning. See Section 3.1 for detailed information on using this recording mode.

6. After answering all questions the unit will go into scanning, which means the NS 5400 is ready to trigger on an event. This is indicated by the scanning message on the LCD and the flashing yellow scanning light. While the scanning light is flashing, the unit is ready to receive a trigger. Once the trigger level is exceeded the scanning light will burn solid for the recording time selected. The LCD and printer (if turned on) will print a message indicating the event is being processed.

2.3. CONTROL CHARACTERS

The NS 5400 will recognize certain global control character commands. These commands are entered by pressing the control, CTRL or yellow, key and the appropriate character key simultaneously.

a) **CTRL   C**   This command is used to enter NCI Mode (see Section 3.3 on NCI Mode for further information.) This command may be entered any time the unit is printing, is waiting for a response from the user or is scanning but has not yet triggered.

b) **CTRL   X**   This is the command to return to scanning. This command is used to interrupt the normal operation of the NS 5400 and immediately return to monitoring for seismic/sound activity. It may be entered at any time during normal operation in the Self-Triggering Mode, provided that the set-up parameters have not changed since last entered. This operation will erase any event being processed. In the event of a false trigger this operation can be used quickly to erase it.

This command is not available in the Continuous Monitor Mode.

c) **CTRL   Q**   This command is used to resume operation from a PAUSE (see page 28, Using NCI in the Self-Triggering Mode, for further information).

d) **CTRL ↓**   This command interrupts the Continuous Monitor and forces a RESTART.

e) **CTRL**   This yellow key is always used to light the LCD once it goes out. To conserve power the LCD automatically goes out after 30 seconds of no activity.

f) **SHIFT**   This red key is used to activate all of the red numbers and symbols on the key board. This key should be pressed while pressing the keys with the red numbers and symbols.

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2.3.1. The ↑ & ↓ Keys

↑ :   This key can be used for different purposes, as follows:

NCI MODE   pressing this key will abort and NCI operation and return to the NCI> prompt.

                               If at the NCI> prompt, this key will return you to the point where you entered the NCI mode. If you were at scanning when you entered the NCI mode, this key will return the NS 5400 to scanning.

Normal Mode   ↑ causes you to back-up to the previous prompt (whereas ENTER takes you ahead to the next).

↓ :   This key is used to break or stop the printing of any graphics mode, such as the graphical record, BOM graph, or the calibration graph.

2.4. ERROR MESSAGES

During the operation of the NS 5400 several errors can be encountered. Some of these errors occur during start-up, while others can be encountered during the unit's operation. All errors are listed below with suggested remedial actions.

2.4.1. Errors During Start-Up

1) RAM ERR

The machine requires service. Please contact your agent and/or return your unit for servicing. This error is reported after performing a RAM test using the NCI command TEST.

2) **A/D ERROR**

The Analogue to Digital converter failed the calibration test. Return it to your agent for re-calibration and/or repair.

3) **A/D ERROR**   CONNECT TRANSDUCER

This error only occurs on the LOW LEVEL seismic option. The unit should be turned off and the transducer connected to the unit. After this connection the unit should be turned on. This does not mean the unit is not working properly.

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4) L,T,V, S BAD

This is a warning printed at the beginning of set-up if the transducer or microphone is not found to be connected, there is a broken wire in the cable, or if one of the elements is found to be outside specifications. The unit prints the warning for either or all elements whichever it finds faulty. This warning may look like:

S BAD
L, V BAD
L, T, V BAD
L, T, V, S BAD   etc.

2.4.2. Errors During Operation

1) SYN ERR

This error (Syntax Error) is reported when the data typed in is not in the format requested/required. A SYN ERR always results in a re-prompt. Therefore, re-enter the data in the correct format.

2) RNG ERR

This error (Range Error) is displayed if you attempt to enter a seismic or sound trigger level which is above or below the range allowed. Re-enter the trigger level within the range specified.

3) BATTERY LOW, PRINTER DISABLED

This error occurs when the battery voltage drops below 5.7 volts. (This may occur randomly while operating the instrument, even when the voltage is above 5.7 volts.) The printer can be turned back on by going into NCI and typing PRI_ON or turning the unit off and back on again. If the printer error continues to occur, the unit should be charged. The NS5400 will continue to operate by storing events in memory and displaying the results on the LCD.

4) PRINTER ERROR, CORRECT AND PRI ON

This error is a malfunction of the printer. Most often, this is caused by a paper outage or by the paper release lever in the up position. Once the problem is corrected, the printer can be turned on by going into NCI and typing PRI_ON or turn the unit off and back on again.

3. USING THE SELF-TRIGGERING MODE

3.1. SETTING THE MONITORING PARAMETERS FOR SELF-TRIGGERING

1. Set up the instrument following the procedure outlined in Section 2.2. When the unit is turned on it prints an introductory message in the following form:

    (If an error message is printed, or the unit does not operate, refer to the Section entitled "Errors", page 6.)

    > UNIT LAST USED 13-NOV-96 10:08
    > 6.3V
    >   AL OFF
    > **** NOMIS NS 5400 Series ******
    > INSTRUMENT # NS 5400M-2001
    > ***** A/D CALIBRATED OK ***
    > 17 -NOV-96   13:50:37

    The unit prints out the date and time of last use. If the power has been disconnected, the unit would print "POWER LOSS SINCE LAST USE" instead of "UNIT LAST USED ....". If this occurs there may be an indication that the unit is having a serious power problem which may affect the operation of the unit.

    The NS 5400 automatically goes into the self trigger mode when turned on. If the continuous monitor mode is desired, refer to section 4. There are certain global 'control' characters available to the user (entering NCI, return to scanning, etc.). Refer to the section, 'Control Characters', on page 5 for more information.

2. <u>The date and time should always be checked at this time</u>. Please note that if you wish to change the date or time, this must be done in the NCI Mode. See page 25 for further information on this procedure.

3. Note that the printer automatically turns off to conserve paper and power while in the set up mode. All prompt questions are displayed and answered on the LCD. The printer can be turned on at the last question before going into scanning. (Note that the user can turn the printer on at any time by going into NCI (CTRL C) and typing "PRI ON" and ENTER.)

Always press the ENTER key to complete an entry. Accidental key presses can be corrected using the DELETE key. Note that a response may already be stored in memory at the right of the prompt. If this is the desired entry, then simply press ENTER to accept this entry.

4. The first question prompt to appear on the LCD is as follows.

    CUSTOMER: ABC MINES

    At this point the NS 5400 will pause and wait for your response. The NS 5400 stores all previously entered setup data, even when the unit is turned OFF. In the example shown above, ABC MINES was entered as the customer name the last time the machine was used. If you wish to keep data as shown, simply press ENTER and proceed to the next question.

    If you wish to change the data, simply type in the new response following by an ENTER . Enter up to 25 characters per heading, terminating each entry with an ENTER. The DELETE key is used to delete the last character and then the second to last, etc., until a whole line is deleted, if desired. A solid box is printed whenever the DELETE key is pressed. The SHIFT key in conjunction with a second key will give numbers and symbols printed in red in the upper right corner of the alpha keys.

    In case of user error, you can go back to the previous question by pressing ↑.

    While in the set up mode the printer does not normally function and all communication will be through the LCD. This will conserve power and should be routine in the event of a low battery. Note that the battery voltage is printed once the unit is turned on each time. When the unit is operated on the internal battery only, the voltage should always be checked. <u>The main user problem we have is from a low battery.</u>

5. The NCSC 5400 now prompts the user as shown below. Note that the previously entered data is printed after each prompt.

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<u>Metric Units</u>	<u>Imperial Units</u>

LOCATION: **LOCATION:**

METERS TO BLAST : (1-32767,N)100   **FEET TO BLAST: (1-32767,N)100**
KGS PER DELAY : (1-3276,N)30   **LBS PER DELAY :(1-3276,N)30**
SCALE DISTANCE = 18.25   **SCALE DISTANCE = 18.25**

OPERATOR: **OPERATOR:**

COMPANY: **COMPANY:**

You may fill in the information for the prompts LOCATION, OPERATOR, and COMPANY as previously described.

The NS 5400 provides a convenient readout of scale distance based on entered values for distance to blast and charge per delay. This may be used for quick estimate of anticipated vibration levels, as well as regression analysis afterwards. The NOMIS Vibration Analysis System (NVAS) program is available to produce vibration prediction analysis and formulas.

The Distance to Blast must be entered in the range of 1 to 32767 or 'N' for none. Measure in meters for metric units or feet for imperial units. For Charge per Delay, the range is 1 to 3276 or 'N' for none. Measure in kilograms for metric units or in pounds for imperial units. <u>An entry must be placed at these 2 prompts.</u> If the distances and explosives per delay are not known before the blast, the operator should put " N " in this prompt.

If both the Distance to Blast and Charge per Delay are set to values other than "N', then the computed Scale Distance is calculated and displayed. Scale Distance is equal to the Distance to Blast divided by the square root of the Charge per Delay.

6. The NS 5400 is now ready to accept trigger information. It first prompts for seismic trigger level. The range of trigger levels is specified within the second set of parenthesis.

Metric Units	Imperial Units

SEIS TRIG (mm/s): (.5 - 100,N,M)2   **SEIS TRIG (ips): (.02 - 4.00,N,M) .05**
.5   **.02**

For units with the low level seismic range the choice of selection will be .3 - 50
mm/sec or .01 - 2.0 IPS. Choose a value within the range indicated. For Metric Units
enter the appropriate value in millimeters. For Imperial Units enter the value in inches
per second. Please note that if the level entered is outside the range, the NS 5400
will give "RNG ERR" and prompt the user to re-enter the trigger level.

If you do not want to trigger on the seismic value, but want to record the levels
present, enter N (for NO trigger).

A Manual trigger feature is also available. If you enter " M " for the seismic trigger
level the seismograph will record seismic activity only when you manually activate it.
You will be prompted with "PRESS ANY KEY TO TRIGGER" when you have
completed the setup. When you do press any key, the unit will immediately begin
recording and will print the results (or write to memory) even if the results are all
zero. When the unit has completed printing it will again prompt "PRESS ANY KEY TO
TRIGGER".

7.   The unit now prompts the sound trigger level.

SOUND TRIG (dB): (100 - 140,N) 110
120

The range allowed is given in the parenthesis. Values outside the range will give a
"RNG ERR". If N is typed, the NS 5400 will record the sound activity data but will
not trigger on it. Note that you should not enter N for both the seismic and sound
trigger levels.

> NOTE: If you do not want to plug in the microphone for some reason, you
> MUST enter N for the sound trigger level. Otherwise, the unit
> will constantly trigger. With the microphone not plugged in the unit will
> read full scale, 140 dB. This will be noted on the sound channel printout
> by a constant oscillation on the sound channel. If this creates a problem,
> a special adaptor plug can be provided to print no results.

For units with the low level sound option (80 -120 dB), it is advisable to set the
sound trigger level to "N". The default for this prompt is N. This sound channel is
extremely sensitive and can be triggered by conversation at 5 feet. If this prompt is
set to anything other than N, false triggers will occur and make the user think the
equipment is not working properly.

8. The NS 5400 next prompts the user for the desired sound scale.

    SOUND WEIGHTING (A/F) ? F

    The 2 choices are the A weighting and the Flat (or Linear) scale. "A" weighting of sound pressure is weighted to match the frequency response of the average human ear. Most blast noise is measured on the Flat scale due to the fact that damage criteria is based on airblast recorded on the Flat scale.

    In the RESULTS section of the seismograph reading the sound reading will be reported as dBA if the "A" weighting was selected, dBF for the Flat scale, and dBN if the digital filter was disabled. (See pages 59 & 60 for frequency characteristics of the "A" scale.)

9. The NS 5400 next prompts for the Recording Period desired.

    RECORD TIME (2,3,5,10,15 s) : 2

    You may enter either 2,3,5,10 or 15 seconds. Anything else will result in "RNG ERR" being printed and allow re-entry. This recording time is the actual time in seconds that the unit will sample the vibration and /or sound. Note that the scanning light burns solid for this period of time when triggered.

    NOTE: Recording time is very important when considering airblast or sound readings Because sound travels at the rate of 1046 feet/sec (319 m/s), adequate time must be given for the airblast to arrive at the microphone and register. For example, if the blast was 2000 feet from the seismograph, then the record time of 3 seconds (or higher) should be selected. The selection of 2 seconds would cause the unit to stop collecting data before the sound arrives. Remember there is a .5 second pre trigger time on the record. Therefore, a 2 second record only collects data after the trigger for 1.5 seconds. The trigger point is noted by the small ⊢ on both sides of the graphic print out.

10. The NS 5400 will now prompt you as to whether a **FREQUENCY PLOT GRAPH** is to be printed after recording an event. (Several plots are available including the USBM/OSMRE Report, the French Standard plot (Recommendation G.F.E.E.), and the Deutsche Norm DIN4150). See Page 31 for information on selecting the reports.

FPLOT REPORT (Y/N)? N
Y

Enter Y or N followed by ENTER to indicate whether or not a Frequency Plot Report is to be printed.

11. Next, the NS 5400 will prompt you as to whether a **GRAPH** is to be printed after recording an event.

GRAPH (Y/N)? N
Y

Enter Y or N followed by ENTER to indicate whether or not a Particle Velocity versus Time Graph is to be printed as part of the report.

12. The NS 5400 asks for the number of copies of the report required.

COPIES PER EVENT: 1
5

Any number from 1 to 9 may be entered. If a number that is out of range is entered, the NS 5400 will respond with "RNG ERR" and prompt the user again. When the unit is turned off and back on again, the default is back to 1 copy.

13. The last question to be answered is as follows.

PRINTER (Y/N) Y

This questions defaults to Y so that the individual events will be printed. If the user does not wish to print all events, then select "N" and press ENTER.

14. If the ALARM function is set ON (see start up print out on page 8) and the current time is less than the start time the NS 5400 will print a message in one of the following formats and go to sleep until the appropriate time.

1) <u>DAILY START/STOP ALARM OPTION</u>:

    ALARM START 15-APR-96   09:00:00
    ALARM STOP DAILY 17:00:00

SLEEPING

2) <u>START/STOP ALARM OPTION</u>:

    ALARM START 01-JUN-96   08:45:00
    ALARM STOP 01-JUN -96   10:30:00

3) <u>START ONLY ALARM OPTION</u>:

    ALARM START 01-JUN-96   23:30:00
    ALARM STOP DAILY   NONE

When an alarm has been set, the unit will automatically start scanning at the pre-set time. ALARM set-up is done in the NCI mode. See page 22 for more information.

15. If no alarm has been set, or if the unit has already passed its wakeup time, the NS 5400 enters the scanning mode and informs the user by printing the following message.

SCANNING

16. When operating in the SCANNING mode, the SCANNING LED will pulse on and off once a second. During this phase the unit is constantly updating its memory so that it has .5 second of pre-trigger information.

17. Once triggered, the SCANNING LED will be lit for 1.5, 2.5, 4.5, 9.5 or 14.5 seconds indicating that the unit is collecting samples. The LED will turn off once the collection period is complete. The unit will print "PROCESSING EVENT DATA. PLEASE WAIT".

18. The NS 5400 requires approximately 30 seconds in which to compute the Peak Particle Velocities, Peak Displacement, Peak Particle Acceleration and Lowest Frequency at Peak Velocity for L,T, and V channels, Peak Sound in dB and kPa/psi, Sound Frequency at Peak in Hz and also the TRUE Resultant Peak Particle Velocity (vector sum).

The NS 5400 is auto-ranging. That is, it reads the input signals and automatically determines the best scale to be used on the graph. Scales used are:

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<u>Metric Units</u>
<u>Seismic Ranges</u>   <u>Imperial Units</u>

∓6.25, ∓12.5, ∓25, ∓50, ∓100 mm/sec.   ∓.25, ∓.5, ∓1, ∓2, ∓4 ips

<u>Sound Ranges</u>

100 - 120 dB and 100 - 140 dB   100 - 120 dB and 100 - 140 dB

The printed report will be similar to that illustrated in **Figure 1** if **both** the Frequency Plot and the GRAPH are selected. If neither graph is enabled for printing then a report similar to that illustrated in Figure 2 will be generated.

NOTE: The ↓ key can be pressed prior to or during the printing of any of the graphs (Fplot, Particle Velocity versus Time, or Calibration Graph). This terminates the printing of the current graph and begins the printing of the next graph in the report.

If either the transducer or microphone should inadvertently be disconnected during operation this will become apparent on both the main and calibration graphs. The report will display either an asymmetrical full scale reading (if the digital filter is on) or an offset straight line (if the digital filter is off).

19. The NS 5400 then returns to the scanning state (Step 15) using the previously entered parameters.

20. If you decide during the printing of the report that you wish to make more than one copy, you may enter the NCI mode and use the "PRINT" command to make as many copies as required or to increase the number of copies per event (see pages 24 & 28 for further details).

21. To change any or all of the parameters, either turn the unit OFF then ON again or use the NCI command RESTART. This RESTART command restarts the setup routine at Step 1 (see page 8). Remember that certain defaults occur when the unit is turned off and on. <u>These defaults do not occur when the RESTART command is used.</u>

There are many other functions available within the unit. These are detailed in the sections following. Please refer also to the section, "Using NCI Commands in the Self-Triggering Mode". These commands may be used to obtain certain status information, to change some operating parameters, and to customize the printed record. See page 21 for further details.

22. Once you have finished with the unit, unplug the microphone and transducer and return them to their respective compartments. The transducer compartment is very compact so it is advisable to wind the cord in a tight roll for a proper fit. The transducer should always be placed in with the arrow pointing up. Close the unit (ensuring that the POWER switch is in the OFF position) and store it in a safe, dry place until you are ready to use it again. If any moisture is inside, the unit should be left open for this water to evaporate. This is an air tight unit such that any moisture inside will not evaporate with the lid closed. See the section on "Maintenance", for further information on caring for your equipment. Be sure to charge the battery from time to time, in order to ensure that the unit is always ready to go when you are. See page 51 for further information on battery charging and capacity.

FREQUENCY (Hz)

```
      GRAPHICAL RECORD
      ****************
    TIME= .04065 sec/mm
    SOUND= 0.195 kPa/div
    L,T,V= 100 mm/s/div
```
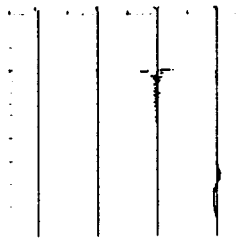

** A/D CALIBRATED OK **

```
      CALIBRATION GRAPH
      ****************
    TIME= .04910 sec/mm
    SOUND= 0.195 kPa/div
    L,T,V= 25 mm/s/div
```
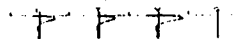

**Figure 1. Self Trigger Mode
Full Graphical Report**

***   NOMIS NS 5400 SERIES   ***

04-DEC-96   21:53:43

INSTRUMENT # NS5400

EVENT # 001

NOTES:

*

*

CUSTOMER:SANDLAPPER COAL CO

LOCATION:KIM HOUSE

DISTANCE TO BLAST(m): 1369

CHARGE PER DELAY (kg): 250

SCALE DISTANCE = 86.58

OPERATOR:SMS

COMPANY: GEOTECH

SEIS TRIG (mm/s): 1

SOUND TRIG (dB): N

RECORD TIME (2,3,5,10,15 s): 2

RESULTS

****

	L	T	V
PPV(mm/s)	1.8	4.3	59.6
Frq(Hz)	39.4	50.1	32.7
PEAK SOUND	123 dBF	0.0274 kPa	
Frq Pk Snd(Hz)	3.2		
PD(mm)	0.0166	0.0110	0.1013
PPA(g)	0.194	0.556	4.870

** A/D CALIBRATED OK **

CALIBRATION GRAPH

****

TIME= .04910 sec/mm

SOUND= 0.195 kPa/div

L,T,V= 25 mm/s/div

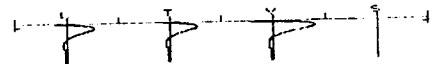**Figure 2. Self Trigger Mode
Short Report**

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3.2.. USING THE USBM/OSMRE REPORT

The United States Bureau Of Mines [1] as well as the Office of Surface Mining Reclamation and Enforcement [2] have each established damage limiting criteria for ground vibrations. These reports have each established guidelines for maximum Peak Particle Velocity as a function of frequency.

The USBM/OSMRE Report generated by the NS 5400 Seismograph is a log log plot of Peak Particle Velocity vs. Frequency along the Longitudinal, Vertical, and Transverse axes. The criteria lines established by both USBM and OSMRE are plotted on the same graph. (Refer to Figure 3).

The Graphs in Figure 3 are scaled in metric units, but because the USBM and OSMRE recommendations are in U.S. Standard Units (Imperial Units) the criteria lines on the graphs are labeled in inches of displacement, and inches/second for velocity.

The USBM recommendations differentiate between Drywall and Plaster, whereas the OSMRE does not. The USBM recommends that the PPV not exceed 0.50 inch/sec. in the frequency range from approximately 2.5 Hz to 10 Hz; this is indicated with a broken line. The Drywall Criteria for the USBM are the same as for the OSMRE in the range from 0 to 11 Hz, and from 40 Hz and higher. Only in the frequency range between 11 Hz and 40 Hz do the USBM and OSMRE differ.

Broken lines are used for the OSMRE criteria in the frequency range of 11 Hz to 40 Hz in order to differentiate them from the USBM criteria lines. The OSMRE criteria allow a higher PPV in the frequency range from 11 Hz to 40 Hz.

----

1. D.E. Siskind, M.S. Stagg, J. W. Kopp, and C.H. Dowding. <u>Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting.</u> RI 8507 Bureau of Mines Report of Investigation/1980.

Appendix B. Alternative Blasting Level Criteria contains a graph of "Safe levels of blasting vibration for a house using a combination of velocity and displacement."

2. Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, 30 C.F.R. Sec. 816.67 and 817.67 (Revised July 1, 1989) pp. 273-274 and 308-309.

Compliance with the USBM/OSMRE is achieved when all the plotted (Peak Particle Velocity, Frequency) points are below the respective criteria lines. The centers of the plotted L, T, V 's correspond to the (PPV, Frequency) pairs. Remember that the USBM/OSMRE graphs are always plotted between the frequencies of 1 Hz and 100 Hz. Any PPV with a frequency outside this range is not plotted. Check the RESULTS section of the printout to ensure that the maximum PPV, for frequencies greater than 100 Hz, do not exceed 2.0 inches/second (50.8 mm/sec). To ensure compliance for frequencies lower than 1.0 Hz, check that the Particle Displacement in the RESULTS section is less than 0.03 inches (7.62 mm).

METRIC UNITS:

For a maximum PPV recording of less than or equal to 25 mm/sec. the PPV scales on the graph range from 0.25 mm/sec. to 25 mm/sec. For a maximum PPV recording greater than 25 mm/sec., the PPV scales on the graph range from 2.5 mm/sec. to 250 mm/sec.

IMPERIAL UNITS:

For a maximum PPV recording of less than or equal to 1 in/sec., the PPV scales on the graph range from 0.01 in/sec. to 1 in/sec. For a maximum PPV recording greater than 1 in/sec., the PPV scales on the graph range from 0.1 in/sec. to 10 in/sec.
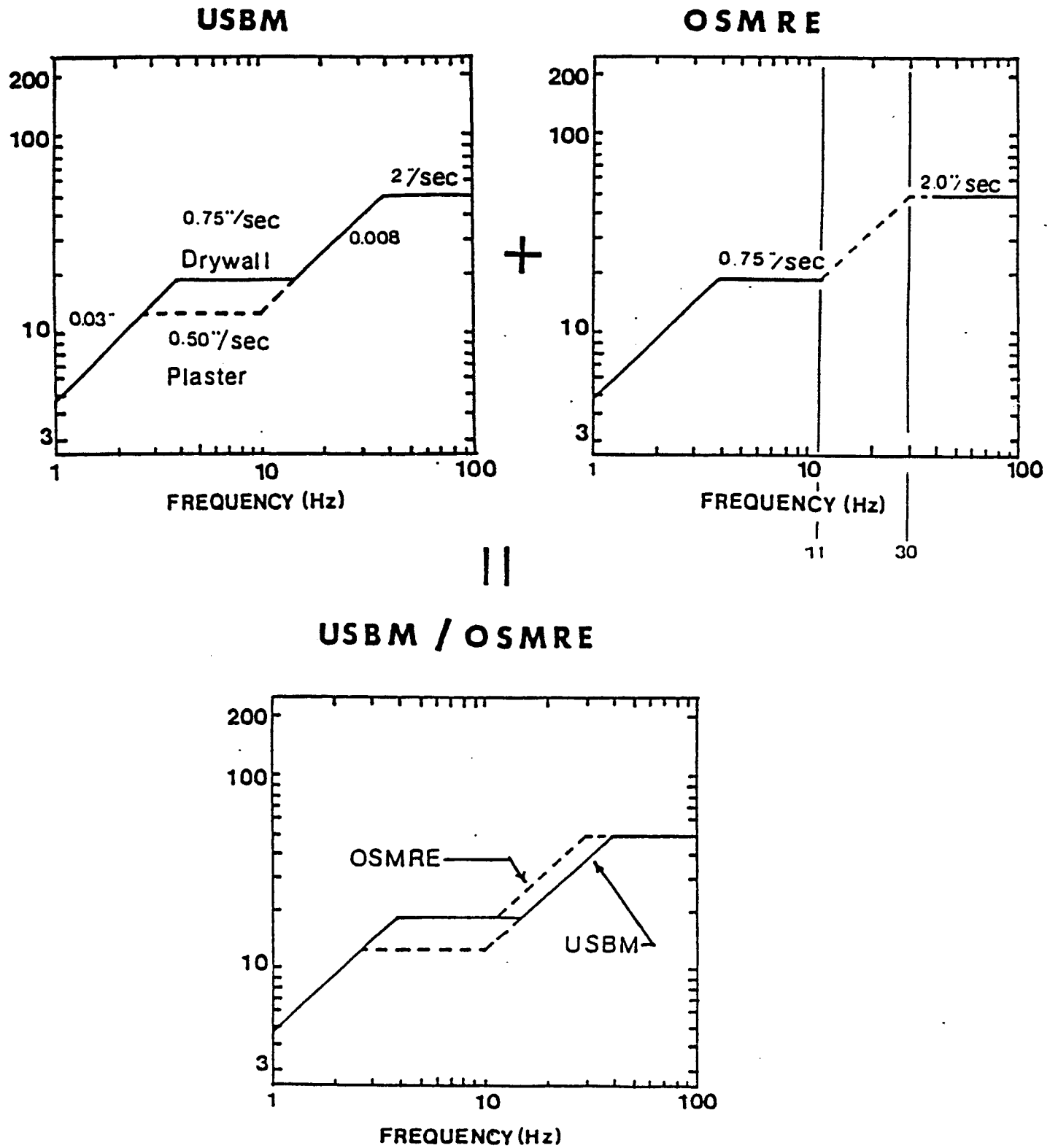
USBM

OSMRE

+

||

USBM / OSMRE

Figure 3. The USBM and OSMRE Criteria Plots

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3.3. USING NCI COMMANDS IN THE SELF-TRIGGERING MODE

The NS 5400 has certain features which can be activated by entering the "NCI" (NOMIS Command Interpreter) mode. NCI commands may be used to customize the graphical printout, to change some operating parameters, or to obtain certain status information about the unit. You may enter NCI at any time (even during a printout) except when the unit is collecting and processing data after triggering.

To enter NCI press the **CTRL** and **C** key simultaneously . The **NS 5400** will respond by printing:

NCI>

Type in the desired NCI command in the format shown below. A listing of NCI functions follows.

> <u>NOTE</u>: [   ] Denotes optional characters.
> ___ Denotes a space between characters.
>
> The PAPER FEED and ↑ keys are active when you are in the NCI mode and have the following functions:
>
> PAPER FEED: This key can be pressed to advance the paper. This key should be used when changing paper rolls or when testing the paper advance mechanism. It is also active whenever the unit is waiting for a response from the user.
>
> ↑ : Pressing ↑ at the NCI> prompt results in an exit of the NCI mode of operation and a return to the main program. If an NCI command is in process, it will terminate that process. Remember that this is a "go backwards" command. In the regular mode this key allows you to repeat the previous questions and in NCI it allows you to return to where you were, previously.
>
> ***CAUTION*** : A TEST command performed while in the NCI mode will corrupt any record which is being printed. If a record is not being printed at the time of entry into NCI, there is no problem.

3.3.1. ALARM Functions

The NS 5400 has an alarm mode. When it is activated, the unit will turn itself ON and OFF at selected times. (You should, of course, leave the ON/OFF switch in the ON position.) To activate the alarm function or to change the alarm setting type:

AL_ON and ENTER

The unit will respond with a prompt in the following format:

    *CURRENT DATE/TIME ARE:
    01-AUG-96 09:57:15
    ENTER DATE (DDMMMYY)
    13NOV96

Note that at the beginning of the prompt is the current date and time. If you press ENTER only, the unit will leave the date at the previous setting. Or, you may enter a new date followed by an ENTER. This will ensure that the unit will turn on and off at the correct times. After you have set the date the NS 5400 will prompt:

    ENTER TIME (HHMM)

If you press an ENTER the unit will leave the time at its previous setting, or you may enter a new time followed by an ENTER . Use the 24-hour clock. For example, 09:57 indicates A.M. 14:05 indicates 2:05 P.M.

After you enter the time the unit will display the alarm start/stop dates and times entered the last time an alarm was set up, and prompt the user with the alarm START date and time as follows:

    ALARM START   16- JUL-96   09:45:00
    ALARM STOP   DAILY   NONE
    *ALARM START DATE AND TIME
    ENTER DATE (DDMMMYY)

If you press ENTER the unit will leave the date at the previous setting. Or you may enter a new date followed by an ENTER. The desired date should be entered in the format shown. For example, 12SEP96 for September 12, 1996.

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The next prompt is the alarm start time:

ENTER TIME (HHMM)

If you press ENTER the unit will leave the time at the previous setting. Or
you may enter a new time followed by an ENTER. After the alarm start time the NS
5400 will prompt:

*ALARM STOP DATE AND TIME
ENTER DATE (DDMMMYY)

If you press ENTER the unit will leave the previous date. If **N & ENTER** are keyed,
the seismograph will begin to scan <u>DAILY</u> between the specified alarm start/stop
times. The user may also enter a new stop date followed by an ENTER. After you
have set the alarm stop date the NS 5400 will prompt:

ENTER TIME (HHMM)

If you press ENTER the unit will leave the entry as is. If **N & ENTER** are keyed for
both the stop date and the stop time, the unit will run continuously until it is turned
off manually.

Once the NS 5400 is in the alarm mode, both the printer and LCD will respond with
the message "sleeping". The unit will go into a power save mode whereby no keys
on the keyboard will be active.   *It is an easy mistake to think that the unit is*
malfunctioning. The unit will not respond until the designated wake up time. If there
is a question as to what mode the unit is in, look at the printer for the word
"sleeping" last printed before entering alarm. <u>The only way to wake the unit</u>
before the designated time is to hold the on/off key down for 10 seconds. The unit
will automatically restart.

<u>PLEASE NOTE THE FOLLOWING WHEN USING THE ALARM FUNCTION</u>:

1) Once the alarm start and stop times have been entered and the alarm stop date is
     set to DAILY the NS 5400 will automatically wake up and monitor during the
     alarm period EVERYDAY, day after day, until the alarm is turned OFF again.

2) If the user wants to select the stop date option, then the alarm stop date should
     be greater than or equal to the alarm start date. (In the case of the alarm start
     date equal to the alarm stop date, then the alarm stop time should be greater than
     or equal to the alarm start time.)

To de-activate the alarm function go into NCI (CTRL and C) and type:

AL_OFF and ENTER

3.3.2. BATTERY Readings

To determine the current battery voltage, type BAT, followed by ENTER.

BAT and ENTER

3.3.3. CALIBRATION CHECK Function

This function checks the calibration of the unit by applying an impulse to the L, T, and V velocity sensors and printing a graph of their response. To perform a calibration check, type:

CAL AND ENTER

CAUTION: This command uses the same buffer as does the data acquisition routine for storing calibration graphs. CAL will replace the calibration graph in memory with this new calibration graph. If you press ↑ to return to the main program and resume printing an event, the most recent calibration graph will be printed, and not the one performed when the event was recorded.

3.3.4. CALIBRATION GRAPH Functions

The Calibration Graph can be toggled on and off from the NCI prompt. To turn off printing of the Calibration Graph, type:

CAL_OFF and ENTER

To re-enable printing of the Calibration Graph, type:

CAL_ON AND ENTER

The Calibration Graph is automatically set to ON when the unit is first powered up. See page 36 for further information on Default Settings.

3.3.5. COPIES Command

This command allows the user to select the required number of copies to be printed after each event. Type:

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COPIES and ENTER

This unit will prompt as follows:

COPIES ? 1

Enter a number from 1 to 9 followed by ENTER.

3.3.6. DATE Command

This command allows the user to set the date and time. Type:

DAT[E] and ENTER

The unit will respond with a prompt in the following format:

17-SEP-96 14:35:01
ENTER DATE (DDMMMYY)

Type in the correct date in the format shown. For example, 26JUL96.

The NS 5400 then prompts for time:

ENTER TIME (HHMM)

The date and time should be entered in the format shown followed by an ENTER.
Note that the 24-hour clock must be used. For example, 14:35 is the setting used to
indicate 2:35 P.M. It is not necessary to enter the seconds, and if either entry (date
or time) is already correct, an ENTER is sufficient.

The NS 5400 has the capability to keep track of the day of the week as well as the
time and date. Setting the correct day of the week allows the unit to adjust for leap
years, as well as adjust for daylight savings time. On the last Sunday in April the
time increments from 1:59:59 A.M. to 3:00:00 A.M. On the last Sunday in October
when the time first reaches 1:59:59 A.M. it changes to 1:00:00 A.M.

The day of the week is set as an optional argument to the **DAT[E]** command.

ENTER DATE (DDMMMYY)
5 29MAR96

This sets the date to 29 MAR 96, and the day of the week: 5 = Thursday.

The format for the day of the week is as follows:

1 = Sunday   5 = Thursday
2 = Monday   6 = Friday
3 = Tuesday   7 = Saturday
4 = Wednesday

There is presently no way of displaying what the day is currently set to. If no error is given, one can assume that it has been set correctly.

NOTE: If either the date or time is not entered in the prescribed format a "SYN ERR" is given and the NS 5400 prompts the user to re-enter the correct figures.

3.3.7. DIGITAL FILTER Function

The NS 5400 uses advanced digital filtering techniques for greater stability, and accuracy. The digital filter ensures that transducers are interchangeable. Setting the digital filter ON ensures essentially flat response from 2 Hz to 500 Hz. However, the digital filter does produce a slight delay in the calculation of data. If you are monitoring a blast and are not interested in seismic or sound response below 6 Hz, it may be beneficial to turn the filter OFF. This will lessen the cycle time of an event printout. To turn the digital filter OFF, type.

DF_OFF and ENTER

To turn the digital filter back ON, type:

DF_ON and ENTER

NOTE: The digital filter must be ON for the unit to meet the Specifications. The digital filter is automatically turned ON whenever the unit is turned ON. See page 36 for further information on Default Settings.

3.3.8. GRAPH Function

The following commands are used to include/exclude the time history graph as part of the printed out report. This is an alternate method of selecting whether a graph is to be printed or not, without having to go through the entire setup, to reach the prompt GRAPH (Y/N). (See also page 36 for further information.)

To turn on the graphical printout, type:

GR_ON and ENTER

To turn off the graphical printout, type:

GR_OFF and ENTER

3.3.9. GRAPH LENGTH Commands

The Graph Length commands set the length of the graphical printout. The length remains operative until it is either changed using an NCI GL command or until the NS 5400 is powered down. Upon powering up, the graph length will be reset to the default (40 cm. for metric units, 15 inches for imperial units). The following commands are used to set the graph length:

Metric Units	Imperial Units
GL_40 and ENTER sets the graph length to 40 cm.	**GL_15 and ENTER** sets the graph to 15 inches.
GL_75 and ENTER sets the graph length to 75 cm.	**GL_30 and ENTER** sets the graph length to 30 inches.

NOTE: __ indicates a space between characters.

(See page 36 for further information.)

3.3.10. ID Command

To obtain the instrument's serial number, type:

ID and ENTER

3.3.11. PAUSE Function

If PAUSE is enabled, the unit will pause after "PROCESSING EVENT DATA", but prior to printing the record. To select the PAUSE type:

PAUSE_ON and ENTER

The NS 5400 indicates it is pausing by printing:

PAUSING...

The NS 5400 then waits for an entry from the operator before printing the record. Pressing the **CTRL** and **Q** keys simultaneously will permit the unit to print the record.

To disable the PAUSE function, type:

PAUSE_OFF and ENTER

(See also page 36 for additional information.)

3.3.12. PRINT Command

This command prints the last event record. Type:

PRI[NT] and ENTER

However, please note that if any changes are made to the input data (i.e. date and time, client name, operation, location, etc.) the print function will be automatically disabled and the NS 5400 will print the following message:

DATA MODIFIED, PRINT DISABLED

It is important to note that if you want to abort the PRINT command at any time, just hit the ↓ key and the unit will return to the NCI> prompt.

If you have turned OFF the NS 5400 and later wish to do a PRINT of the last event, turn ON the unit and press the **CTRL** and **C** keys to enter the NCI mode.

NOTE: The PRINT function is disabled whenever the unit enters the scanning mode. If this is the case the last event can be printed by using the HELP menu.

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3.3.13. PRINTER ON Command

This command allows the operator to turn the printer off or on. Of course, this can be done at the start up prompt when the unit is turned on. To turn the printer on after the paper has run out, or any time it is off, type the following:

PRI[NTER]_ON and ENTER

To turn the printer off, type:

PRI[NTER]_ OFF and ENTER

Note that the printer is automatically turned off when the paper runs out or the battery voltage drops too low. If this has occurred a notation will appear beside the scanning message which indicates the paper is out or the printer is off. The printer must be turned back on, if printing is desired, by turning the unit off and back on again or by going into the NCI Mode and using the PRINTER ON command

3.3.14. RESULTS Location

The RESULTS function is used to specify the position within the report in which the unit will print the Results section. The Results section consists of 6 lines of data which summarize the peak velocities, peak displacement, peak particle acceleration, and peak frequency readings for the seismic and sound channels. The Results may be printed either immediately before or immediately after the graph.

To print the Results before the graph type:

RSLT_BEG and ENTER

To print the Results after the graph type:

RSLT_END and ENTER

The default setting is Results at the beginning of the graph. When the unit is turned on this setting is made automatically. See page 36 for further information on default settings.

3.3.15. RUN Command

This command exits NCI and takes the user back to the point of entry into NCI. (The Run command has virtually the same effect as typing ↑ at the NCI prompt.) Type:

   RUN and ENTER

3.3.16. STATUS Command

In response to this command, the NS 5400 will display the current version of the software housed in the unit, the battery voltage, the last event number printed and the status of all software switches. Type:

   STA[TUS] and ENTER

The NS 5400 will respond with a report in the following format:

```
5400/CM/M/RC/2H/FH/V5.2.5
6.3V
LAST EVENT #002
GL 75
DF ON
FPLOT OFF
GR ON
CAL ON
PAUSE OFF
AUTO OFF
COPIES 1
AL OFF
RSLT END
REMOTE OFF
BAUD 1200
RPPV OFF
MS OFF
PRI ON

NCI>
```

3.3.17. TEST Command

This command is used to test the unit's memory and printer. The **NS 5400** checks the data memory (RAM) by writing a pattern into it and confirming it by reading it back. Also the printer is sent the test string 3 times. To use the TEST function type:

TES[T] and ENTER

The NS 5400 will respond with a printout in the following format:

```
TEST
RAM OK
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
PTR OK

NCI>
```

CAUTION: Note that the TEST command corrupts the data in the unit's memory. If an event is in the memory, TEST will destroy it. Returning to the Main program using ↑ may result in completely erroneous results being displayed.

3.3.18. Frequency Plot Functions

All units are capable of generating two different frequency plots: the USBM/OSMRE plot and the DIN4150 plot. Please refer to Deutsche Norm DIN4150 Part 3 for complete information on the interpretation of this report. Refer to U.S. Bureau of Mines Report RI 8507 and U.S. Office of Surface Mining Reclamation and Enforcement C.F. R. Sec. 816.67 for information on these reports.

The Frequency Plot Report can be toggled on and off from the NCI prompt as follows. To turn off printing of the Frequency Plot, type:

FPLOT_OFF and ENTER

To turn on printing of the Frequency Plot type:

FPLOT_ON and ENTER

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Once you have selected FPLOT ON the unit will respond with a prompt showing the currently selected frequency plot. For example:

NCI> FPLOT ON
FPLOT US 1

NCI>

If you wish to change the type of frequency plot, use one of the following commands:

FPLOT_DN and **ENTER** to select the DIN4150 report.

FPLOT_US and **ENTER** to select the USBM/OSMRE report.

FPLOT_ GF and **ENTER** to select the Recommandation G.F.E.E. plot

The frequency plot can be further refined by printing separate graphical representations for each of the L, T, and V traces or combining them on one plot. (Of course, the 3 plots take more print time and consume more power.) To select the desired type of plot enter NCI Mode and type:

FPL[OT]_1   This results in a single plot, with each channel's value being shown by its corresponding letter (i.e.: L,T,V).

FPL[OT]_3   This results in 3 separate frequency plots, one for each seismic channel.

The unit retains the previous setting stored in memory when turned on. When the STATUS command is used the unit will show whether or not the Frequency Plot has been enabled and which settings were selected. See page 36 for further information on the Status command.

3.3.19. ZERO Event Number

In response to this command, the unit will zero out the event number and start at 001 when printing the next event. Type:

Z_EN and ENTER

The unit responds by typing **"EVENT # CLR'D"**.

3.3.20 RESTART Command

This command returns the user to the beginning of the **setup routine (see page 8)** without having to turn the unit 'OFF' and then 'ON' again. **To RESTART** type:

RES[TART] and ENTER

<u>The importance of this feature is that the default prompts do not get turned on by this restart</u>. A restart by the ON/OFF switch turns on certain default prompts. (See page 31)

3.3.21 AUTO SCAN Command

This feature allows you to set the unit so that when the power is switched on the unit will go into SCANNING automatically. To use this feature type the following:

AUTO_ON and ENTER

Make sure the prompts are all set correctly before turning the unit off. When the unit is next turned on, it will automatically go into scanning. If AUTO ON has been selected but the seismograph is unable to go into scanning because the prompts have not been set properly, an error message is printed as follows:

DATA MODIFIED, AUTO SCAN BYPASSED

To turn off the AUTO SCAN, enter the NCI Mode and type:

AUTO_OFF and ENTER

3.3.22 RPPV Command

This command is used to enable the Resultant Peak Particle Velocity (or Vector Sum) calculation in the results section. This calculation will appear on the paper as well as

the LCD. To turn this feature on, type:

RPPV_ON and ENTER

To turn this feature off, type:

RPPV_OFF and ENTER

Once this feature is turned on it will stay that way until the operator turns it off.

3.3.23 MILLISECOND TO PEAK OPTION

This option allows the user to calculate the time segment in milliseconds (ms) from the trigger point to the maximum vibration peak on each channel. This calculation is displayed in the results on the printer and stored in the memory. This result will not be displayed on the LCD. To turn on the MS option type:

MS_ON and ENTER

To turn off the MS option type:

MS_OFF and ENTER

This option will remain on until it is changed by the user.

3.3.24 REMOTE ON Option

This option is used to activate the RS232 port for data transfer. Once turned on data can be transferred by direct connection to a computer or by modem. To activate this feature, type:

REMOTE_ON and ENTER

To turn this feature off, type:

REMOTE_OFF and ENTER

This option will default to off once the unit is turned off and on again.

3.3.25 BAUD RATE Option

This option will allow the user to set the baud rate up to a maximum of 19.8. The communication software has been designed to pick the best rate for the data transfer. This option allows the user to pick any desired rate. To choose the baud rate you desire, type the following:

BAUDXXXXX   and   ENTER

This will select the baud rate entered. This rate will be store in memory and used at the time of the next data transfer.

3.3.26 HELP MENU

The HELP MENU can be entered once you go into NCI. Enter NCI by pressing CTRL and C at the same time. At the next prompt press CTRL and H at the same time. The following will appear on the LCD:

NORMAL RESTART
CONTINUOUS MONITORING RESTART
STATUS
DIRECTORY OF EVENTS
PRINT, VIEW, ERASE AN EVENT

Use the arrow keys (↑ or ↓) to move the cursor at the left of the menu to the desired option and press enter to select.

NORMAL RESTART - Use this selection to restart the seismograph from the beginning of the self trigger mode. This is also the exit from the HELP menu.

CONTINUOUS MONITORING RESTART - Use this selection to go into the continuous monitoring, strip chart mode. This is normally used for pile driving operations or any continuous vibration or sound measurement. This is the only selection for this mode.

STATUS - See page 30.

DIRECTORY OF EVENTS - Use this selection to list all of the events stored in memory. If the printer is turned on, the number of events stored and free space will be printed after a listing of the events. This will also appear on the LCD in the upper right corner after the listing. (See page 37)

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PRINT, VIEW, ERASE AN EVENT - Use this selection to first view the summary results of an event. By viewing the results the event can either be printed or erased by moving the cursor to the appropriate position and pushing ENTER. The help lines at the bottom of the LCD will instruct the operator on how to use this menu.

NOTE: Each time an event is viewed on the LCD this requires the event to be loaded into memory. The previously set prompts will then be changed to those of the event being viewed on the LCD. It may be necessary to edit the prompts before returning to scanning. This is easily done by exiting the HELP menu at the NORMAL RESTART selection.

3.3.4. DEFAULT SETTINGS

When the NS 5400 is turned OFF and ON again, the unit is automatically set up as follow:

Metric Settings	Imperial Settings
DF ON	DF ON
PAUSE OFF	PAUSE OFF
GR ON	GR ON
CAL ON	CAL ON
GL 40	GL 15
PRI ON	PRI ON

The AUTO ON, AL ON, RSLT BEG/END, RPPV ON, & MS ON will remain on their settings until they are changed by the user.

The FPLOT ON/OFF Switch defaults to OFF on a Cold Start (i.e. loss of power). Otherwise, the previous value, retained in memory , is active.

All of the Default Settings can be changed by issuing NCI commands. After making the appropriate changes you can resume operation by pressing ↑ , or entering either the RUN or RESTART commands. If you wish to immediately return to scanning press CTRL X. (Hold down the CTRL key while pressing X).

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3.5 USING INTERNAL MEMORY

The internal memory is designed to store 100+ events when the 2 second record length has been selected. These events are stored in memory with unique file names, such as E001.021. The "E" stands for "event." The 001 represents the event number as printed on the seismograph record at the time of a self trigger. The 021 is an extension which is used to make sure that no two same event numbers recur.

3.5.1. Viewing the Memory

1. The contents of the memory can be determined in two ways. The first way is for the operator to go into NCI (by pressing CTRL and C at the same time) and type

   DIR and ENTER

   The directory of the memory is printed out. The second way to view the memory is to go into NCI. Once there, type CTRL & H at the same time. This brings up the HELP menu. At the HELP menu use the arrow key to move the cursor up or down to the desired option. At the desired option, press the ENTER key to select "DIRECTORY OF EVENTS". All of the events stored in memory will be displayed in increments of five. The LCD display and printer will show the following:

   Directory of 5400M-2013

E001.001	01-Dec-96	14:51
E002.002	02-Dec-96	09:10
E003.003	03-Dec-96	11:50
E004.004	03-Dec-96	17:00
E005.005	04-Dec-96	08:50

   If the ENTER or SPACE key is pressed again, the contents of the memory will be displayed in the next increment of five events. Continue to press ENTER until all events are displayed. (It may be best to print this directory such that the entire list can be viewed at one time.)   37

Once the list is complete, the printer will show space used and open in the memory. On the LCD this will appear in the upper right corner as follows:

010/090

Note that each event number has a date and time associated with it. <u>This date and time indication is the best way to identify any blast or other event being recorded.</u> Always make sure the date and time are correct.

3.5.2 Print, View, Erase an Event

1. An event can be printed, viewed on the LCD, or erased by going to the HELP menu (see page 35). Once the operator moves the cursor beside this option, pressing the ENTER key will select it. The simple instructions at the bottom of the LCD will tell the operator what to do to accomplish their desired operation.

   Please note that once an event is ERASED, it will be deleted from the memory. If a printed copy has not been made, the event is lost.

3.5.3 CLEARING THE MEMORY

1. All events can be cleared from memory with one command. <u>Please note that all events stored will be deleted such that the memory will be completely empty.</u> This can be done by going to the NCI prompt (CTRL C) and typing:

   FORMAT and ENTER

   The printer will print

   FORMATTING

   and then show the free space in memory of 100 events.

4. USING THE CONTINUOUS MONITOR MODE

4.1. Setting Monitoring Parameters For The Continuous Monitor

Follow the initial set-up procedures outlined in section 2.2. The NS 5400 will print the following introductory message and pause for your response:

```
UNIT LAST USED 02-AUG-96  10:07
6.3V
                                    AL OFF
*****NOMIS NS 5400 SERIES*****
INSTRUMENT #NS 5400M-2008
**A/D CALIBRATED OK**
02-AUG-96  12:17:14
```

Note the format of the instrument number. An "M" in the serial number indicates a Metric unit. An "I" in the serial number indicates an Imperial (U.S.) unit. You must use the unit of measure appropriate for your machine, as indicated in parenthesis after each prompt.

The unit prints the date and time that it was used last. Verify that the date and time are correct - if not, use the NCI command DATE to set them (see page 48).

Always press the ENTER key to complete an entry. Accidental key presses can be corrected using the DELETE key. Note that a response may already be stored in memory at the right of the prompt. If this is the desired entry, then simply press ENTER to accept this entry.

1. To enter the Continuous Monitoring Mode go into the NCI by pressing CTRL and C at the same time. At the NCI prompt press CTRL and H at the same time to go into the HELP menu. The HELP menu appears as follows:

   NORMAL RESTART
   CONTINUOUS MONITORING RESTART
   STATUS
   DIRECTORY OF EVENTS
   PRINT, VIEW, ERASE AN EVENT

   The cursor can be moved up and down using the up and down arrow keys. Move the cursor to the line of your choice and press ENTER. The feature will be selected and executed. In this particular case the Continuous Monitor Mode will be activated.

2. The first question to appear on the LCD and printer is as follows.

   CUSTOMER: ABC MINES

   At this point the NS 5400 will pause and wait for your response. The NS 5400 stores all previously entered setup data, even when the unit is turned OFF. In the example shown above, ABC MINES was entered as the customer name the last time the machine was used. If you wish to keep data as shown, simply press ENTER and proceed to the next question.

   If you wish to change the data, simply type in the new response followed by an ENTER. Enter up to 25 characters per heading, terminating each entry with an ENTER. The DELETE key is used to delete the last character and then the second to last, etc., until a whole line is deleted, if desired. A solid box is printed whenever the DELETE key is pressed. The SHIFT key in conjunction with a second key will give numbers and symbols printed in red in the upper right corner of the alpha keys.

   In case of user error, you can go back to the previous question by pressing ↑.

   If you selected N at the Printer prompt, then the printer will not function and all communication will be through the LCD. This will conserve power and should be routine in the event of a low battery. Note that the battery voltage is printed once the unit is turned on each time. When the unit is operated on the internal battery only, the voltage should always be checked. The main user problem we have is from a low battery.

3. The NS 5400 now prompts the user as shown below. Note that the previously entered data is printed after each prompt.

Metric Units	Imperial Units
LOCATION:	**LOCATION:**
METERS TO BLAST : (1-32767,N) 100	**FEET TO BLAST : (1-32767,N) 100**
KGS PER DELAY : (1-3276,N) 300	**LBS PER DELAY : (1-3276,N) 300**
SCALE DISTANCE = 5.77	**SCALE DISTANCE = 5.77**
OPERATOR:	**OPERATOR:**
COMPANY:	**COMPANY:**

You may fill in the information for the prompts LOCATION, OPERATOR, and COMPANY as previously described.

The NS 5400 provides a convenient readout of scale distance based on entered values for distance to blast and charge per delay. This may be used for quick estimate of anticipated vibration levels, as well as regression analysis afterwards. The NOMIS Vibration Analysis System (NVAS) program is available to produce vibration prediction analysis and formulas.

The Distance to Blast must be entered in the range of 1 to 32767 or 'N' for none. Measure in meters for metric units or feet for imperial units. For Charge per Delay, the range is 1 to 3276 or 'N' for none. Measure in kilograms for metric units or in pounds for imperial units. <u>An entry must be placed at these 2 prompts.</u> If the distances and explosives per delay are not known before the blast, the operator should put " N " in this prompt.

If both the Distance to Blast and Charge per Delay are set to values other than "N', then the computed Scale Distance is calculated and displayed. Scale Distance is equal to the Distance to Blast divided by the square root of the Charge per Delay.

4. The unit now asks whether to monitor seismic activity. If the answer is **Y** it asks you to enter a range. The 5 ranges possible are shown in the parentheses.

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Metric Units	Imperial Units

MONITOR SEISMIC (Y/N)? Y
Y
RANGE(6.25, 12.5, 25, 50, 100 mm/s)? 6.25
50

MONITOR SEISMIC (Y/N)? Y
Y
RANGE9(0.25, 0.5, 1, 2, 4, IPS)? 0.25
0.5

5. The unit now asks whether you want Resultant or Peak values:

    RESULTANT OR PEAK (R/P)? P

6. The unit now asks whether to monitor sound. If the response is **Y** it asks you to enter a range. The **2** ranges possible are shown in parenthesis:

    MONITOR SOUND (Y/N)? Y
    Y
    RANGE (120/140 dB) ? 120
    140

    120 means 100 to 120 dB.   140 means 100 to 140 dB.

7. Next you must select the interval at which short reports are to be printed:

    REPORT INTERVAL (0.1 - 99.0 HRS, N)? 0.1
    24

    NOTE: 'N' means only on demand. Short reports can be obtained on demand at any time. For more information on short reports refer to **No. 13 below.**

8. The Bar Interval is the number of seconds of monitoring that one bar will represent. The absolute value of the velocity/sound level that occurs during the bar interval is printed as a single bar. Note that the printer prints seven bars at once, and that , on the paper, there are 25 bars for every cm (64 bars for every inch).

    BAR INTERVAL (1 - 60 secs)? 45
    5

Selecting **5** will result in 5 seconds of monitoring for velocity/sound level being printed as one bar (in bar chart fashion). Since seven bars are printed at once, the printer will print a new line every thirty-five seconds (seven times five). The default value is 45. This is the value automatically set when the unit is turned OFF and then turned ON again.

9. The unit now enters a self-check mode and will print out the message:

    A/D CALIBRATED OK

10. The unit will then print a calibration graph so as to verify that the transducer and microphone are plugged in and working correctly. To run the calibration check again, press ↑ to return to 'Report Interval' and then press ENTER. This is handy if you have forgotten to plug in the devices prior to monitoring.

    After the calibration graph, the unit will print the message:

    TO START MONITORING PRESS ENTER

11. The unit will then wait for an ENTER. Press ENTER to commence monitoring. Once the unit has begun monitoring, it is <u>always</u> monitoring, even while printing, the bar chart, short report or status. Since monitoring takes place while printing, the printer will operate more slowly.

12. While the unit is monitoring, at the previously selected interval, it will print out bar charts representing the peaks seen. A continuous bar chart will be printed out until:

    - the unit's battery runs down;
    - it runs out of paper;
    - it is restarted by pressing CTRL ↓ (Press both the CTRL and the ↓ keys simultaneously);
    - it is turned OFF.

    See Figure 4 for an example of the Bar Chart.

13. The Short Report will be printed out at the interval requested. This report contains the current date and time, the seismic peak and the date and time of its occurrence, the sound peak and the date and time of its occurrence. The reported peaks are those that have occurred <u>since</u> the <u>last</u> short report. This will cause the unit to print the seismic and sound peaks and their times of occurrence for the 24 hour period.

The Short Report can be produced on demand at any time, by pressing the CTRL and R keys simultaneously. See Figure 4 for an example of the Short Report.

14. The unit will produce a Status (Log) Report upon request. Press the CTRL and S keys simultaneously. The Status Report contains the following information:

   - date and time monitoring commenced;
   - seismic peak since monitoring commenced, and the date and time when it occurred;
   - sound peak since monitoring commenced, and the date and time when it occurred;
   - report interval in hours;
   - bar interval in seconds/bar;
   - sound range selected;
   - battery voltage;
   - current date and time.

   See Figure 5 for an example of the Status Report.

15. If you wish to exit the monitoring mode, for example to change the setup parameters, press CTRL ↓ simultaneously; the unit will restart at the beginning of the setup. .

   NOTE: CTRL X is supported only in the Self-Triggering Mode.

16. Once you have finished with the unit, unplug the transducer and microphone and restore them to their respective storage locations. Lock the unit (ensuring that the POWER switch is in the OFF position) and store it in a safe, dry place until you are ready to use it again. See the section on "Maintenance" for additional information on caring for your equipment.

   Be sure to charge the battery from time to time, in order to ensure that the unit is always ready to go when you are. See page 51 for additional information on battery charging and capacity.

   There are many other functions available within the unit. These are described in other sections of this manual. Please also refer to the sections on using the NCI mode.

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```
**** NOMIS  NS 5400  SERIES ****
INSTRUMENTAL # NS 5400M/D/RC-0362
** A/D CALIBRATED OK **
17-OCT-90  09:15:43
CUSTOMER:ABC MINES
LOCATION:JONES FARM
DISTANCE TO BLAST (m): (1-9999,N) 1000
CHARGE PER DELAY (kg): (1-999,N) 400
SCALE DISTANCE = 50.00
OPERATOR:GEORGE
COMPANY: XYZ CONSULTING
MONITOR SOUND (Y/N)? Y
RANGE (6.25, 12.5, 25, 50, 100 mm/s)  100
RESULTANT OR PEAK (R/P)? P
MONITOR SOUND (Y/N)? Y
RANGE (120/140 dB)?  120
REPORT INTERVAL (0.1-99 hrs, N)? .1
** A/D CALIBRATED OK **

            CALIBRATION GRAPH

            ****************

            TIME= .04910 sec/mm

            SOUND= 0.195 kPa/div

            L.T.V= 25 mm/s/div
```
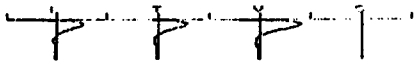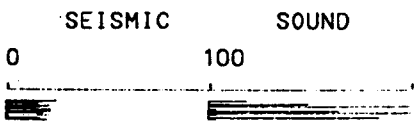
```
TO START MONITORING PRESS ENTER

            GRAPHICAL RECORD

            ****************

 BAR INTERVAL (sec, 81 bars/cm) = 15

            SOUND= 20 dB/div

            SEISMIC = 100 mm/s/div


NS5410CM  04-DEC-96  18:23:48


        SEISMIC          SOUND
   0                100
```

```
04-DEC-96  18:29:48

  25.8 mm/s PEAK   04-DEC-96  18:23:56

  124 dB PEAK      04-DEC-96  18:25:32
```

Figure 4. Continuous Monitor Report Format.

```
MONITOR BEGUN:  17-OCT-90   09:16:11
PEAKS SINCE MONITORING BEGUN :
 24.0 mm/s  RPPV  17-OCT-90  09:18:19
119 dB     PEAK  17-OCT-90  09:16:55
REPORT INTERVAL  =  .1 hr.
BAR INTERVAL  (sec, 25 bars/cm)  =  15
SEISMIC RANGE  =  100 mm/s  RESULTANT
SOUND RANGE   =   120 dB
6.3V
17-OCT-90  09:22:35
```

Figure 5. Continuous Monitor Status Report

4.2. USING NCI COMMANDS IN THE CONTINUOUS MONITOR MODE

NS 5400 has certain features which can be activated by entering the "NCI" (NOMIS Command Interpreter) mode. This mode can be entered <u>while you are setting up for monitoring</u> (but not once the unit actually begins monitoring).

To enter NCI press the CTRL and C keys simultaneously. The **NS 5400** will respond by printing

NCI>

The following NCI functions are available:

> <u>NOTE</u>:   [ ] denotes optional characters.
>
> Both the PAPER FEED and ↑ keys are active at all times
> when the unit is in the **NCI** mode. They have the following functions:
>
> PAPER FEED: The PAPER FEED key can be pressed to advance the paper.
> This key should be used when changing paper rolls or when testing the
> paper advance mechanism. It is also active whenever the unit is waiting for
> a response from the user.
>
> ↑ : The ↑ key exists the **NCI** mode, and takes the user back
> to the previous mode of operation that was in effect when CTRL C was
> pressed. If an **NCI** command is in process, it will terminate that process.
>
> ***CAUTION***: If you return to the main program while an event is being
> processed or printed out, the data will be corrupted if a TEST command
> was performed while in the **NCI** mode.

4.2.1. BATTERY Readings

A separate Battery Check function is available, reducing the amount of paper and power consumption from that of the 'STATUS' command. To obtain the current battery voltage, type **BAT**, followed by an **ENTER**:

BAT and ENTER

4.4.2. DATE Setting

This command allows the user to change the date and time. Type:

DAT[E] and ENTER

The unit will respond with a message in the following format:

02-AUG-96   01:06:21
ENTER DATE (DDMMMYY)

Enter the date in the format shown. For example,

01DEC96

The NS 5400 then prompts for time:

ENTER TIME (HHMM)

The time should be entered in the format shown followed by an **ENTER..** Use the 24-hour clock when entering the time. In the example shown above 14:55 indicates 2:55 P.M. For example,

1455

NOTE: If either date or time is not entered in the prescribed format a **"SYN ERR"** is reported and the NS 5400 allows the user to re-enter the correct figures.

The NS 5400 has the capability to keep track of the day of the week as well as the time and date. Setting the correct day of the week allows the unit to adjust for leap years, as well as adjust for daylight savings time. On the last Sunday in October when the time first reaches 1:59:59 A.M. it changes to 1:00:00 A.M.

The day of the week is set as an optional argument to the **DAT[E]** command.

ENTER DATE (DDMMMYY)
529MAR96

This sets the date to 29 MAR 96, and the day of the week: 5 = Thursday.

The format for the day of the week is as follows:

1 = Sunday	5 = Thursday
2 = Monday	6 = Friday
3 = Tuesday	7 = Saturday
4 = Wednesday	

There is presently no way of displaying what the day is currently set to. If no error is given, one can assume that it has been set correctly.

4.2.3. ID Command

In response to this command the unit prints the instrument's serial number. Type:

ID and ENTER

4.2.4. RESTART Command

This command returns the user to the beginning of the setup procedure (see page 40) without having to turn the unit **'OFF'** and then **'ON'** again. Type:

RES[TART] and ENTER

4.2.5. RUN Command

This command exits **NCI** and takes the user back to the point from which they entered **NCI** mode. (The Run command has virtually the same effect as typing in ↑ at the NCI prompt). Type:

RUN and ENTER

4.2.6. STATUS Command

In response to this command, the NS 5400 will display the current version of the software housed in the unit and the battery voltage. Type:

STA[TUS] and ENTER

The NS 5400 will respond with a printout in the following format:

```
NCI>
STA
5400/CM/M/2H/V3.14C
6.1V
NCI>
```

4.2.7. TEST Command

This command is used to test the unit's memory and printer. The NS 5400 checks the data memory (RAM) by writing a pattern into it and confirming it by reading it back. Also the printer is sent the test string 3 times. To use the Test function type:

TES[T] and ENTER

The NS 5400 will respond with a printout in the following format:

```
TEST
RAM OK
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789
PTR OK
NCI>
```

CAUTION: Note that the TEST command corrupts the data in the unit's memory. If an event is in the memory, TEST will destroy it. Returning to the main program using ↑ may result in erroneous results being displayed.

NOTE: No other NCI commands may be used in the Continuous Monitor Mode. Additional NCI commands are available in the Self-Triggering mode only (see page 21 for further details).

5. MAINTENANCE

5.1. PHILOSOPHY

The NS 5400 has no user-serviceable components. If the operation of the unit is suspect, consult your dealer as to the proper procedure to follow to have the unit repaired. This section will cover those regular maintenance items which are the responsibility of the user, i.e. changing the paper, charging the battery, cleaning the machine, etc.

5.2. VERIFYING UNIT OPERATION

Verification of proper operation is done by following Section **3**, "Using the Self-Triggering Mode". If the unit passes its own internal diagnostics (executed when the unit is turned on) and run through a complete sequence with the graph in a proper manner with no errors, the unit is functioning correctly, and only the transducer and microphone need to be checked to ensure 100% validity. These items are calibrated at the factory and should not require adjustment. However, if the unit's calibration is suspect, your agent can assist in verifying its proper operation. It is recommended that the unit be checked twice yearly by qualified personnel.

5.3. BATTERY

5.3.1. State

The BATTERY lamp glows red to indicate that the AC adapter has been plugged in and that the battery is being charged. The BATTERY lamp will remain lit as long as the AC adapter is plugged in, even if the battery has been fully charged.

For a precise determination of the battery level, check the voltage regularly, using the **NCI**, **'STATUS'**, or **'BAT'** commands. (See Sections **3.2** and **4.2** on using **NCI** commands.) It is recommended that the battery not be allowed to drop below 6.0 Volts (V), and immediate recharging is required when the level has fallen to 5.5.V. The unit is designed to automatically shut-off when the battery reaches approximately 4.8 V and so these guidelines will help to prevent accidental shut-off due to a low battery.

5.3.2. Charging

The AC adapter provided is used to charge the batteries. The adapter provides 9VDC at 500 mA and can fully recharge a battery in about 50 hours.
For further information regarding the use of other external power supplies see page 47.

The battery should be charged until the battery reading indicates 6.5V. While the AC adapter is connected to the unit, the battery lamp will glow red. Use either the NCI "BAT" or "STATUS" command to determine the level of charge. Once the battery reaches 6.5 Volts DC, the charger may be disconnected. Note that the unit will read 6.7V with the charger plugged in. Always check the battery voltage with the charger disconnected. It is best to wait at least five minutes after the charger has been unplugged.

Please note that the AC adapter may be left connected indefinitely if the unit is located near a source of AC power. This will ensure that the battery is always fully charged.

5.3.3. Using the External Charging Connection

An external charging connection is located on the end of the unit. This connector gives external access to both the battery and the power input of the unit. The External Power plug connects these two together. Both circuits are internally fused at 4 Amps (fast-blow). The charging plug is a positive (+) tip standard type plug.

CAUTION: If any of the following conditions involving the use of this connector and/or its functions are violated, NOMIS will not assume responsibility for any resulting damage.

This connector allows users to power the unit from an external source (i.e. larger capacity battery for longer running periods, permanent installations where it would be more convenient to swap batteries, etc.) and/or charge the battery using a solar panel.

The following section details these and indicates precautions that should be observed when making use of the connector.

5.3.3.1. Powering the Unit from an External Source:

The unit may be powered from an external DC source providing that:

1) The voltage is between 5.5 and 7.0 volts DC.

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2) Under no circumstances does it exceed 7.0 VDC. Damage may occur as a result,

3) The power source is capable of delivering at least 2 Amps without a drop in its output voltage.

4) Great care is taken to connect the polarity of the external source correctly. Damage may result if reversed.

5) If the external source is not current-limited, it should have a 20 Amp fuse placed in series with it before connecting to the unit.

5.3.4 BATTERY MAINTENANCE

The NS 5400 contains a gel-type battery pack. It is sealed, enabling it to operate in any orientation, and requires no maintenance other than charging.

The battery is not considered a user-serviceable component of the seismograph. Any attempt to open the unit is strongly discouraged by NOMIS and may void the warranty. Consult with your agent or NOMIS on how best to approach repairs to the unit.

The internal battery has a very large short circuit current capacity (in excess of 200 Amps). Extreme caution should be exercised when working in its proximity. Always remove all rings and watches prior to opening up the unit. <u>Always disconnect the battery before servicing the unit</u>. When replacing the battery, it is recommended that it be purchased from NOMIS, to ensure original equipment quality.

The battery is a sealed unit and no attempt should be made to remove its vent cover or to add electrolyte to it.

If any problem with the battery appears to exist, contact NOMIS for advice immediately.

5.4 CHANGING THE PAPER

The NS 5400 incorporates an integral paper take up mechanism to handle prolonged monitoring applications. This consists of a nylon take up spool which is held in mesh by a spring loaded pin on the end of the take up spool.

Paper Insertion/Removal

The paper can be torn off from the printer at the point where it **exits the printer body**. This will provide a good, smooth tear, in most cases. Of course, with the unit turned on, the PAPER FEED key can be used to advance the paper such that the paper can be torn by hand.

To remove the paper from the take up spool, lift the plexiglass door by pulling up. Simply hold the take up spool with two fingers and push to the left. This will disengage the mesh on the right side of the take up spool. The take up spool can then be lifted vertically out of the printer case.

The supply roll of paper for the printer is located directly below the printer body. The new roll of paper will rest in this compartment and feed from this position. It is important that the paper feeds from the side of the paper roll closest to the front of the seismograph. This is thermal paper which will allow printing on one side only. (If the printer feeds paper but does not print, check to make sure the correct side of the paper is being printed upon.)   The paper should be pulled from the supply spool towards the printer and enter the printer through the slot in the bottom. The paper release lever on the right side of the printer should be flipped up to allow the paper to be pushed through the printer. Push the paper straight through from bottom to top. Once through make sure the paper alignment is straight and close (flip down) the paper release lever. If the printer is already on, the PAPER FEED key should be pressed continuously to feed the paper. If the seismograph has not been turned "ON", power the unit on and respond to the first question, PRINTER (Y/N) . If the printer ran out of paper and turned off automatically, you will need to 1) turn the unit off and back on again or 2) go into the NCI Mode and type PRI ON and ENTER. As previously stated, care should be taken to make sure the paper is aligned straight going into and coming out of the printer mechanism. This will prevent the paper from walking to one side.

Once the paper has been fed through the printer, the seismograph can be operated in two ways. The first way is for the paper to be fed through the available slot in the printer door. This will allow for the paper to be removed rather easily after individual recordings. Using this method, the paper can be torn off without opening the printer door.

5.4 CHANGING THE PAPER (CONT'D)

The second method for using the seismograph is to use the take up mechanism provided for the paper. The take up spool has been designed so as to provide for easy paper removal and insertion. The paper should be folded into a point and pushed through the open slot in the take up spool. Care should be taken to align the paper on the take up spool with the path coming out of the printer body. If the paper is collected on the take up spool, it can be removed rather easily by pushing the take up spool out of the finished roll. The spool should be pushed from the end with the retractable pin. This will eliminate the time and necessity of unwinding many feet of paper.

A diagram of the printer paper path is provided on the adjacent page to clarify the paper loading operation.

MAINTENANCE

PRINTER SIDE VIEW

PRINTER BODY

PAPER RELEASE LEVER

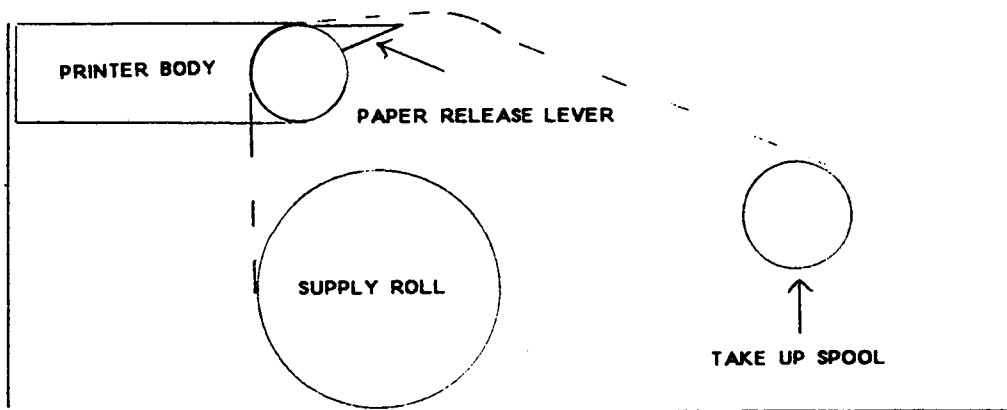SUPPLY ROLL

TAKE UP SPOOL

Figure 6- Paper Path for NS 5400 Printer

5.5 Printer Maintenance

The printer in your NS 5400 seismograph is a mechanical device. As such, it is probably the most important and sensitive component of your machine. Its proper operation is vital to insure the accuracy of the graphical print out. This printer is a high resolution, super fast printer which provides excellent print quality in a minimal period of time.

Consequently, it is important that the printer be protected as much as possible from the dust and grit which is always present in blasting operations. Otherwise, over time, this dirt will build up inside the printer and may impede its operation. This printer is very durable and should endure most environments, even when abuse is evident.

The philosophy behind this printer is that little maintenance should be required to maintain its excellent print quality. The printer should never be oiled as this is not required and will only harm the operation of the printer. The printer should be inspected each time the paper is changed. There are very few moving parts visible to the eye. Any paper lodged in the paper path should be removed, as this may impede paper flow through the unit.

5.6. CLEANLINESS

The NS 5400 is a delicate, scientific instrument, and even though it is a portable field unit, it should be treated with the respect appropriate for such a device. Reasonable care should be taken to avoid the ingestion of dust, moisture, etc., into the unit. The same care should be taken for the transducer and microphone.

In addition, when you are finished with the unit, disconnect the transducer and microphone and (carefully) stow them back in their storage compartments. It is a good idea to wipe the cables down with a cloth to remove excess water, as this can cause corrosion and mildew if trapped in the sealed case. Be sure that the windscreen is dry before storing it inside the case.

It is recommended that after the day's use, and especially if the unit has been exposed to excessive moisture, condensing vapor, liquids, dust, dirt, etc., the unit be cleaned inside and out with a non-abrasive cloth which has been dipped in warm water and mild detergent (dish type or similar).

The bands and vinyl overlays are made of a soft plastic and should not be exposed to solvents of any kind (other than the mild detergent used when cleaning).

Care should be taken not to spill any liquids inside the paper cavity as this may have a harmful effect on both the paper and the unit.

6. SPECIFICATIONS

"A" Sound Weighting

The "A" Sound Weighting is now available on all units, along with the previously supplied "F" weighting. "A" sound weighting of sound pressure is weighted to match the frequency response of the average human ear.

Another feature introduced is windowing during filtering. During digital filtering, a windowing function (Cosine squared) is applied to the first 100 samples in the S channel to prevent overshoot.

During setup the unit will prompt for the sound weighting desired:

    SOUND WEIGHTING (A/F)?F
    A

In the Results section of the report the frequency will be reported as dBA if "A" weighting was selected, dBF for Flat and dBN if the digital filter was disabled.
e.g.

    PEAK SOUND   101 dBA   0.0023 kPa
    Frq Pk Snd (Hz) 24.3

In the above example, the peak on the sound channel was 101 dBA (i.e.20uPa). 24.3 Hz was the characteristic frequency of the peak that occurred at 101 dBA.

Specifications:

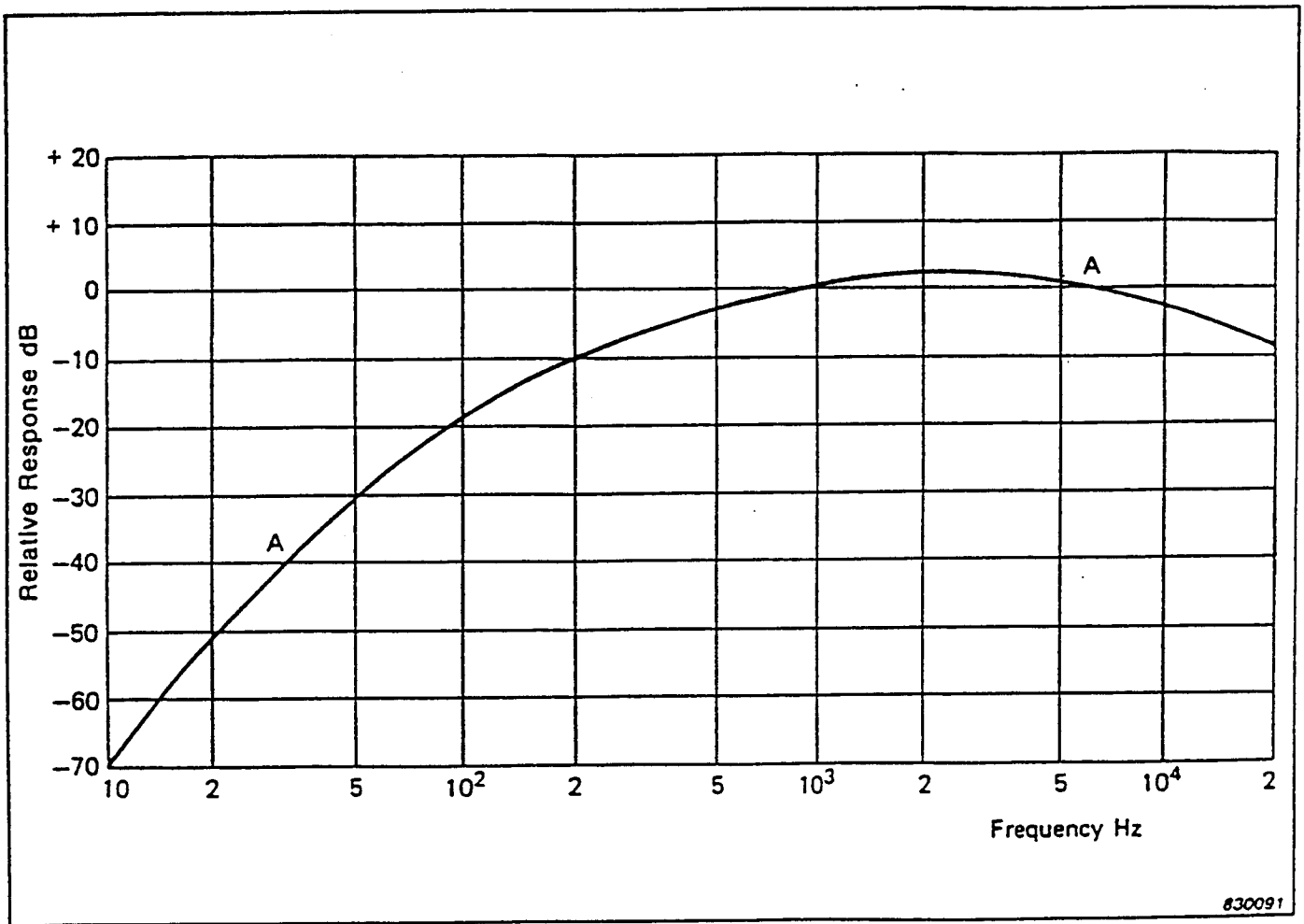|	
Weighting Scale:	"A" sound pressure level weighting
Measuring Range:	100 - 140 dBA peak (Low Level Option- 70 - 100)
Frequency Range:	40 Hz to 500 Hz
Accuracy:	± 2 dBA from 100 - 140 dBA
Trigger Level:	dBA is not directly applicable to the sound trigger level, as the seismograph triggers on pre-filtered data.

FIGURE 7   NOMINAL "A" WEIGHTING FREQUENCY CHARACTERISTICS

SEISMIC

Trigger Level:

Metric Units — Programmable in steps of 0.1 mm/sec. from 0.5 mm/sec. to 100 mm/sec.
Minimum Trigger level of 0.3 mm/sec optional

Imperial Units — Programmable in steps of 0.01 inch/second from 0.02 inch/second to 4.00 inch/second.
Minimum Trigger level of .01 ips optional

Measuring Range:

Metric Units — $\pm$ 100 mm/s (Auto-range scaled output - 5 ranges - 6.25 / 12.5 / 25 / 50 / 100)
200 mm/sec Optional
Low Level Option - .1 to 50 mm/sec.

Imperial Units — $\pm$ 4.00 ips (Auto-range scaled output - 5 ranges - 4 / 2 / 1 / 0.5 / 0.25)
8.0 IPS Optional
Low Level Option - .007 to 2.0 IPS

Frequency Range: — 2 - 500 Hz (2,3,5-second graph)
2 - 250 Hz (10-second graph)
2 - 150 Hz (15-second graph)
1 Hz Geophones Optional

Accuracy: — $\pm$ 3% of full scale of 160 Hz

Transducers: — Three perpendicular oriented electrodynamic, normalized Geophones, 2 Hz Standard (1 Hz Optional)

SOUND

Weighting Scale: — F (Flat or linear) & A Scales

Measuring Range:	F: 100 - 140 dBF peak (80 - 120 optional)
	Auto range scaled: 100 - 120, 100 - 140 dB
	A Scale: 100 - 140 dBA peak (70 - 100 Optional)
Metric Units	0 to 19.46 x 10^{-2} KPa graphically
Imperial Units	.000055 to .028 psi graphically
Frequency Range:	2 - 500 Hz
	F Scale: -3 dB at 2 Hz
Accuracy:	$\pm$ 0.7 dB at reference point (127 dB, 250 Hz)
Trigger Level:	100 - 140 dB in 1 dB steps

RESOLUTION/DYNAMIC RANGE: (METRIC UNITS) (V3.15 or later)

READING	5 Sec. F_s = 1024 sps		10 Sec. F_s = 512 sps		15 Sec. F_s = 341 sps	
	Resolution	Range	Resolution	Range	Resolution	Range
PPA (g)	±.02	21.20	±.01	10.60	±.007	7.08
PPV (mm/s)	±.1	100	±.1	100	±.1	100
PD (mm)	±.0001	12.5	±.0002	12.5	±.0003	12.5
Frq (Hz)	$\Delta Frq = \dfrac{1}{k}\dfrac{(Frq)^2}{F_s}$	0.5 to 512.0	Same as 5 Sec.	0.25 to 256.0	Same as 5 Sec.	0.167 to 170.0

RECORDING PERIOD

Note: "F_s" denotes the number of samples per second per channel

To Determine k:

	Frq ≤ F_s/4	Frq > F_s/4
PPV ≥ 12.5 mm/sec	k = 8	k = 4
1.6 mm/sec ≤ PPV < 12.5 mm/sec	$k = \dfrac{PPV}{1.563\ mm/sec}$	$k = \dfrac{PPV}{3.125}$
PPV < 1.6 mm/sec	k = 1	

Figure 9. Resolution/Dynamic Range:(Metric Units)

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RESOLUTION/DYNAMIC RANGE: (IMPERIAL UNITS) (V3.15 or later)

RECORDING PERIOD

READING	5 Sec. F_s = 1024 sps		10 Sec. F_s = 512 sps		15 Sec. F_s = 341 sps	
	Resolution	Range	Resolution	Range	Resolution	Range
PPA (g)	±.02	21.20	±.01	10.60	±.007	7.06
PPV (in/s)	±.005	4.00	±.005	4.00	±.005	4.00
PD (in)	±.000004	0.5	±.000008	0.5	±.000011	0.5
Frq (Hz)	$\Delta Frq = \frac{1}{k} \frac{[Frq]^2}{F_s}$	0.5 to 512.0	Same as 5 Sec.	0.25 to 256.0	Same as 5 Sec.	0.167 to 170.0

Note: "F_s" denotes the number of samples per second per channel

To Determine k:

	Frq ≤ F_s / 4	Frq > F_s / 4
PPV ≥ 0.5 in/sec	k = 8	k = 4
0.05 in/sec ≤ PPV < 0.5 in/sec	k = $\frac{PPV}{0.06252}$ in/sec	k = $\frac{PPV}{0.125}$
PPV < 0.05 in/sec	k = 1	

File: Resolutn.Imp

Figure 10. Resolution/Dynamic Range: (Imperial Units)

File: Resolutn.Imp

GENERAL

Recording:	Thermal printer, dot matrix, graphic capability, 3.2 inches wide paper printout, 55 + events per roll, paper take up standard.
Internal Memory:	Internal memory standard - 100+ event capacity for 2 second records.
Date and Time Indication:	Month, day and year. Hours, minutes, and seconds (24-hour clock)
Measuring Time:	User selectable, 2,3,5,10, 15 sec recording period, including .5 sec pre-trigger information.
Total Cycle Time:	Approximately 75 seconds with long report (2 sec. event) 40 seconds with printer off
Shielding:	Analog circuits shielded against interference Special RF shielding layers on keyboard, printer doors, LCD, and interior of case
Temperature Range:	0 - 120° F -20 to +60° C
Graphical Printout:	USBM/OSM log log plot of Peak Particle velocity vs Frequency (standard) Particle velocity vs Time Graph - .25, .50, 1, 2, 4 IPS scales on seismic trace: (8.0 IPS optional) (auto-ranging) 100-120 dB, 100-140 dB scales (70-120 dB optional) on sound trace (auto-ranging) Timing marks every 1/10 second .000055 to .028 Psig on sound

Metric Units:

	L	T	V
PPV:	mm/sec		
PD:	MM	MM	MM
PPA:	g	g	g
Freq:	Hz	Hz	Hz
RPPV:	True Vector		
Peak Sound:	dB, Kpa		
Frq Pk Snd:	Hz		

Imperial Units:

	L	T	V
PPV:	IN/S	IN/S	IN/S
PD:	IN.	IN.	IN.
PPA:	g	g	g
F(Vel):	Hz	Hz	Hz
RPPV:	True Vector		
Peak Sound:	dB, psig		
Frq Pk Snd:	Hz		

LCD:	8 line by 40 column text display Back light for dim areas (optional) (LCD viewing greatly reduces power use by turning off printer)
RS 232:	Standard on all units
Storage:	Unit is self-contained in unbreakable plastic case
Weight:	16 lb. (7.3 kg)
Size:	7 x 10 x 11 inches 178 x 154 x 279 mm
Instrument Number:	NS 5400M-XXXX where XXXX is the unit number. NS 5400I-XXXX

M - indicates a Metric Unit
I - indicates an Imperial Unit

Maintained when Instrument is Shut Down:	The clock, instrument number, event number and user-entered data, internal memory protected against power loss with internal lithium battery.
Mounting Accessories:	Microphone - mast (adjustable to 36 inches/ 1 meter) and support bracket on case Transducer - 3-inch spike with 3/8-inch stud, detachable leveling plate 10 feet (3 meter) extension cord for transducer and microphone (optional)

POWER

Internal Battery:	6V, 12.5Ah gel-type, rechargeable Up to 20 days operation with printer on
External Power:	AC Adapter: 9 VDC at 500mA. Time to charge flat battery will vary between 10 to 50 hours, depending upon its state of charge.

7. QUICK REFERENCE

7.1. COMMANDS

NCI Mode

Description	Command	Page
Turn off/on alarm function	AL OFF/AL ON	23
Set alarm date and time	AL ON	22
Print current battery level	BAT or CTRL & C	21,24,30,47
Perform Calibration Check	CAL	24
Disable/Enable Calibration Graph	CAL OFF/CAL ON	24
Set number of report copies	COPIES	24
Change date and time	DATE	25, 48
Disable/Enable the Digital Filter	DF OFF/DF ON	26
Disable/Enable Frequency Plot Report	FPLOT OFF/FPLOT ON	31,32
Select DIN4150 Frequency Plot	FPLOT DN	31,32
Select USBM/OSMRE Frequency Plot	FPLOT US	31,32
Select 15 inch/40 cm graph	GL 15/GL 40	27
Select 30 inch/75 cm graph	GL 30/GL 75	27
Turn off/on graphical report	GR OFF/GR ON	27,49
Print instrument serial no.	ID	27, 49
Turn off/on Pause function	PAUSE OFF/PAUSE ON	28
Reprint last event	PRINT	28
Turn on printer after error	PRI ON	29
Turn printer off when not needed	PRI OFF	29
Go to set-up procedure	RESTART	15, 33, 49
Print Results before/after graph	RSLT BEG/RSLT END	29
Exit from NCI Mode	RUN, CTRL & X, ↑	6,21,30, 47,49
Display software version, battery level, event #, functional settings	STATUS	30, 49
Test memory and printer	TEST	5, 31,50
Zero event number	Z EN	32
Automatic scanning when turned on	AUTO ON	33
RPPV results printed	RPPV ON/RPPV OFF	33
Millisecond from trigger to peak	MS ON/MS OFF	34
Activate RS 232 port	REMOTE ON	34
Directory of memory	DIR	36
Help menu	CTRL & H	35,37
View event from memory	CTRL & H	37
Clear all events from memory	FORMAT	38

QUICK REFERENCE

Control Commands

Description	Key	Page
Enter NCI Mode	CTRL & C	5,21,47
Resume after Pause	CTRL & Q	5,28
Return to Scanning	CTRL & X	5,36
Interrupt the Continuous Monitor	CTRL & ↓	5,43,44
Print Monitor Short Report	CTRL & R	44
Print Monitor Status Report	CTRL & S	44
Abort NCI Operation/Exit NCI	↑	6,36,47
Light up LCD	CTRL	5
Help menu	CTRL & H	35,37,40

Other Functions

Description	Key	Page
Delete character to left	DELETE	9,39
Terminate graph printing	↓	6,15,28
Repeat last prompt	↑	6,21,30,40
Advance paper 1 line	PAPER FEED	21,54
To end operator input	ENTER	4, 9,39,40
Enter numbers (red characters)	SHIFT (red)	5,9,40

7.2. ERROR MESSAGES

Description	Message	Page
A/D failure	**A/D ERROR	6
Sensor failure	L, T, V, S BAD	7
Incorrect trigger value	RNG ERR	7
Incorrect data entry	SYN ERR	7
Low Level Option Only Transducer Not Connected	A/D ERROR CONNECT TRANSDUCER	6

8. SPECIAL NOTES

8.1. TRANSDUCER PLACEMENT PROCEDURE

Placement of the transducer block is very important when taking vibration readings. It is important to realize that this block must always make firm contact with the surface if the vibration reading is to be accurate. There are very few incidents where the transducer block can be simply placed on the surface for a vibration measurement. While movement can not be seen with the eye, the possibility does exist that the transducer can actually vibrate or "walk" on the surface during vibration activity. This creates an inaccurate reading due to the fact that the measurement is that of the block vibrating against the surface and not the actual vibration source. The simple procedure of leveling the transducer on a surface is a minor part of setting up the instrument correctly. It is very important to make sure that the transducer is secured to the surface.

There are 4 generally accepted procedures for mounting the transducer in preparation for recording vibration activity. These 3 procedures are listed below.

1. Bury transducer in soil.
2. Secure transducer block with bolt thru center hole.
3. Spike transducer to soil.
4. Place sand bag on top of transducer block.

These are the 4 most generally excepted procedures for assuring there is no transducer slippage. These procedures are arranged in the order of the most desirable on down to the least desirable.

Burial of Transducer Block

Burying of the transducer block is the most accepted procedure and will produce the most dependable results. This procedure can be further evaluated using the U.S. Bureau of Mines Bulletin RI 8506 - Measurement of Blast Induced Ground Vibrations and Seismograph Calibration. For most blasting operations (vibration readings less than 1.0 ips, 25.4 mm/s) the transducer block can be buried in the soil with the top of the block level with the surface of the ground. It is advisable for the spike to be placed on the transducer block and spiked in the bottom of the hole in which the transducer is placed. This will add additional coupling. The soil should be packed tightly around the transducer block when the hole is filled with soil. If the transducer block moves any at all when a

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slight force is applied to it, the soil is not packed tightly enough around the transducer block. For larger blasting vibration recordings (in excess of 1.0 ips, 25.4 mm/s) one should consider burying the transducer block deeper in the soil. It may be advisable to place the transducer block in a hole which is at least 6 inches deep and pack the soil on top of this transducer block. This will provide a very good coupling with the soil such that no slippage can occur.

Bolting of Transducer Block

When soil is not available it may be desirable to bolt the transducer block to a rock or concrete surface. A hole is provided through the center of this transducer block for such a procedure. Depending on the anchors available in your area, an anchor can be placed in the concrete or rock and a threaded bolt placed through the hole to bolt the transducer block into place. This procedure will assure no slippage and result in accurate readings of the vibration levels.

Spiking of Transducer Block

For most vibration levels less than .5 ips (12.7 mm/s) spiking the transducer block is often adequate. One must be sure that the spike is pushed into soil which is adequate for providing a good coupling for the spike. As in any of the other cases, the transducer block should not be able to move with a slight force applied to it. In areas where the vibration recording is desired on a beautiful, landscaped lawn, spiking may be the only alternative. It is not always feasible or acceptable to dig a hole to bury the transducer block. Once vibration levels exceed .50 ips (12.7 mm/s) the operator should consider burying the transducer block.

Sandbagging of Transducer Block

As a last resort if may be necessary to sandbag the transducer block to eliminate slippage. This should be considered when burying, bolting, or spiking of the transducer block is not permissible or acceptable. The effectiveness of sandbagging will depend on the vibration level experienced and the weight of the sand placed on the transducer block. One should realize that the higher the vibration level being recorded, the heavier the sand bag should be. For vibration levels less than 1.0 ips (25.4 mm/s) a 15 pound (7 kg) bag of sand should be adequate. This sand bag should be placed on top of the transducer block such that the sand can form around the block to provide good coupling with the transducer block and prevent horizontal slippage. In an emergency situation, a plastic trash can bag filled with sand can provide an adequate anchor for the transducer block.

This has been a brief explanation of proper transducer placement procedures. As previously stated the practice of simply placing the transducer on a surface and using the leveling feet to level this transducer block is not acceptable. For this reason NOMIS is very hesitant to provide leveling feet with the transducer block. If the leveling feet are provided, the operator may falsely assume that this is the most important procedure for proper transducer installation. With the type of geophone elements being used in the NOMIS Seismograph, the leveling of the transducer block is not extremely critical. A bubble balance is provided for this leveling procedure. However, it should be noted that the manufacturer of the geophones only requires that the geophone elements be with in a 20 degree angle with the horizon. This can often be detected by the eye.

The most common result of a transducer not being installed properly is an abnormally high reading. For this reason it is to the operators advantage to make sure that this transducer block is set up properly. If there are any questions on this issue please do not hesitate to contact the engineers at NOMIS Seismographs.

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