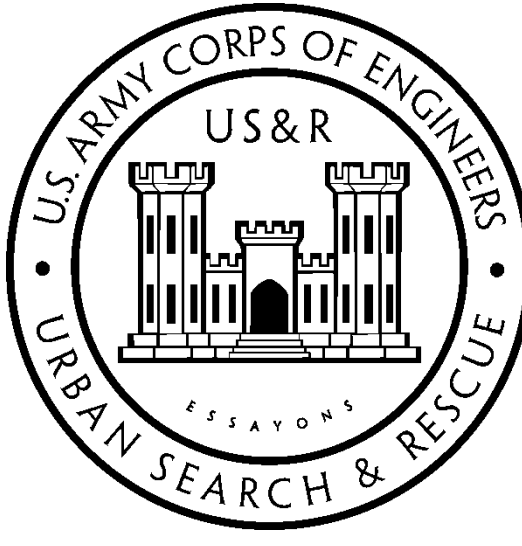
Corrections made June 2014 as follows:
Pg 1-28, Pages 5-37 thru 50, Pg 7-3

U.S. Army Corps of Engineers
Urban Search and Rescue Program

Urban Search & Rescue Structures Specialist

FIELD OPERATIONS GUIDE



7th Edition, 4th Printing
June 2014
(Changes are to pages 5-37 thru 5-50, plus minor corrections on 1-28 & 7-3 – see Disasterengineer.org)

SEARCH ASSESSMENT MARKING (continued)

In most cases, extemporaneous information will not be conveyed using the marking system. This type of communication will usually take place as a result of face-to-face meetings between Search, Rescue, and other components of the Task Force.

Search Markings should be made at each area within a structure, such as rooms, voids, etc, but only information related to the results of the search will be marked upon exiting each space (No Time or TF designation).

- An adhesive-backed search mark placard has been approved for use in incidents like Hurricanes and large earthquakes where many structures are involved. All FEMA Task Forces have been supplied with the graphic to be used in creating the stick-on search marks, which should be printed on orange paper. See Library, Disasterengineer.org

VICTIM LOCATION MARKING SYSTEM

- During the search function it is necessary to identify the location of potential and known victims.
- The amount and type of debris in the area may completely cover or obstruct the location of any victim.
- The victim location marks are made by the search team or others aiding the search and rescue operations whenever a known or potential victim is located and not immediately removed.
- The victim location marking symbols should be made with orange spray paint (using line marking or "downward" spray can) or orange crayon.
- The following illustrates the marking system:

TOTAL STATION (Nikon NPL-352 or Nivo 5M)

- A Total Station measures distances, horizontal and vertical angles, and can determine XYZ coordinates. This capability allows for the monitoring of a building's movement over time.
- Distances of approximately 300 ft. can be measured without the need for a prism at the point measured. The surface of the point measured will influence the maximum range. Greater range can be obtained using a prism or a reflector-type target.
- Some keys have menus specific to their function. These menus can be shown by pressing the key in question down for 3 seconds. Nikon refers to these keys as "**1-second keys**".
- Sometimes options are given in the display on the keyboard. These options appear at the bottom of the screen and can be selected by pressing one of the white keys below the screen. These are called "**soft keys**" by Nikon.
- The display window of the total station is configured to show four different combinations of data. Nikon calls these the **Basic Measurement Screens (BMS)**. The screens are indexed in the upper right corner as **1/4**, **2/4**, **3/4** and **4/4**. Most applications of the total station for US&R purposes use screen **4/4**, which displays the **XYZ** coordinates. Pressing the **DSP** key toggles between the different **BMS** screens. The up and down cursor keys can also be used to navigate through the **BMS** screens.

Initial Setup Procedure

1. Set the tripod at a proposed station location without the total station attached:
   - With the legs together, extend them to chin height.
   - Spread the legs so tripod mounting surface is approx. level.
   - Set the far leg first, spacing the other two legs to level.
   - Snugly fasten all the leg clamps, but do not over-tighten.
2. Remove the total station from the carrying case and mount it on the tripod. Insert the tripod mounting screw into the center hole of the base plate of the instrument, and snugly fasten the screw, but do not over-tighten.

Nikon NPL 352 Initial Setup Procedure (continued)

3. Level the total station by loosening a tripod leg clamp and adjusting the leg length until the air bubble is in the center of the circular level, (bull's-eye level). Lengthening a leg moves the bubble towards that leg.
4. The total station can be leveled further by using the procedure described in the Leveling section below (see page 5-45).
5. Turn on the total station by pressing the **PWR** key. The **Tilt Telescope** screen will appear showing the current date and time, and the last values set for temperature and pressure.
6. Tilt the telescope to initialize the vertical angle.
7. Check the level compensators screen by pressing the **0** key (the screen will appear automatically whenever the instrument is out of level by 3 minutes or more). The level compensators electronically adjust the measurements made by the total station if it is out of level by less than 3 minutes. Return to the BMS by pressing the **ESC** key
8. Focus the telescope cross hairs by adjusting the smaller knurled ring of the eyepiece. This provides consistent sighting of targets (also see Sighting section below, page 5-46).

Creating a New Job

To generate a grid in the total station, a new **Job** must be created:

1. Press the **MENU** key and select "**1.Job**" by pressing the **1** key (or scroll to highlight "**1.Job**" and press the **REC/ENT** key) to get to the Job Manager screen. A new Job is created by pressing the softkey (the white **MSR1** key) under "**Creat**" on the Job Manager screen to get to the Create Job screen.
2. Each Job requires a unique name. Use the default Job name which appears in the Create Job screen (the date YYMMDD followed by a dash and a sequential digit). Press the **REC/ENT** key once. Read what is written on the screen.
3. Press the softkey (the white **MSR2** key) under "**Sett**" to get to the Job Settings screen.

Creating a New Job (continued)

The job settings can only be changed at this time. The default settings suggested for US&R use are:

Scale:	1.000000
T-P corr:	ON
Sea Level:	OFF
C&R Corr:	0.132
Angle:	DEG
Distance:	US-Ft (Decimal-Ft)
Temp:	ºF
Press:	inHg
VA zero:	Zenith
AZ zero:	North
Order:	ENZ
HA:	Azimuth

Use the left and right scroll keys to change an incorrect setting. Press **REC/ENT** after each setting is verified. After pressing the **REC/ENT** key for HA: Azimuth, you return to the **BMS**, completing the creation of the new Job.

4. Now check the coordinate ordering and labeling convention. Press the **MENU** key and select "**3.Settings**" by pressing the **3** key. Select "**3.Coord**." by pressing the **3** key again. **Order** should be set to "**ENZ**", **Label** should be set to "**XYZ**" and **AZ zero** should be set to "**North**". Press **REC/ENT** after each setting is verified. After pressing the **REC/ENT** key for **AZ zero**, you return to the Settings screen.

5. While still on the Settings screen, check the data recording format. Select "**8.Rec**" by pressing the **8** key. **Store DB** should be set to "**RAW+XYZ**", and **Data Rec** should be set to "**Internal**". Press **REC/ENT** after each setting is verified. After pressing the **REC/ENT** key for **Data Rec**, you return to the Settings screen. Press the **ESC** key to return to the MENU screen. Press the **ESC** key again to return to the BMS.

Creating a New Job (continued)

6. Configure the **MSR1** and **MSR2** keys**.** These settings can be changed at any time. Hold the **MSR1** key down for 3 seconds to enter/check settings, then repeat for the **MSR2** key:

MSR1:	Target:	Prism
	Prism Constant:	18mm (or for prism used)
	Mode:	Precise
	AVE:	3
	REC MODE:	MSR only
MSR2:	Target:	N-Prism
	Prism Constant:	0
	Mode:	Normal
	AVE:	1
	Rec mode:	MSR only

Press **REC/ENT** after each setting is verified. After pressing **REC/ENT** for **Rec mode**, you return to the **BMS** screen.

Creating a New Grid (relative to the center of the total station)

1. Having set up the total station as described previously and having created the new Job, the new Grid can be created. A known point and an orientation of the grid are required to establish the new Grid. The coordinates of the known point and the orientation of the grid are entered into the Job by creating a new Station.
2. Establish the center of the instrument as the new Station. Press the **STN** key (the **7** key). Select "1.**Known**" by pressing the **1** key. Number this Station as **1** (ST: 1), then press **REC/ENT**. Input assumed coordinates for the new Station (use X = 1000 ft, Y = 100 ft, and Z = 10 ft) and press **REC/ENT** after entering each coordinate. The cursor will skip to the **CD** line. Leave it blank and press **REC/ENT** to return to the Input Station menu.

Creating a New Grid (continued)

3. Enter the height of instrument as zero (HI: 0), press **REC/ENT**.
4. The next screen displayed is the **Backsight** (**BS**) screen. A **BS** is used to orient the grid. Select "**2.Angle**" by pressing the **2** key. This brings you to the **Input BS Point** screen. Number the **BS** as 9, press **REC/ENT**. Enter zero for the height of the target (HT: 0), press **REC/ENT**. This brings you to the **Input BS Angle** screen. Enter zero for the azimuth angle (AZ: 0), press **REC/ENT**. Now the orientation of the total station must be established. For US&R use, select a **BS** point that is forward of the total station (towards the building being monitored). Sight through the telescope so the line of sight is approximately perpendicular to the face of the building to be monitored (this will roughly align the X Y grid with the building layout) and press **REC/ENT**. This returns you to the **BMS**. It is not necessary to measure the location of the BS point as it is only used for the initial orientation of the grid.
5. The instrument can now measure and record point coordinates.

Sighting and Measuring

1. Loosen both the horizontal and vertical tangent screws.
2. Ensure that the telescope focuses properly. (See page 5-46).
3. Use the optical sight on top of the telescope to roughly point the telescope at the target.
4. Snug the horizontal tangent screw. Do not over tighten.
5. Look through the eyepiece and move the telescope vertically until the target is in view.
6. Snug the vertical tangent screw. Do not over tighten.

Sighting and Measuring (continued)

7. Rotate the focusing ring to bring the target into sharp focus on the eyepiece crosshairs.

8. While looking through the telescope, use the horizontal and vertical tangent screws to sight the telescope crosshairs on the center of the target.

9. Press either **MSR1** or **MSR2** to take measurement. **MSR1** is for measurements to a reflector (prism), **MSR2** is for reflectorless measurements. **MSR2** is used most of the time.

10. When the X, Y, Z coordinates are displayed on BMS Screen 4/4, press the **REC/ENT** key. The **Record PT** screen is displayed; this is where the point number can be changed.

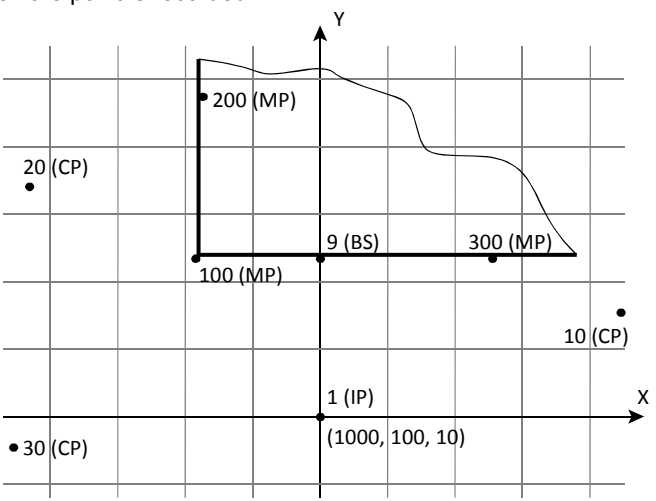
11. Use the default Point Number (PT) shown or scroll up to the PT line and enter a new number, press **REC/ENT**. Unless using a prism on a pole, leave the Height of Target (HT: 0.00) as zero, press **REC/ENT.** The cursor will move to the **CD** line. Leave it blank and press **REC/ENT.** The point has been recorded in the memory of the total station and you are returned to the **BMS** ready to measure the next point.

12. The data for recorded points can be viewed in the **DAT** screen. Press the **DAT** key (the **6** key). Scroll to the point you want to view and press **REC/ENT.** Exit this screen by pressing the **ESC** key. This returns you to the point list screen. Exit this screen by pressing the **ESC** key. The **DAT** screen data format can be changed. Starting in the **BMS** screen, hold the **DAT** key (the **6** key) down for 3 seconds to enter/check the data reporting format. The format should be "**3.XYZ data**". Change it to "**3.XYZ data**" by pressing the **3** key. If it is already set to "**3.XYZ data**" use the **ESC** key to exit out of this option. If you change it from another option you are taken directly to the XYZ data screen. Exit this screen by pressing the **ESC** key.

Building Monitoring Setup

Building movement should be monitored with the coordinate system or grid aligned to the building plan.

Control points should be numbered using two digits (10, 20, etc.). Monitoring points should be numbered using three digits (100, 200, etc.). After a reading is taken on a monitoring point or control point, its number should be incremented (101, 102, etc. or 11, 21, etc.) when the point is recorded.



Sight and record monitoring points on the building to begin the monitoring process. Establish a minimum of 3 control points separate from the building. Continue re-sighting the monitoring points at appropriate intervals. Ensure all sightings are properly recorded. Control points should be established immediately after the first set of monitoring points have been recorded and the monitoring process has begun. Periodically re-sight and record control points to verify control.

Creating a New Station within an Existing Coordinate System

There are several methods available to move the total station to a new location on a grid and then tie it back into that same grid. These methods are accessed by pressing the **STN** key (the **7** key) and then selecting a method from a list of options. One method is recommended below for US&R building monitoring.

Option No. 7 – Known Line Method. This method uses any two points which can be seen from the new location, and whose grid coordinates are known, to establish where the total station is on the existing grid. The Known Line Method generically refers to these two points as **P1** or **PT1**, and **P2** or **PT2**.

1. Set up and level the total station at a new location. It is not necessary to establish this location as a permanent Instrument Point (IP) but only to use the center of the total station as a temporary Instrument Point. Given this, the HI is zero (HI = 0).

2. After pressing the **STN** key (the **7** key), select the option "**7.Known Line**" by pressing the **7** key again. This brings you to the **Input PT1** screen.

3. Input the point number of the known point to be used for **PT1** and press **REC/ENT**. If the known point is recorded within the current Job, the recorded coordinates will be shown. Press **REC/ENT** to accept these coordinates. If it has not been previously recorded, input the point's coordinates and press **REC/ENT** after entering each coordinate. Enter HT = 0.0 if sighting the point directly (enter the target height if using a prism on a pole). Press **REC/ENT**. The cursor will move to the **CD** line. Leave the CD line blank and press **REC/ENT** to return to the **Input PT1** screen.

5. The known point used as **PT1** must now be sighted and measured. Sight the point and press **MSR2** (**MSR1** if using a prism) and then press **REC/ENT** after the instrument has completed the distance measurement.

Option No. 7 – Known Line Method (continued)

6. Select option "**1.By Coord**" by pressing the **1** key.
7. Input the point number of the known point to be used for **PT2**. If the point has already been recorded in the current Job, it's coordinates will be shown after **REC/ENT** is pressed. Otherwise, input the point number, press **REC/ENT**, enter the known point coordinates, and press **REC/ENT** after each entry.
8. Enter the target height (HT = 0.0 if sighting a point directly). Press **REC/ENT**.
9. Sight the point and press **MSR2** (**MSR1** if using a prism) and then press **REC/ENT** after the instrument has completed the distance measurement.
10. The new location of the instrument is now shown in the display screen. Press **REC/ENT** to record this point's coordinates.
11. A default station number is displayed. Erase that number and enter a number for this point and press **REC/ENT**. We are using the center of the total station as the position of the point, so enter HI = 0.0 and press **REC/ENT**. Leave the **CD** line blank and press **REC/ENT**. The cursor moves to the **BS** line, which displays the point number of the known point used for **PT1**. Accept this by pressing **REC/ENT**.
12. The total station is now oriented on the original coordinate grid.

Leveling – (Additional)

1. Un-snug the horizontal tangent screw.
2. Rotate the alidade until the plate level is parallel with any two of the three leveling posts.
3. Use these two leveling posts to move the bubble to the center of the level. Note: bubble moves in the direction of left thumb.
4. Rotate the alidade approximately 90° and use the third post to move the bubble into the center of the level. Do not move either of the other two posts while adjusting the third post.

Sighting Adjustments

To measure distances accurately, the total station must be properly adjusted and focused on the target.

- To bring the telescope crosshairs into sharp focus, aim the telescope at a blank area, such as a piece of paper. Look through the telescope and adjust the smaller knurled ring of the eyepiece until the crosshairs are in sharp focus.
- To check for parallax, sight the telescope at the target image. Rotate the focusing ring (largest ring between the eyepiece and the telescope body) to bring the target image into sharp focus on the crosshairs. Move your eye vertically and laterally to see if the target image moves relative to the crosshairs. Readjust the eyepiece if relative movement is detected.

Menu Key

The **MENU** screen is used to access important functions and settings of the Total Station. To display the **MENU** screen, press the **MENU** key. The following options are given in the **MENU** screen:

1. Job (Job Manager) – Used to create and manage stored jobs.
2. Cogo – Coordinate geometry calculations.
3. Settings – Used to change various settings (use the left or right arrow keys (◄/►) to toggle between the available selections.
4. Data – Used to view data (Use **DSP** to view toggle between RAW and XYZ data).
5. Comm. (Communication) - Transfer data to and from a computer.
6. 1sec Keys – several keys (illumination key, REC/ENT, MSR1, MSR2, DAT and DSP) have menus or additional functionality if held down for longer than1 second.
7. Calibrat. (Calibration) – Used to make corrections to the instrument to assure correctly measured data.
8. Time – Edit date and time.

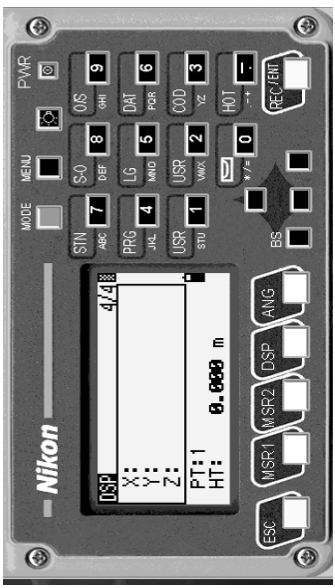
US&R STRUCTURES SPECIALIST FOG
EQUIPMENT OPERATING PROCEDURES

Instrument Handling

- Always carry the instrument in its case.
- Do not carry the instrument from the top handle.
- When leaving the instrument set up, place the lens cap on and cover the whole instrument with the vinyl cover.
- Protect the instrument against the weather.
- During transportation always place accessories in their correct position to prevent displacement.

Drying a wet instrument

- Wipe the total station carefully, remove the foam inserts from the case and let them dry out completely.
- Allow the total station to air-dry before it is returned to its case. This prevents the telescope optics from fogging.



Nikon NPL 352
Keyboard and Display

5

Nikon NPL 352 Keyboard and Display (continued)

Key	Function
PWR	Turns the instrument on or off.
	Illumination key. Turns the backlight on or off. Provides access to the 2-switch window if held down for one second.
MENU	Displays the MENU screen.
MODE	Changes the key input mode between alphanumeric and numeric if pressed when you are in a PT or CD field. Activates Qcode mode if pressed when you are In the Basic Measurement Screen (BMS).
✸ REC ENT	Records measured data, moves on to the next screen, or confirms and accepts the entered data in input mode. You have the option to record the measurement as a CP record instead of an SS record, if you hold this key down for one second in the Basic Measurement Screen (BMS). The instrument outputs the current measurement data (PT, HA, VA, and SD) on the COM port if you press this key in the BMS or in a Stakeout observation screen. (The Data Rec settings must be set to COM.)
✸ ESC	Returns to the previous screen. In numeric or alphanumeric mode, deletes input.
✸ MSR1	Starts distance measurement, using the measure mode settings for the [MSR1] key. Displays measurement mode settings, if held down for one second.

Key	Function
✱ MSR2	Starts distance measurement, using the measure mode settings for the [MSR2] key. Displays measurement mode settings, if held down for one second.
DSP	Moves to the next available display screen. Changes the fields that appear on the DSP1, DSP2, and DSP3 screens, if held down for one second.
ANG	Displays the Angle menu.
✱ STN ABC 7	Displays the Station Setup menu. In numeric mode, enters 7. In alphanumeric mode, enters A, B, C, or 7.
S-O DEF 8	Displays the Stakeout menu. Shows stakeout settings, if held down for one second. In numeric mode, enters 8. In alphanumeric mode, enters D, E, F, or 8.
O/S GHI 9	Displays the Offset Point Measurement menu. In numeric mode, enters 9. In alphanumeric mode, enters G, H, I, or 9.
PRG JKL 4	Displays the Programs menu, which contains additional measuring programs. In numeric mode, enters 4. In alphanumeric mode, enters J, K, L, or 4.
MNO 5	In numeric mode, enters 5. In alphanumeric mode, enters M, N, O, or 5.
✱ DAT PQR 6	Displays RAW, XYZ, or STN data, depending on your setting. In numeric mode, enters 6. In alphanumeric mode, enters P, Q, R, or 6.

Key	Function
USR STU 1	Executes the function that is assigned to the USR1 key. In numeric mode, enters 1. In alphanumeric mode, enters S, T, U, or 1.
USR WX 2	Executes the function that is assigned to the USR2 key. In numeric mode, enters 2. In alphanumeric mode, enters V, W, X, or 2.
COD YZ 3	Opens a window where you can enter a code. The default code value is the last code entered. In numeric mode, enters 3. In alphanumeric mode, enters Y, Z, a space, or 3.
HOT .-+ -	Displays the (HOT) menu, which includes Height of Target, Temp-Press, Target, Note recording, and Default PT settings. In numeric mode, enters – (minus). In alphanumeric mode, enters . (period), – (minus), or + (plus).
*/= 0	Displays the Bubble indicator. In numeric mode, enters 0. In alphanumeric mode, enters *, /, =, or 0.

Nikon Nivo 5M - Replacement Total Station for the NPL-352

The Nivo 5M is very similar to the NPL-352 with the exception of the following:

- The Nivo 5M is smaller and lighter than the NPL 352.
- Under ideal conditions, the maximum measured distance is 900 ft for reflectorless mode.
- The Nivo 5M uses two batteries, which allows for replacing batteries without turning the total station off.
- There is only one face (display/keyboard). The display and keyboard layout is the same as the NPL-352.
- There is no plate level bubble. Instead, the electronic bubbles must be used to fine level the instrument. There is still a circular level (bull's eye level) for initial leveling.

INTRODUCTION TO USEFUL TABLES - TIMBER DESIGN

Following this page there are tables that provide:

- Allowable Loads for Plywood
- Allowable Loads in Bolts and Lag Screws
- Allowable Loads in Nails & Screws

This information is provided for Southern Pine, Douglas Fir, Hem-Fir Group and Spruce-Pine-Fir Species.

The Tables have been reproduced from "National Design Specifications for Wood Construction, 1991 Edition".

WORKING LOAD STRESSES – DOUG. FIR & SO. PINE

One may increase these values by 25% for US&R Shores

(On page 7-12, note that a 60% increase is recommended when using nails that resist transient loading – Raker Shores)

Mod. of Elasticity = E = 1,400 to 1,600 ksi

Bending Stress = F_b = 1500 psi for 4x & 1200 psi for 6x
(Sect. Modulus = S = $BD^2/6$, Mom. of Inertia = I = $BD^3/12$)

Horiz. Shear Stress = F_v = 95 psi for 4x & 85 psi for 6x
(F_v has been increased by about 100% in the 2001 NDS)

Compression Parallel to Grain = F_c = 1100 psi

Compression Perpendicular to Grain = $F_{c\perp}$ = 625 psi

Buckling Strength = F_a = 480,000 psi / $(L/D)^2$

L/D = 25 max. (to see crushed cross-grain before buckling)

L/D = 50 max. (but failure may be by sudden buckling)

Note that Working Load Stresses for Hem-Fir Group are 15% less, and Spruce-Pine-Fir Species are 25% less than those listed above