Chapter 6

VERTICAL OBSERVATION (VERT OBS) DATA

INTRODUCTION

The purpose of this chapter is to provide detailed specifications and instructions for the coding and keying of the observation data set of a vertical control job. As explained in Chapter 5, a vertical control job consists of two distinct data sets which must be submitted together. The companion data set to the vertical observation (VERT OBS) data set discussed in this chapter is the data set containing original descriptions and/or recovery descriptions for the control points which occur in the vertical control job. This description data set is treated in Annex P.

VERT OBS DATA SET RECORDS

The data which constitute a VERT OBS data set are organized into four categories:

1. Line Identification Data
2. Survey Equipment Data
3. Field Abstract Data
4. Observation Data

Within these categories, the respective data have been grouped into one or more logical units called “records.” A record is a string of characters containing data coded according to a specific format. Every record in a VERT OBS data set consists of 80 characters or “card columns” (cc). Within each record, the 80 columns are divided into fixed-length character fields, each field being the space reserved for a specific data item. Accordingly, for each desired data item, there exists a field of appropriate length into which the data item in question is to be entered after it is converted into a string of alphanumeric characters. The set of rules according to which specific data items are converted into strings of alphanumeric characters to be entered into the fields of a record is known as the “format” of that record.

The types of records which may appear in a VERT OBS data set are listed in Table 6-1. Each type of record has been given a name, and a diagram illustrating the respective format has been prepared to serve as a model for that record - see format pages, p. 6-27 ff.

Except for the first and last records of the data set, the second character field of each record (cc 7-10) contains a two-digit numerical data code, preceded and followed by an asterisk, which specifies the type of that record (*10*, *11*, ..., *43* - see Table 6-1 below). The first and last records of the data set (the *aa* Data Set Identification Record and the *aa* Data Set Termination Record) display the two-character alphanumeric job code assigned by the submitting agency in this field (*A1*, *A2*, ..., *ZZ* - see Chapter 5). The first character field of every record (cc 1-6) is optional but is reserved for the respective record sequence number - see Chapter 5. The remaining portion of each record (cc 11-80) contains character fields which are peculiar to each individual record type.

TABLE 6-1
VERTICAL OBSERVATION DATA SET RECORDS

FIRST RECORD
aa - Data Set Identification Record

LINE IDENTIFICATION DATA
10 - Line Information Record
11 - Line Title Record (Optional)
12 - Line Title Continuation Record (Optional)
13 - Line Title Continuation Record (Optional)
14 - Line Title Continuation Record (Optional)
15 - Comment Record (Optional)

SURVEY EQUIPMENT DATA
20 - Instrument Information Record
21 - Rod Information Record
22 - Rod Standardization Record
23 - Rod Calibration Record

FIELD ABSTRACT DATA
30 - Field Abstract Record

OBSERVATION DATA
40 - Survey Equipment Record
41 - Running Record
42 - River/Valley Crossing Record
43- Correction/Rejection Record

LAST RECORD
aa- Data Set Termination Record

Note: The symbol *aa* denotes the two-character job code assigned by the submitting agency - see Chapter 5.

STRUCTURE OF THE VERT OBS DATA SET

The first record of a VERT OBS data set must be the *aa* Data Set Identification Record which contains the required information to identify the data set and to correlate it with its companion description data set - job code, data type (“VERT OBS”), name of submitting agency, and date the data set was created.

The last record of the data set must be the *aa* Data Set Termination Record. It is the only other record in the data set on which the respective job code appears in the same field (cc 7-10) as on the Data Set Identification Record.

The VERT OBS data set records which are bracketed by these two delimiting records may pertain to one or more units of field work; i.e., field observation data for several leveling lines may be submitted in one VERT OBS data set under the same job code, provided that the total number of survey points (bench marks and temporary bench marks (BMs and TBMs)) in the job does not exceed 9,999 (see Chapter 5). When two or more leveling lines are included in a vertical control job, the data for each line must appear as a complete unit in the respective VERT OBS data set, i.e., as a block of records which contains all information pertinent to that line (see table 6-2 below). Each line’s data must begin with a *10* record followed by the appropriate respective number of the other types of records in sequence and conclude with one or more *40 - series records.

TABLE 6-2
STRUCTURE OF THE VERT OBS DATA SET

aa Data Set Identification Record	
10-series record	
20-series records (if any)	FIRST
30 records	LEVELING LINE
40-series records	
10-series records	
20-series records (if any)	SECOND
30 records	LINE
40-series records	
::::	::::
::::	::::
10-series records	
20-series records (if any)	LAST
30 records	LINE
40-series records	
aa Data Set Termination Record	

A leveling line is a unit of field work consisting of a number of survey points (BMs and TBMs - see Chapter 5) which are connected by chains of differential leveling observations called “runnings.” When coded as part of a VERT OBS data set, a leveling line is a block of records comprising record groups arranged in the following order:

1. Line Identification Data (*10*-Series) Records (p. 6-7 ff.):

   10 record
   11 record (optional; possibly *12*,*13*, and *14* records as well)
   15 records (optional, any number allowed)

2. Survey Equipment Data (*20*-Series) Records: (p. 6-11 ff.):

   20 records (at least one if instrument not previously reported; in general, one for each previously unreported stadia factor determination) for the first instrument used
   20 records (at least one if instrument not previously reported; in general, one for each previously unreported stadia factor determination) for the second instrument used
   ::::
   20 records (at least one if instrument not previously reported; in general, one for each previously unreported stadia factor determination) for the last instrument used
   21,*22*, and/or *23* record(s) - *21* record alone if rod not previously reported and no standardization or calibration data are available; in general, one *21* record followed by one or more *22* records (one for each previously unreported rod standardization), one or more *22*,*23*, ...,*23* record sets (one such set for each previously unreported single-temperature rod calibration), and/or one or more *23*, *23*, ..., *23* record sets (one such set for each previously unreported multiple-temperature rod calibration with one or more *23* record(s) for each calibration temperature) - for the first rod used
   21,*22*,and/or *23* record(s) - *21* record alone if rod not previously reported and no standardization or calibration data are available; in general, one *21* record followed by one or more *22* records (one for each previously unreported rod standardization), one or more *22*, *23*, ..., *23* record sets (one such set for each previously unreported single-temperature rod calibration), and/or one or more *23*, *23*, ..., *23* record sets (one such set for each previously unreported multiple-temperature rod calibration with one or more *23* record(s) for each calibration temperature) - for the second rod used
   ::::

::::
21,*22*, and/or *23* record(s) - *21* record alone if rod not previously reported and no standardization or calibration data are available; in general, one *21* record followed by one or more *22* records (one for each previously unreported rod standardization), one or more *22*, *23*, ..., *23* record sets (one such set for each previously unreported single-temperature rod calibration), and/or one or more *23*, *23*,..., *23* record sets (one such set for each previously unreported multiple-temperature rod calibration with one or more *23* record(s) for each calibration temperature) - for the last rod used

Note that for instruments and/rods which are used in more than one leveling line submitted in the same or in different vertical control jobs, it is not necessary to repeat the same *20*-series records in each such line or each such VERT OBS data set. It is sufficient to submit the respective *20*-series records once as part of the first line submitted in which such instruments and/or rods appear and thereafter only if the stadia factor is redetermined for an instrument and/or if a rod is restandardized or recalibrated - see SURVEY EQUIPMENT DATA RECORDS, p. 6-11.

3. Field Abstract Data (*30*) Records (p. 6-16 ff.):

30 records - one for the first (starting) survey point (BM or TBM) followed by one *30* record for each elevation carried forward to a survey point along the leveling line.

4. Observation Data (*40*-Series) Records (p. 6-20 ff.):

40 record giving the date, instrument/rod combination, and collimation error data for the first set of runnings
41 record for the first running in the first set
43 record (if needed) for the first running in the first set
41 record for the second running in the first set
43 record (if needed) for the second running in the first set
::::
::::
41 record for the last running in the first set
43 record (if needed) for the last running in the first set

40 record giving the date, instrument/rod combination, and collimation error data for the second set of runnings
41 record for the first running in the second set
43 record (if needed) for the first running in the second set
41 record for the second running in the second set
43 record (if needed) for the second running in the second set
::::
41 record for the last running in the second set
43 record (if needed) for the last running in the second set
::::
40 record giving the date, instrument/rod combination, and collimation error data for the last set of runnings
41 record for the first running in the last set
43 record (if needed) for the first running in the last set
41 record for the second running in the last set
43 record (if needed) for the second running in the last set
::::
41 record for the last running in the last set
43 record (if needed) for the last running in the last set
42 record for the first river/valley crossing along the line
43 record (if needed) for the first river/valley crossing along line
42 record for the second river/valley crossing along the line
43 record (if needed) for the second river/valley crossing along line
::::
42 record for the last river/valley crossing along the line
43 record (if needed) for the last river/valley crossing along line

LINE IDENTIFICATION DATA RECORDS

10 Line Information Record
11 Line Title Record (Optional)
12 Line Title Continuation Record (Optional)
13 Line Title Continuation Record (Optional)
14 Line Title Continuation Record (Optional)
15 Comment Record (Optional)

The line identification data records, bearing the *10*-series data codes, are listed above; the diagrams illustrating the respective formats will be found under FORMAT DIAGRAMS, p. 6-25 ff.

The *10* record contains essential line identification data and is always required. The *11* record is optional; however, it is highly desirable that a line title (reflecting the geographic location of the line - see below) be given. The line title should be concise so as to fit on the *11* record (up to 70 characters); however, one, two, or three continuation records (the *12*, *13*, and *14* records) may be appended if the title is lengthy or if a main title followed by subtitle(s) is called for. Following the *11* record (or else the last title continuation record), there may appear as many *15* records as appropriate to give comments pertinent to the leveling line (e.g., significant problems encountered, deviations from standard procedures, etc.), if any.

The entries on these records are for the most part self-explanatory; however, the following data items will be explained in greater detail:

Leveling Line: As stated on p. 6-4, a leveling line is a unit of field work consisting of a number of survey points (BMs and TBMs) which are connected by chains of differential leveling observations called “runnings.” Each segment of a leveling line consisting of two neighboring survey points connected by a running is called a “section” of the leveling line.

The objective of differential leveling is the extension of vertical control by precise determination of differences of elevation between successive survey points along the leveling line. The end product is a string of permanently marked vertical control points or BMs.

Tolerance Factor: To control the accumulation of error in the differential leveling process, each section of a leveling line is normally “double-run,” i.e., observed twice by runnings in opposite directions; the disagreement between the respective differences of elevation as determined by the two runnings must not exceed a tolerance limit computed as the product of the appropriate tolerance factor and the square root of the section length.

Aside from the units of measurement involved, the numerical value of the tolerance factor used for this purpose depends on the type and intended accuracy of the vertical control survey in question; it is

one of the specification parameters which characterize a given order and class of vertical control survey (see below).

Note that the tolerance factor is expressed in mixed units, i.e., in "Units of Elevation Difference Disagreement Per Square-Root of Units of Section Length." For the purpose of this publication, two such unit combinations are allowed (must be specified by the respective units code given as part of the tolerance factor data group in the *10* record):

1. Millimeters per square-root of kilometers (units code MM), and
2. Feet per square-root of statute miles (units code FT).

Order and Class of Survey: A two-digit code is provided on the *10* record to specify the order of accuracy of the survey. The first digit of this code reflects the order and the second digit the class of the survey in accordance with "Classification, Standard of Accuracy, and General Specifications of Geodetic Control Surveys," prepared by the Federal Geodetic Control Committee (FGCC), and published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce (February 1974). In addition to the five vertical control survey categories defined in this publication, three other survey categories need to be considered - old vertical control surveys of first or second order for which no class is specified and surveys of lower-than-third-order accuracy. The respective two-digit codes are as follows:

10 - First-Order (Class Unspecified)
11 - First-Order, Class I
12 - First-Order, Class II
20 - Second-Order (Class Unspecified)
21 - Second-Order, Class I
22 - Second-Order, Class II
30 - Third-Order
40 - Lower-Than-Third-Order

The order-and-class code assigned to a leveling line should reflect the procedures and specifications according to which that entire line has been observed. When well-defined segments of a leveling line fall into different order-and-class categories, the line must be divided accordingly and the respective parts submitted as separate lines.

State or Country Code: Provision is made on the *10* record to indicate the political unit(s) and/or geographic area(s) in which the leveling line is located using the two-letter state or country codes given in ANNEX A. Up to three such codes may be entered, in the order of progress along the line in question. In the United States or in Canada, enter the appropriate code for the respective state, commonwealth, province, or territory; elsewhere enter the appropriate code for the respective country, island group, or geographic area - see ANNEX A.

Line Title: The desired elements of information in the title of a leveling line are (1) the respective line number or other identification symbol, (2) the order of accuracy of the survey, (3) whether original leveling or releveling, and (4) the geographic locality (or localities) of the survey. Since the first three elements are explicitly coded on the *10* Line Information Record (see FORMAT DIAGRAMS, p. 6-25 ff.), it would be superfluous to repeat them in the line title, and hence only the geographic location needs to be specified. The use of geographic location alone as the title of a leveling line has traditionally been the practice of NGS and its predecessors.

In general, the title by which the leveling line is known to the submitting agency should be given, supplemented to reflect geographic location, as required. Omit punctuation marks (periods, commas, etc.) and parentheses whenever their omission can be tolerated, and use ANNEX A state and country codes whenever reference to a state or country is necessary. Furthermore, edit and/or abbreviate the line title in the interest of fitting the entire title on the *11* Line Title Record, if at all possible. However, up to three additional records (the *12*, *13*, and *14* Line Title Continuation Records) may follow the *11* Line Title Record if the title must be lengthy or when a main title followed by one or more subtitles is desired.

The geographic location of the leveling line should be descriptive of the route followed, i.e., the starting locality, any prominent “via” points, and the ending locality should be specified in the order of progress of the survey (Example: ALBANY GA VIA MORVEN TO CALLAHAN FL). If the leveling line is a member of a special project or of an area network to which a specific name or title has been assigned, such a name or title should be carried as a main title on the *11* record and the title of the line proper should follow as a subtitle on one or more of the continuation records. Example:

11 Record: TULARE-VASCO ARVIN-MARICOPA AREA CA
12 Record: 9.1 KM SE OF KETTLEMAN CITY TO PIXLEY

DATE AND TIME

Date of the VERT OBS data set creation must appear on the *aa* Data Set Identification Record, and the dates on which survey operations commenced and terminated are to be entered on the *10* Line Information Record. In addition, character fields are reserved for the date and/or time on several other records of the VERT OBS data set. Throughout the VERT OBS data set, date and time are to be coded as follows:

Date: Full date is coded as an eight-digit integer number consisting of four two-digit groups denoting (from left to right) the last whole century, number of full years since the turn of century, month of the year, and day of the month (CCYYMMDD).

(Note: The “century” columns are omitted on the *20*- and *40*-series records, and dates there are coded as six-digit integer numbers denoting the year, month, and day (YYMMDD)). If the day is not known (e.g., in connection with old data extracted from archives for which the date is not fully specified), leave the last two columns of the field blank; if the month is not known, leave the last four columns of the field blank. For example, February 8, 1970, would be coded as follows :

1.	Full date is known:	19700208	or	700208
2.	Day of the month is not known:	197002	or	7002
3.	Month of the year is not known:	1970	or	70

Time: The time of day is coded as a four-digit integer number consisting of two-digit groups denoting (from left to right) the hours and minutes (HHMM) of a 24-hour clock. Each four-character time field or pair of (beginning and ending) time fields is preceded by a one-character field reserved for the appropriate one-letter U.S. Navy time zone designation (see below). In every case, the local zone time is to be used; in this manner, ambiguities are avoided concerning the date, which is always assumed to be the “local” date (i.e., the date changes at local midnight).

Time Zone: A time zone is a geographic region in which uniform time differing by an integer number of hours from Greenwich Mean Time (GMT) is maintained by law. In theory, a time zone extends 7-1/2 degrees in longitude east and west of a “time meridian” whose longitude is a multiple of 15 degrees (since the Earth rotates 360 degrees in 24 hours, 15 degrees of longitude difference equals one hour of time difference). In practice, the lines which separate adjacent time zones often follow political boundaries and are therefore irregular. Associated with every time zone is a “time zone description” - an integer number positive west of Greenwich and negative east of Greenwich - which represents the number of hours which must be added (algebraically) to the local zone time in order to obtain the corresponding GMT. The time zone description is reduced by one hour when the standard zone time is changed to daylight-saving time.

Instead of the numeric time zone description, it is more convenient to use the U.S. Navy one-letter codes which uniquely identify each time zone. In this system, GMT is the “Z” (Zulu) Time Zone. Time zones east of Greenwich are identified by letters A, B, C, etc., through L, with the letter J omitted. Time zones west of Greenwich are identified by letters N, O, P, etc., through X. The letter Y is used to designate the western half of the time zone centered on the meridian of longitude 180 degrees (International Date Line), and the letter M is used to designate the eastern half of this zone

The world-wide use of the time zone descriptions and the U.S. Navy one-letter designations is illustrated in ANNEX H. In the continental

United States, Alaska (AK), and Hawaii (HI), the time zones are as given in Table 6-3:

TABLE 6-3 - U.S. NAVY TIME ZONE DESIGNATIONS

STANDARD TIME		DAYLIGHT TIME		TIME MERIDIAN	TIME ZONE DESCRIP'N	U.S. NAVY DESIGNATION
Atlantic	AST	Eastern	EDT	60W	+4	Q (Quebec)
Eastern	EST	Central	CDT	75W	+5	R(Romeo)
Central	CST	Mountain	MDT	90W	+6	S(Sierra)
Mountain	MST	Pacific	PDT	105W	+7	T(Tango)
Pacific	PST	Yukon	YDT	120W	+8	U(Uniform)
Yukon	YST	AK/HI	HDT	135W	+9	V(Victor)
AK/HI	HST	Bering	BDT	150W	+10	W(Whiskey)

If the time zone cannot be reliably ascertained, leave the time zone field blank. In this case, the time given will be interpreted as the standard time in a zone determined on the basis of the longitude of the vertical control point from which the respective leveling observations (running) originate. As of this printing, Arizona, Hawaii, eastern Indiana, Puerto Rico, the Virgin Islands, and American Samoa do not observe daylight savings time. Verify locally (during the time of observations) whether or not daylight savings time is in effect.

SURVEY EQUIPMENT DATA RECORDS

20 Instrument Information Record
21 Rod Information Record
22 Rod Standardization Record
23 Rod Calibration Record

The survey equipment data records, identified by *20* -series data codes, are listed above; the diagrams illustrating the respective formats are given in the format pages, p. 6-27 ff. The survey equipment data records contain identification and calibration data pertaining to the leveling instruments and rods used to carry out the differential leveling observations. See STRUCTURE OF THE VERT OBS DATA SET, p. 6-3 ff., for the proper sequence in which the *20*-series records must appear in the block of records which constitutes a leveling line in a VERT OBS data set.

The *20* Instrument Information Record contains the data required to identify a leveling instrument (the appropriate NGS survey equipment code and the instrument serial number), date of stadia factor determination, and the stadia factor itself (see p. 6-14). This stadia factor will be used in the computation of the lengths of sights made with that instrument subsequent to the respective stadia factor determination date. Several *20* records may be submitted as a group for a leveling instrument, one for each past stadia factor determination.

The *21* Rod Information Record contains analogous data (the appropriate NGS survey equipment code and the rod serial number) required to identify a leveling rod; however, it does not contain any calibration data. Rod calibration data, which are required only for rods used in first- and second-order differential leveling work, must follow the *21* record in the form of a *22* record, a record set consisting of a *22* record and one or more *23* record(s), or a record set consisting of two or more *23* records, all bearing the same standardization/calibration date.

Again, several such *22* records, *22*, *23*, ..., *23* record sets, and/or record sets of the form *23*, *23*, ..., *23*, as appropriate, may be submitted as a group for a leveling rod following the respective *21* Rod Information Record--one such *22* record, *22*, *23*, ..., *23*record set, or *23, *23* record set for each past calibration of the leveling rod in question.

The *22* Rod Standardization Record contains the summary of a rod calibration. For the purpose of this chapter, the term "standardization" will be used to denote a group of data which is the end product of a rod calibration (i.e., the respective coefficient of thermal expansion, rod excess, and index error - see below). The *22* Rod Standardization Record may appear alone, or it may be followed by one or more *23* Rod Calibration Record(s) containing the (single-temperature) calibration data on which the standardization summary is based. Optionally, a *22* record may also precede a set of two or more *23* records of a multiple-temperature calibration; however, in this case, all data contained on the leading *22* record are inferable from the accompanying *23* records.

The *23* Rod Calibration Record contains data pertaining to the calibration of a leveling rod at one temperature. For single-temperature calibrations, submit one or more *23* record(s) following the corresponding *22* record (see above) - as many as are required to accommodate all calibration intervals (three per *23* record - see format pages, p. 6-27 ff.). For multiple-temperature calibrations, submit a set of *23* records (one or more per calibration temperature), with or without a preceding *22* record, which is optional in this case. In general, *23* Rod Calibration Records should be submitted whenever the respective data are available.

NGS Leveling Instrument and Rod Database: The purpose of the *20*-series records is to provide input to a permanent computer file in which a historic record is maintained for each leveling instrument and leveling rod ever used in a VERT OBS data set submitted to the National Geodetic Survey. A record is established in this file for an instrument or rod at the first time it is encountered in the processing of a VERT OBS data set. Thereafter, the file is updated by adding new information to the respective instrument and/or rod records

whenever standardization or calibration data not previously available are encountered among the *20*-series records of a subsequently processed leveling line in the same or a different VERT OBS data set.

Accordingly, it is not necessary to repeat identical *20* Instrument Information Records among the *20*-series records of every leveling line in which that instrument appears. It is sufficient, for any instrument, to submit one or more such records (one for each past determination of the respective stadia factor) once initially, and thereafter only when a new stadia factor is determined (e.g., following the installation of a new reticle). Of course, for each leveling line, care must be taken to ensure that any omitted *20* Instrument Information Records have previously been made available for inclusion in the NGS Leveling Instrument and Rod database.

Analogously, it is not necessary to repeat identical *21* Rod Information Records, *22* Rod Standardization Records, and/or *23* Rod Calibration Records among the *20*-series records of every leveling line in which the respective rod appears. It is sufficient, for any rod, to submit an appropriate grouping of these records (covering all past calibrations) only once initially and thereafter only when the leveling rod in question is recalibrated. Again, in connection with every leveling line, care must be taken to ensure that any omitted *21*, *22*, and/or *23* records have previously been made available for inclusion in the NGS Leveling Instrument and Rod database.

To summarize, submit a *20* record for every previously unreported leveling instrument and/or previously unreported stadia factor determination. For every leveling rod, submit a *21* record alone if the rod has not previously been reported and no calibration data follow (e.g., a rod used in third- or lower-order differential leveling work exclusively). Otherwise, submit (as a group) one *21* record followed by one or more *22* records, one or more *22*, *23*,..., *23* record sets, and/or one or more *23*, *23*,..., *23* record sets, as appropriate; one such *22* record, *22*,*23*,..., *23* record set, or *23*, *23*,..., *23* record set for each previously unreported calibration of the leveling rod in question.

NGS Survey Equipment Code: A three-digit numeric identification code assigned to each category of survey equipment and within each category to specific instruments or other commonly used items. In particular, leveling instruments are assigned 200-series survey equipment codes, while leveling rods and staves are assigned 300-series survey equipment codes (see ANNEX F).

Instrument/Rod Serial Number: Assigned by the manufacturer, the serial number is the ultimate identifier of a specific leveling instrument or leveling rod. Serial numbers are normally numeric; however, alphabetic characters are often used as prefixes, suffixes, etc.; special characters such as a blank (space), hyphen (minus sign), front slash (diagonal), etc., may appear imbedded in the

respective alphanumeric character group. For this reason, a serial number must be treated as alphanumeric information to be entered in the respective character field left-justified and blank-filled on the right. (See Data Field Types, p. 6-25 ff.)

The instrument or rod serial number will be used together with the respective survey equipment code (see above) to create appropriate entries in the NGS Leveling Instrument and Rod Database, to keep these entries up-to-date, and to access this database for the retrieval of the respective stadia factor and/or rod calibration data in the course of routine processing of VERT OBS data sets. Use the identical serial number representation consistently whenever reference is made to that specific instrument or rod in any VERT OBS data set. Embedded blanks and leading zeros should be excluded from the serial number.

Stadia Factor: An instrument-specific constant numerically equal to the ratio of the focal length of the instrument to the respective stadia interval, i.e., to the distance which separates the stadia lines (two horizontal lines spaced equally above and below the level line) in the reticle of the leveling instrument. By design, the stadia interval is chosen so that the stadia factor is a convenient integer number such as 100.

The stadia factor (p. 6-14) is used to obtain the distance between the leveling instrument and a rod as the product of the stadia factor multiplied by the respective (full) stadia intercept (p. 6-23). Note that a sight length so obtained is in the same units as the stadia intercept, i.e., in rod units, and hence must be further multiplied by a conversion factor to obtain the sight length in other units.

Rod Units: The units in which the respective rod scale is graduated. Four different rod units are acceptable, each identified by a two-letter code. They are as follows:

CF - centifeet (0.01 ft)
CM - centimeters (0.01 m = 1 cm)
CY - centiyards (0.01 yd = 0.03 ft)
HC - half-centimeters (0.005 m = 0.05 cm = 5 mm)

Rod Graduation Code: A one-digit code denoting the type of graduation of the respective leveling rod:

1 - line graduation (single scale)
2 - line graduation (double scale)
3 - block graduation (including checkerboard)
4 - other

Temperature Scale: The temperature at which the leveling rod was calibrated must be given on both the *22* Rod Standardization Record (Standardization Temperature) and the *23* Rod Calibration Record (Calibration Temperature). On either record, provision is made to indicate which of the two possible temperature scales applies by means of a one-letter code immediately preceding the respective temperature field:

C - Celsius Temperature Scale
F - Fahrenheit Temperature Scale

Coefficient of Expansion: The relative change in linear dimension (expansion or contraction) per unit of temperature change peculiar to the material of the respective leveling rod scale (possible materials include INVAR or other low-expansion metal alloys for modern rods, and specially treated wood for rods used in older differential leveling work of high precision). Aside from the scale factor 10,000 mentioned below, the coefficient of expansion given on the *22* Rod Standardization Record must be in units which are compatible with the respective temperature scale and rod units (see above), as specified in Table 6-4.

TABLE 6-4
UNITS OF COEFFICIENT OF EXPANSION

ROD UNITS	TEMPERATURE SCALE C	TEMPERATURE SCALE F
CF	feet per degree Celsius	feet per degree Fahrenheit
CM	meters per degree Celsius	meters per degree Fahrenheit
CY	feet per degree Celsius	feet per degree Fahrenheit
HC	meters per degree Celsius	meters per degree Fahrenheit

The coefficient of expansion expressed in either one of the four possible unit combinations (see above) is always a very small decimal fraction. To avoid the keying of a long string of zeros preceding the first significant digit, enter the respective coefficient of expansion multiplied by 10,000, i.e, with the decimal point moved four places to the right. (Example: A coefficient of expansion of 0.00000079 is entered as 0.0079 or .0079.)

A-Flag: Enter 'A' if the coefficient of expansion (see above) is an "assumed" value (i.e., as given by the manufacturer or a standard value for the material in question). Leave the field blank if the coefficient of expansion has been determined by means of a multiple-temperature calibration of the respective leveling rod.

Rod Excess: A factor used to compute the rod correction for a single running of a section of a leveling line. The rod calibration process precisely determines the actual length of the respective rod (or of a representative segment thereof). Rod excess is the ratio of the difference between the actual and nominal lengths (actual minus nominal) to the nominal length of the rod (or calibrated segment thereof).

Note that the rod excess is a unitless number; however, since it is always a small (positive or negative) decimal fraction, it is convenient to express rod excess as the aforementioned ratio multiplied by 1,000 (i.e., as millimeters per meter, if metric units are being used). Accordingly, regardless of the respective rod units, enter the rod excess with the decimal point moved three places to the right.

Index Error: The distance above or below the bottom surface (foot) of the leveling rod at which the nominal origin (zero) of the respective graduated scale is located (the origin of the low scale of a rod with a double-scale graduation). The index error is positive when the scale origin falls below the foot of the rod; it is negative when the scale origin falls above the foot of the rod. Note that the index error is expressed in rod units (see above) of the leveling rod in question.

FIELD ABSTRACT DATA RECORDS

30 Field Abstract Record

The purpose of the *30* record is to provide cross-reference between the primary identifier (i.e., the designation) of a vertical control point and the corresponding job-specific station serial number (SSN). In addition, the accumulated distance along the leveling line and the respective "field" elevation (see below) are given on this record. Following established practice, these latter two data items are computed from the detailed differential leveling field notes as the work progresses and are normally recorded on a form called the "Field Abstract" - hence the name "Field Abstract Record." The diagram illustrating the respective format can be found on page 6-35.

Submit a *30* record for the first (starting) survey point, followed by a *30* record for each elevation carried forward to a survey point by the differential leveling process. Normally, in the absence of any closed loops, there will be as many *30* records as there are survey points along the leveling line.

However, if a loop is closed (as in the case of a spur loop or if the line itself forms a closed loop), an additional *30* record must appear in proper sequence (see below) for the endpoint of each such loop, reflecting the elevation carried forward to that BM or TBM via the loop.

Order of the *30* Records: The order of the *30* records is crucial. This is because the *30* records, as a group, define the leveling line in question, i.e., they define the nominal sequence of BMs and TBMs along the leveling line.

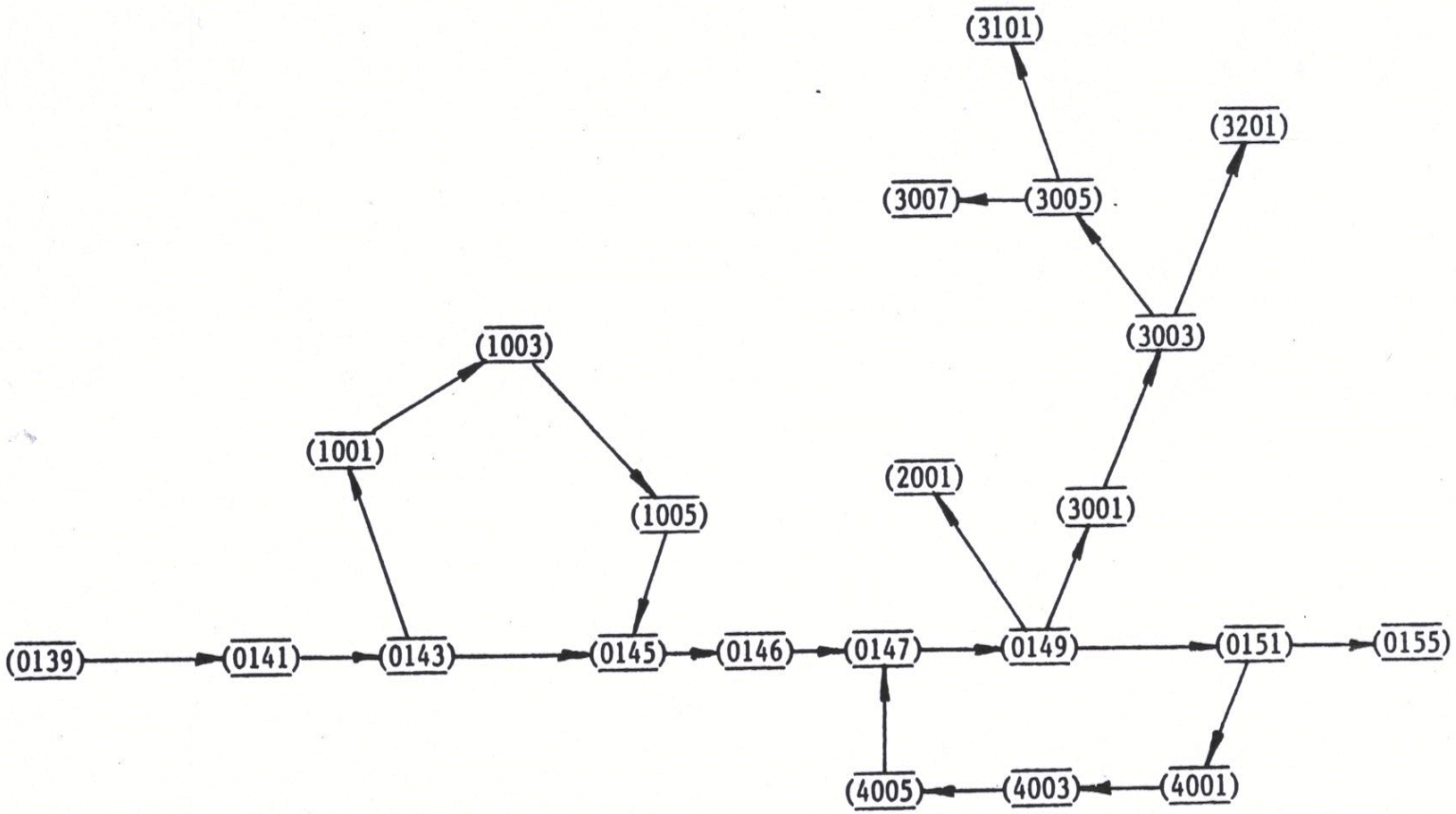
Normally, the *30* records should follow the same sequence as the respective survey points occur along the leveling line. However, one or more spurs may emanate from any survey point - in which case, after the *30* record for such a "base" point, the *30* records for all survey points along the longest spur must follow first, then those along the next longest spur, etc. Only when all spurs emanating from that base have thus been exhausted should the *30* record for the elevation carried forward to the next survey point along the main route of the leveling line be given - see examples in Figure 6-1, p. 6-18.

Station serial number: For the purpose of identifying the initial and terminal points of each section of the leveling line in a concise and unique manner (e.g., on the respective *41* and *42* records - see p. 6-20 ff., OBSERVATION DATA RECORDS), each survey point in a vertical control job is assigned a job-specific serial number in the range 0001 to 9999. See Chapter 5 for an explanation of the survey point numbering system.

The station serial number (SSN) is also used in the correlation of the data pertaining to the BMs and TBMs which appear in the VERT OBS data set with the corresponding data contained in the companion description data set of the vertical control job. For this reason, special care must be taken to ensure that the identical station serial number assigned to a BM or TBM in the VERT OBS data set is also used to identify the same survey point in the respective companion description data set.

Designation: A vertical control point or BM is normally identified by a numeric or alphanumeric symbol which is stamped on the disk marker (or otherwise inscribed on the BM monument). Less frequently, a BM is assigned a recognizable name (e.g., when a horizontal control point also becomes a BM). Do not append the abbreviation or acronym of the agency whose name is precast in the marker or monument–-see Annex D, Guideline 3.

A maximum length of 25 characters (including all imbedded blanks) is allowed for the designation on the *30* record. By contrast, a length of 50 characters is allowed in the description file, per Annex P. The designation from the description is used for publication. Use the same general guidelines for the designations of any TBMs.



Sequence of the *30* Records:

1. 0139	5. 1003	9. 0146	13. 3003	17. 3201	21. 4003
2. 0141	6. 1005	10. 0147	14. 3005	18. 2001	22. 4005
3. 0143	7. 0145	11. 0149	15. 3101	19. 0151	23. 0147
4. 1001	8. 0145	12. 3001	16. 3007	20. 4001	24. 0155

FIGURE 6-1 - Example of Field Abstract Record sequence.

Accumulated Distance: The distance covered by the differential leveling operation from the nominal starting point of the leveling line to the survey point in question. It is obtained by successively adding the lengths of the intervening sections (following the line-order conventions used for the ordering of the *30* records in the case of a survey point located on a spur or leveled to via a spur loop --see Order of the *30* Records, p. 6-17). Recall (p. 6-7) that "section" is a segment of the leveling line consisting of two neighboring survey points connected by a chain of differential leveling observations (i.e., connected by a "running").

The individual section lengths are obtained by accumulating the lengths of the backsight and foresight of each setup of the respective running, which in turn are usually obtained as a function of the corresponding stadia intercepts and the stadia factor of the leveling instrument used (see Stadia etc. on p. 6-23 and Stadia Factor on p. 6-14). For this purpose, use the minimum section length if more than one running has been made over a section, as is the normal case.

With hand-keyed data, the accumulated distance (as well as the field elevation, p. 6-20) is carried on the *30* record to provide a check against certain undetected keying errors, line order errors, errors in the assignment of station serial numbers, etc. For this reason, the accumulated distance entered in this field must be the value which is normally computed and "abstracted" in the course of the differential leveling operation. The accumulated distance must not be generated (e.g., by software) from the respective *41* and *42* records, as this would defeat the purpose for which it is intended.

Field Elevation: The approximate elevation of the survey point in question is obtained as the (algebraic) sum of the elevation of the starting point of the leveling line and the raw (i.e., uncorrected) elevation differences determined for the intervening sections (following the line-order conventions used for the ordering of the *30* records in the case of a survey point located on a spur or leveled to via a spur loop - see Order of the *30* Records, p. 6-17).

The end product of every running over a section of the leveling line is the respective observed, uncorrected elevation difference (see Elevation Difference, p. 6-24). When more than one running has been made over a section, as is the normal case, a "section mean" must be computed using all forward and backward runnings made over that section which have passed appropriate field rejection criteria.

Noting that a backward running produces an elevation difference of opposite sign, the respective section mean is defined as the algebraic difference between the sum of elevation differences determined by forward runnings and the sum of elevation differences determined by backward runnings divided by the number of runnings. In other words, if ΣF is the sum of all acceptable forward-running elevation differences,and ΣB is the sum of all acceptable backward-running elevation differences, the desired section mean is $(\Sigma F - \Sigma B)/n$, where n is the number of runnings.

With hand-keyed data, the field elevation (as well as the accumulated distance, p. 6-19) is carried on the *30* record to provide a check against certain undetected keying errors, line order errors, errors in the assignment of station serial numbers, etc. For this reason, the field elevation entered in this field must be the value which is normally computed and "abstracted" in the course of the differential leveling operation. The field elevation must not be generated (e.g., by software) from the respective *41* and *42* records, as this would defeat the purpose for which it is intended.

OBSERVATION DATA RECORDS

40 Survey Equipment Record
41 Running Record
42 River/Valley Crossing Record
43 Correction/Rejection Record

The observation data records, identified by *40*-series data codes, are listed above. The diagrams illustrating the respective formats are on p. 6-27 ff. The purpose of the *40*-series records is to provide the means to record the differential leveling observations carried out along a leveling line. Recall (p. 6-7) that a leveling line is a unit of field work consisting of a number of survey points (BMs and TBMs) connected by differential leveling observations; a "section" is a segment of the leveling line consisting of two neighboring survey points which are connected by one or more differential leveling observations.

The differential leveling observations carried out over a section of leveling line are of two basic types, runnings and crossings, as follows.

Running: Normally, the (observed) elevation difference between the endpoints of a section is determined as the accumulation of a continuous series of small elevation difference measurements, each obtained as the difference between the respective backsight and foresight readings on a pair of leveling rods positioned vertically over "turning points" at a relatively short sight distance from the leveling instrument. This type of differential leveling observation, which consists of a chain of small elevation difference measurements (i.e., leveling instrument "setups"), is called a "running."

When carried out in the nominal direction of progress of the leveling line, it is called a "forward" running; when carried out in the opposite direction, it is called a "backward" running. A section which is "double-run" (as is the normal case) will have at least one forward and one backward running (among possibly several runnings in either direction) which meet field acceptance criteria (i.e., the disagreement between the respective observed elevation differences does not exceed the tolerance which is in effect for the order and class of the vertical survey in question).

Submit a *41* record for every running carried out along the leveling line, regardless of its field acceptance or rejection status (rejected runnings may be brought within the respective tolerance after various corrections are applied in the course of subsequent data processing). The *41* records must be submitted in sets consisting of a *40* record followed by one or more *41* record(s) - one for each running made on the same date, using the same leveling instrument and the same leveling rods, and subject to the same level collimation error (see p. 6-22), as specified in the respective leading *40* record. See also STRUCTURE OF THE VERT OBS DATA SET, p. 6-3 ff.

Crossing: The other type of differential leveling observation is the "river/valley crossing" (or "crossing") which is used when a gap larger than the maximum allowable sight length of a setup must be spanned, as when a river (or dry canyon) must be crossed without using a suitable bridge. This type of differential leveling observation is the result of a series of reciprocal measurements carried out simultaneously from both sides of such a gap using special "valley-crossing" equipment. Note that each individual river/valley crossing must be treated as a separate section of the leveling line.

Submit a *42* record for every river/valley crossing along the leveling line. The *42* records, if any, must appear as the last group of records of the respective leveling line block in the VERT OBS data set (see STRUCTURE OF THE VERT OBS DATA SET, p. 6-3 ff).

Submit a *43* record for each running or river/valley crossing for which a refraction correction was determined from temperature profile measurements made by field personnel or for which a rod correction was determined using detailed rod calibrations. Also, if a running or a river/valley crossing was rejected, include a *43* record indicating the source of the rejection (field or office). Each required *43* record should immediately follow its corresponding *41* or *42* record. If temperatures were observed only at the upper- and lower-temperature probes, leave the columns labeled "Mean temperature for middle probe" and "Height of middle probe" blank. The columns labeled "Rod Correction in mm" refer to values determined using "detailed" rod calibrations (the calibration of all rod graduations) furnished formerly by the National Bureau of Standards and now by various entities.

Level Collimation Error: The (small) angle by which the line of sight defined by the center of the crosslines in the reticle and the optical center of the objective lens of a leveling instrument departs from the horizontal when the instrument is "level:" positive when the line of sight deviates upward, and negative when the line of sight deviates downward from horizontal. The collimation error is due to a small misalignment between the respective bubble vial (in the case of spirit-level instruments) or compensator mechanism (in the case of self-aligning instruments) and the line of sight (line of collimation).

The level collimation error can be resolved into two components--a residual constant component (which can be minimized by careful adjustment of the instrument) and a variable component. This latter component is caused by transient deformation of the structural parts of the instrument brought about by stresses and strains due to uneven temperature distribution (differential heating) and other intermittent physical forces, which are active in the course of the daily handling of the instrument.

The level collimation error must be determined at sufficiently frequent intervals–-daily, unless doing 3rd order work and/or using a level with reversible compensator--to permit the application of meaningful corrections to the respective leveling rod readings. It is the total accumulated length imbalance between all the backsights and foresights of a running to which the correction for collimation error is applicable. The effect of the collimation error cancels for a setup with backsight and foresight of equal length.

Tangent of Collimation Error: The observing procedure by means of which the collimation error is determined (commonly known as the "C-Test" or "peg test") produces the ratio of the corresponding rod reading error to the length of line of sight, i.e., the trigonometric function tangent of the collimation error.

Note that the tangent of an angle is a unitless number; however, since it is a very small (positive or negative) decimal fraction, it is convenient to use the tangent of collimation error multiplied by 1000 (i.e., as millimeters per meter, if metric units are being used). Accordingly, enter the tangent of collimation error with the decimal point moved three places to the right.

Wind Code: A one-character numeric code which denotes the approximate wind conditions prevailing during the course of the running. The three wind codes are:

0 - wind speed less than 10 kilometers per hour
1 - wind speed from 10 to 25 kilometers per hour
2 - wind speed greater than 25 kilometers per hour

Sun Code: A one-character numeric code which denotes the approximate conditions of insolation prevailing during the course of the running. The three sun codes are:

0 - less than 25% of setups under sunny conditions
1 - 25% to 75% of setups under sunny conditions
2 - more than 75% of setups under sunny conditions

Stadia, Stadia Intercept, and Stadia Intercept Code: Stadia is a method of obtaining the approximate distance (typically to the nearest 0.1 meter) between the leveling instrument and a vertically positioned leveling rod as the product of the instrument's stadia factor (as specified in the corresponding *20* record) and the respective stadia intercept - the difference between the high and low stadia line readings on the respective rod. Recall that stadia lines are two horizontal lines spaced equally above and below the horizontal crossline in the reticle of the leveling instrument. Note that the distance obtained in this manner is in the same units as the stadia intercept, i.e., in rod units of the respective leveling rod (as specified in the corresponding *21* record).

For differential leveling observations, stadia information is desired (1) to compute the total length of the running, and (2) to compute the total accumulated length imbalance between the backsights and foresights of the running (to eliminate the residual effect of collimation error - see Level Collimation Error above). Because of the latter requirement, two fields are provided for the entry of stadia information, one for the Sum of Backsight Stadia Intercepts and the other for the Sum of Foresight Stadia Intercepts.

As mentioned, the two stadia lines are equidistant from the horizontal crossline (level line) of the leveling instrument. The use of full stadia intercepts requires the observation and recording of two rod readings (the stadia high and the stadia low readings) in addition to the level line reading. It is possible to observe only one stadia line reading (either the stadia high or the stadia low) in addition to the level line reading, in which case half stadia intercepts are obtained. Note that either full stadia intercepts or half intercepts must be observed consistently throughout a running. To specify which one of the two possible procedures has been followed, provision is made on the *41* record for a one-letter Stadia Intercept Code:

F - full stadia intercepts observed
H - half stadia intercepts observed

Units: A set of two-letter codes for the various units of length in which the length of running (*41* record), length of crossing (*42* record), and elevation difference (*41* and *42* records) may be given. It is the same set of unit codes which is used on the *30* record to denote the units of accumulated distance and field elevation - see FIELD ABSTRACT DATA RECORDS, p. 6-16 ff. The specific unit codes are:

MT - meters	KM - kilometers
FT - feet	KF - kilofeet
YD - yards	SM - statute miles

Running Length: The overall length of the running (i.e., the distance covered by the differential leveling observations), preceded by the respective units code, used only if the stadia information (see above) is not available; otherwise leave blank.

Crossing Length: Enter the overall length of the crossing (i.e., the distance spanned by the river/valley crossing observations), preceded by the respective units code.

Elevation Difference: Enter the observed difference of elevation as determined by the running or crossing in question, preceded by the respective units code. Note that this must be the raw observed elevation difference, i.e., the result of the running or crossing observations to which no corrections have been applied.

FORMAT DIAGRAMS

For each record which appears in a VERT OBS data set (see Table 6-1, p. 6-2), a diagram has been prepared to illustrate the respective format. These format diagrams have been designed to fulfill the following objectives:

1. Each record is 80 characters long.

2. Each record has a fixed format, i.e., every data field has a specific length and specific position within the record.

3. Each format diagram is a graphic image of the respective record.

4. Information and instructions concerning the data item to be entered in each data field are provided on the format pages.

5. When appropriate, sample entries are shown in the data entry line of each format diagram.

6. Each data field is characterized as to its type by a string of lower-case characters which appear immediately below the data entry line and which refer back to the types enumerated in the following section.

Data Field Types:

1. Alpha Field (aa...a) - intended for a data item which is coded as a string of alphabetic, numeric, and/or special characters, with or without imbedded blanks, to be entered into the respective data field *left-justified and blank-filled on the right*. See Chapter 5 for a list of special characters which are allowed.

2. Blank Field (bb...b) - to be blank-filled. Data fields which are designated as blank fields must be entirely blank, i.e., no data items may be entered in these fields.

3. Constant (Numeric) Field (cc...c) - intended for a data item which is a number (i.e., an integer, a proper or improper fraction, or a decimal fraction) coded as a string of numeric characters (prefixed with a minus sign if the number is negative) which may contain one leading or imbedded (but not trailing) decimal point if it is a decimal fraction, or an imbedded hyphen and/or slash if it is a proper or improper (mixed) fraction such as 3/4, 5-1/2, etc., to be entered into the respective data field *left-justified and blank-filled on the right*.

4. Floating-Point Field (ff...fdd...d) - intended for a data item which is coded as a decimal number, i.e., as a string of numeric characters (prefixed with a minus sign if the number is negative) which may not contain any imbedded blanks. *If the decimal point is coded*, the character string representing the integer digits, the decimal point, and the decimal fraction digits may be positioned anywhere within the respective field (generally left-justified), and the unused columns of the data field are blank-filled.

If the decimal point is not coded, the "f" portion of the floating-point field is to contain the integer part of the decimal number and the "d" portion the corresponding decimal fraction part, the decimal point being implied between the rightmost "f" column and the leftmost "d" column of the field.

Accordingly, a string of numeric characters representing m integer digits followed by n decimal fraction digits with an implied decimal point must be positioned in the floating-point field so that its integer part falls into the m rightmost "f" columns and its decimal fraction part into the n leftmost "d" columns, any unused columns of the data field being blank-filled. When a negative number is entered, code the minus sign immediately preceding the leading digit.

5. Integer Field (ii...i) - intended for a data item which is coded as a string of numeric characters representing a positive or negative integer number, to be entered into the respective data field *right-justified*. In the case of a positive integer number, *zero-fill* any unused columns on the left. In the case of a negative integer number, code the minus sign immediately preceding the leftmost non-zero digit and *blank-fill* any unused columns to the left of the minus sign.

6. Specific Character Field (ss...s) - intended to contain a specific alphabetic or numeric special character or a specific group of characters. Every "s" column of a specific character field must contain the character shown in that position in the data line of the respective format diagram.

Required Data: In general, only those records which are applicable to the data at hand should be included in a VERT OBS data set (e.g., no *42* records need be submitted if there are no river/valley crossings along the respective leveling line).

Data items are required unless noted as optional on the following format pages. Fields must be filled in accordance with the instructions given on the respective format page or in the text of this chapter.

Records or portions of records which are optional, or which may be omitted under certain circumstances, are so designated in the headings, footnotes, or bodies of the corresponding format pages.

aa DATA SET IDENTIFICATION RECORD

This must be the first record of every data set submitted.

The job code used in this record must be identical to the job code in the *aa* Data Set Termination Record--the last record in the Vertical Observation Data Set (VERT OBS)--and identical to the job code used in both the Data Set Identification Record and the respective companion description data set.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

aa FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Must be “000010" on this record. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Job code. Must be *aa*, where "aa" denotes the two-character code assigned by the submitting organization. The first “a” must be a letter; the second may be a letter or number.
CC 11-14	Data class. Must be “VERT.”
CC 15-18	Data type. Must be “OBS.”
CC 19-24	Abbreviation of submitting organization. See Annex C. If not listed there, request a new listing per hyperlink under “Annex C” at bluebook web site.
CC 25-66	Full name of submitting organization. See Annex C. Optional.
CC 67-68	Starting height datum code.“29" for NGVD 29, “88" for NAVD 88, “LT” for local tidal or “PR” for PRVD 02. Optional.
CC 69-72	Blank
CC 73-80	Date data set created. Integer. Century, year, month, day (ccyymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.

For a more detailed explanation of the contents of this record see Chapter 5, page 5-1, JOB CODE AND SURVEY POINT NUMBERING and Chapter 6, pp. 6-2 ff.

Column numbers and example data, *aa* RECORD

```
0000000001111111111222222222233333333334444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789O
000010*CX*VERTOBS NGS   NATIONAL GEODETIC SURVEY                  88    19990510
iiiiiisaasssssssssaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaabbbbiiiiiiii
```

10 LINE INFORMATION RECORD

This must be the leading record of each leveling line included in the job as noted on p. 6-3.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer and specific character) with the details of justification, decimal point placement, etc.

10 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *10*.
CC 11-18	Accession number (commonly called “L number”) such as “L22024"
CC 19-22	Line or part number if needed to supplement the accession number.
CC 23	Releveling code. “R” if releveling over previously established line, otherwise blank.
CC 24-31	Date field operations commenced. Integer. Century, year, month, day (ccyymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 32-39	Date field operations terminated. Integer. Century, year, month, day (ccyymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 40-41	Units of tolerance factor used to compute maximum disagreement allowed for each double-run section of the line. Either “MM” = mm/sq rt of km distance or “FT” = ft/sq rt of statute mile distance.
CC 42-45	Tolerance factor. Constant.
CC 46-47	Order and class of survey. Integer, per table below.
CC 48-49	State or country code for the state or country in which the leveling line begins and into which it extends--see Annex A.
CC 50-51	State or country code for an additional state or country into which the leveling line extends--see Annex A.
CC 52-53	State or country code for an additional state or country into which the leveling line extends--see Annex A.
CC 54-56	Initials of Chief of Party (person responsible for the survey). Leave blank if unknown. Optional.
CC 57-76	Abbreviation of agency which made the observations. See Annex C.
CC 77	Blank
CC 78	Running code. Integer. ‘1' to indicate either single- or double-simultaneous run, ‘2' to indicate double-run.
CC 79	Rejection method. “A” if 1948 rejection algorithm used in reduction, “B” if Halperin rejection algorithm used in reduction. Optional.
CC 80	Position code. “1" to indicate positions obtained from *30* records. Optional.

10 LINE INFORMATION RECORD, cont.

ORDER AND CLASS OF SURVEY

ORDER	1ST			2ND			3RD	LOWER
CLASS	*	I	II	*	I	II	**	**
CODE	10	11	12	20	21	22	30	40

* Class unspecified **No class subdivision

Column numbers and example data, *10* RECORD

```
000000000111111111122222222223333333333444444444455555555556666666666777777777 8
123456789012345678901234567890123456789012345678901234567890123456789012345678 90
nnnnnn*10*L22024  2   R1999110200002 24MM3.0 11CA    CS NGS                    1
iiiiiisiisaaaaaaaaaaaaaiiiiiiiiiiiiiiiaaccccciiaaaaaaaaaaaaaaaaaaaaaaaaaaaabiaa
```

11 LINE TITLE CONTINUATION RECORD (Optional)
12,*13*, *14* LINE TITLE CONTINUATION RECORDS (Optional)

Use the *11* record to give the title of the line (or of area network or special project of which the line is a part) and the *12*, *13*, and *14* records for continuation and/or subtitles, if any.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer and specific character) with the details of justification, decimal point placement, etc.

11,*12*,*13*,*14* FORMAT

Card col.

CC 01-06 Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.

CC 07-10 Data code. Must be *11*,*12*,*13* or *14*.

CC 11-80 Line title. Abbreviate and/or edit a line title in the interest of fitting the entire title on the *11* record if possible.

Use *12*-*14* records as required if the title exceeds 70 characters or if subtitles are necessary (e.g. the title of an area network followed by title of the line).

The title of a leveling line should be descriptive of the route followed, i.e., it should indicate the starting and ending locations and prominent “via” points, if any. (Example: ALBANY GA VIA MORVEN TO CALLAHAN FL).

Do not divide words (or other character groups) between the *11*,*12*,*13*,*14* records. Omit punctuation marks (periods, commas, etc.) and parentheses whenever possible. Use Annex A state and country codes whenever reference to a state or country is necessary.

Column numbers and example data, *11*-*14* RECORDS

```
0000000001111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
nnnnnn*11*TULARE-VASCO ARVIN-MARICOPA AREA CA
nnnnnn*12*9.1 KM SE OF KETTLEMAN CITY TO PIXLEY
iiiiiisiisaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
```

15 COMMENT RECORD (Optional)

Use the *15* record for any comment(s) pertinent to the leveling line. If the comment(s) exceed 70 characters, use another *15* record for continuation; any number *15* records is allowed. Do not divide words between consecutive *15* records.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

15 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *15*.
CC 11-80	Comment(s).

Column numbers and example data, *15* RECORD

```
0000000001111111111222222222233333333334444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*15*GRAVITY SURVEY OBSERVED OVER THIS LINE.
iiiiiisiisaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
```

20 INSTRUMENT INFORMATION RECORD

Submit this record for every instrument (identified by the respective Survey Equipment Code and Instrument Serial Number; see p. 6-13) once for each past stadia factor determination (to form a historical file) and when a new stadia factor is determined.

Omit this record for those instruments for which *20* records(s) containing identical information have been given in another line of this data set–or in a previously submitted VERT OBS data set.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

20 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *20*.
CC 11-13	NGS Survey Equipment Code. Integer. See Annex F.
CC 14-21	Instrument serial number, identical to the s/n given in the corresponding *40* record.
CC 22-37	Instrument manufacturer.
CC 38-49	Instrument model or type.
CC 50-69	Agency or firm which owns or has the custody of the instrument using the code in Annex C assigned to the agency.
CC 70-77	Determination date of stadia factor. Integer. Century, year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 78-80	Stadia factor. Integer. Instrument-specific number which when multiplied by stadia intercept gives distance to rod.

Column numbers and example data, *20* RECORD

```
00000000011111111112222222222333333333344444444455555555556666666666777777777 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*20*23190760   ZEISS/OBERKOCHENNI1        NGS                  19990217100
iiiiiisiisiiiaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaiiiiiiiiii
```

21 ROD INFORMATION RECORD

Submit this record for every rod (identified by the respective Survey Equipment Code and Rod Serial Number; see p. 6-13) once initially with or without one or more *22* Rod Standardization and/or *23* Rod Calibration Records for that rod.

Aside from being required at least once initially for every rod, this record must precede every *22* and/or *23*,....,*22* and/or *23* record group subsequently submitted for any given rod.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

21 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *21*.
CC 11-13	NGS Survey Equipment Code. Integer. See Annex F.
CC 14-21	Rod serial number.
CC 22-37	Rod manufacturer. Optional.
CC 38-49	Rod model or type (for example, “INVAR” or “LOVAR”). Optional.
CC 50-69	Agency or firm which owns or has custody of the rod, using the code in Annex C assigned to the agency. Optional.
CC 70-71	Rod units. CF (centifoot, 0.01 ft), CM (centimeter, 0.01 m), CY (centiyard, 0.01 yd) or HC (half-centimeter, 0.005 m)
CC 72	Graduation code. Integer. 1 = line graduation, single scale. 2 = line graduation, double scale. 3 = block graduation including checkerboard. 4 = other.
CC 73-80	Blank

Column numbers and example data, *21* RECORD

```
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*21*316120900  KERN            INVAR       NGS                 HC2
iiiiiisiisiiiaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaibbbbbbbb
```

22 ROD STANDARDIZATION RECORD

Submit this record for every rod (with or without accompanying *23* record(s)) once for each past standardization or calibration (to form a historical file) and whenever rod is restandardized or recalibrated--see footnote. The *22* record is optional if all data elements contained in the record are inferable from accompanying *23* records. Not required for 3rd- and lower-order work.

Omit this record for those rods for which *22* and/or *23* records(s) containing identical data have been given in another line of this data set or in a previously submitted VERT OBS data set.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

22 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *22*.
CC 11-13	NGS Survey Equipment Code. Integer. See Annex F.
CC 14-21	Rod serial number.
CC 22-27	Abbreviation of laboratory or other source of standardization. Enter “MAKER” if standardization is furnished by the rod manufacturer.
CC 28-33	Date of standardization. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 34	Temperature scale of standardization. “C” = Celsius; “F” = Fahrenheit.
CC 35-38	Standardization temperature. Constant.
CC 39-44	Coefficient of Expansion x 10,000. Constant. See p. 6-15.
CC 45	A-flag. “A” = assumed; blank otherwise. See p. 6-16.
CC 46-51	Rod Excess x 1,000. Constant. See p. 6-16. Optional if inferrable from *23* record(s).
CC 52	Blank.
CC 53-58	Index error in rod units. Constant. See p. 6-16. Optional if inferrable from *23* record(s).
CC 59	Blank.
CC 60-65	Computed Rod Scale Constant in rod units. Used with detailed rod calibration data only. Constant.
CC 66	Blank.
CC 67-70	3-sigma error of micrometer. Used with detailed rod calibration data only. Units of microns, to 1 decimal place. Floating point with implied decimal after cc 69.
CC 71-79	Blank.
CC 80	Century code for date of standardization. “8" for 19th century, “9" for 20th, “0" for 21st century.

Column numbers and example data, *22* RECORD

```
000000000111111111122222222233333333334444444445555555556666666667777777778
123456789012345678901234567890123456789012345678901234567890123456789012345678
nnnnnn*22*316120900  NBS   990211C25.0.0080 A-0.650 .01534
iiiiiisiisiiiaaaaaaaaaaaaaiiiiiiaccccccccccacccccbccccccbccccccbfffdbbbbbbbbba
```

23 ROD CALIBRATION RECORD

In addition to the respective *22* record, submit one or more *23* records for every past single- and multiple-temperature calibration of the rod for which the data are available and when rod is recalibrated. Not required for 3rd- and lower-order work.

Omit this record for those rods for which *22* and/or *23* records(s) containing identical data have been given in another line of this data set or in a previously submitted VERT OBS data set.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

23 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *23*.
CC 11-13	NGS Survey Equipment Code. Integer. See Annex F.
CC 14-21	Rod serial number.
CC 22-27	Abbreviation of laboratory or other source of calibration. Enter “MAKER” if calibration is furnished by the rod manufacturer.
CC 28-33	Date of calibration. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 34	Temperature scale of calibration. “C” = Celsius; “F” = Fahrenheit.
CC 35-38	Calibration temperature. Constant with explicit decimal pt.
CC 39-40	Units of Measured Length (FT, MT or YD). For the three below intervals 1, 2 and 3, specify the point on the rod (xxx in rod units) at which the calibration measurement starts, the point at which it ends, and the measured length of the respective interval in feet, meters or yards per discussion of Units on p. 6-24.
CC 41-43	Starting point, Interval 1. Integer. In rod units.
CC 44-46	Ending point, Interval 1. Integer. In rod units.
CC 47-53	Measured Length, Interval 1. Floating-point. Decimal point implied after CC 47.
CC 54-56	Starting point, Interval 2. Integer. In rod units.
CC 57-59	Ending point, Interval 2. Integer. In rod units.
CC 60-66	Measured Length, Interval 2. Floating-point. Decimal point implied after CC 60.
CC 67-69	Starting point, Interval 3. Integer. In rod units.
CC 70-72	Ending point, Interval 3. Integer. In rod units.
CC 73-79	Measured Length, Interval 3. Floating-point. Decimal point implied after CC 73.
CC 80	Century code. “8" for 19th century, “9" for 20th, “0" for 21st century. Optional.

Column numbers and example data, *23* RECORD

```
00000000011111111112222222223333333333444444444455555555556666666666777777777 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*23*316120900  NBS   990211C25.0MT000200100005000040020000700006003000090
iiiiiisiisiiiaaaaaaaaaaaaaiiiiiiaccccaaiiiiiifddddddiiiiiifddddddiiiiiifddddddda
```

30 FIELD ABSTRACT RECORD

Submit this record for the first (starting) survey point (bench mark or temporary bench mark) and thereafter for each elevation carried forward (possibly more than once for any given survey point) in the order of occurrence along the leveling line–see p. 6-16 ff.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

30 FORMAT

Card col.

CC 01-06 Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.

CC 07-10 Data code. Must be *30*.

CC 11-14 Station serial number (SSN). Integer.

CC 15-39 Designation. 25 characters or less, abbreviated and/or edited to be this length per Annex D. A length of 30 characters is allowed in the HZTL OBS data set (see Chapter 2, p. 2-31), and 50 characters in the GEOD DESC data set (see Annex P, section 3.3.1, Description Header Record, Field Format of Designation). The 50-character station name will be used in the automated publication of geodetic data sheets, station descriptions, and associated indexes.

Three versions of a long station name may then exist - one 25 characters long for processing vertical observations, one 30 characters long for processing horizontal observations, and one 50 characters long used for publication. The three versions should differ only as to the manner in which the station name has been abbreviated and/or edited.

Items in CC 40-61 must be keyed from the Field Abstract and not generated from the respective *41*/*42* records. See pp. 6-19 and -20.

CC 40-41 Units of distance, per footnote.

CC 42-49 Accumulated Distance. Constant with explicit decimal point.

CC 50-51 Units of Elevation. “MT”, “FT” or “YD”.

CC 52-61 Field Elevation. Constant with explicit decimal point.

CC 62-67 Permanent identifier (PID) if assigned. From NGS data base. Optional.

CC 68-73 North latitude to nearest second. Integer. Optional.

CC 74-80 West longitude to nearest second. Integer. Optional.

Units of distance: MT - meters FT - feet YD - yards
KM - kilometers KF - kilofeet SM - statute miles

Column numbers and example data, *30* RECORD

```
000000000011111111112222222222333333333344444444455555555556666666666777777777 8
123456789012345678901234567890123456789012345678901234567890123456789012345678 90
nnnnnn*30*0187D 1056                    KM23.49   MT57.11702  FU30763556041194019
iiiiiisiisiiiiaaaaaaaaaaaaaaaaaaaaaaaaaaccccccccaaccccccccccaaaaaaiiiiiiiiiiii
```

40 SURVEY EQUIPMENT RECORD

The leading record of every *40*, *41*, *41*,...*41* set containing runnings made on the same date using the same equipment and affected by the same collimation error.

Submit this record to reflect the start of each day's work; also to reflect a change in any of the following: an item of survey equipment, the height of instrument by 5 cm or more, the heights of the temperature probes, or the determination of collimation error. Follow a *40* record by one or more *41* records for the runnings to which data on the *40* record apply.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

40 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *40*.
CC 11-16	Date of running. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 17-19	NGS survey equipment code for level instrument–see Annex F. Integer.
CC 20-27	Instrument serial number, identical to the s/n given on the corresponding *20* record.
CC 28	M-Flag. "M" if micrometer is used, blank otherwise.
CC 29-31	NGS survey equipment code for Rod 1–see Annex F. Integer.
CC 32-39	Rod 1 serial number, identical to the s/n given on the corresponding *21* record.
CC 40-42	NGS survey equipment code for Rod 2–see Annex F. Integer.
CC 43-50	Rod 2 serial number, identical to the s/n given on the corresponding *21* record.
CC 51-53	Average height of instrument in cm. Integer.
CC 54-56	Height of upper temperature probe in cm. Integer. This and next two fields blank if temperature probes were not used.
CC 57-59	Height of lower temperature probe in cm. Integer.
CC 60-62	Height of middle temperature probe in cm. Integer.
CC 63-64	Blank.
CC 65-69	Tangent of collimation error x 1000 (i.e., enter with decimal point moved three places to the right.) Constant. Leave blank if none determined. See pp. 6-22 and 6-23.
CC 70	Time zone of collimation error determination. See Annex H. Optional in a *40* record preceding a *42* record.
CC 71-74	Local time of collimation error determination–hours and minutes (HHMM). Optional in a *40* record preceding a *42* record.
CC 75-80	Blank.

Column numbers and example data, *40* RECORD

```
000000000111111111122222222233333333334444444445555555556666666667777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*40*99032623190760   M316118018  316120900  150250050250  -.005T0750
iiiiiisiisiiiiiiiiaaaaaaaaaiiiaaaaaaaaiiiaaaaaaaaiiiiiiiiiiiibbcccccaiiiibbbbbb
```

41 RUNNING RECORD

Submit this record for every running other than a river/valley crossing. The *41* records for all runnings made on the same date, using the same equipment, and to which the same collimation error applies must be grouped immediately after the respective *40* record.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

41 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *41*.
CC 11-16	Date of running. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 17-20	Starting station serial number (SSN). Integer. Must be same as SSN on the corresponding *30* record.
CC 21-24	Ending station serial number (SSN). Integer. Must be same as SSN on the corresponding *30* record.
CC 25	Time zone–see Annex H.
CC 26-29	Local starting time of running–hours and minutes (HHMM). Integer.
CC 30-33	Local ending time of running–hours and minutes (HHMM). Integer.
CC 34	Temperature scale: “C” = Celsius, “F” = Fahrenheit.
CC 35-38	Air temperature at starting time and place. Constant.
CC 39-42	Air temperature at ending time and place. Constant.
CC 43	Wind code. Integer. See p. 6-22.
CC 44	Sun code. Integer. See p. 6-23.
CC 45-47	Number of setups in the running. Integer.
CC 48	Stadia intercept code. “F” = full, “H” = half.
CC 49-53	Sum of backsight stadia intercepts. Floating-point with implied decimal point after CC 52. Enter to the nearest 0.1 of the respective rod unit.
CC 54-58	Sum of foresight stadia intercepts. Floating-point with implied decimal point after CC 57. Enter to the nearest 0.1 of the respective rod unit.
CC 59-60	Units of length–see *30* record.
CC 61-65	Length of running in the units indicated, if stadia data unavailable; leave blank otherwise. Constant.
CC 66-67	Units of elevation difference–“MT”, “FT”, or “YD”.
CC 68-77	Elevation difference. Constant. The observed, uncorrected elevation difference determined by the running.
CC 78-80	Initials of the observer. Optional.

Column numbers and example data, *41* RECORD

```
0000000001111111111222222222233333333334444444444555555555566666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789O
nnnnnn*41*75032601870091T13171358C18.920  02 12H 1563 1572       MT-5.68392  NLM
iiiiiisiisiiiiiiiiiiiiiaiiiiiiiiaccccccccciiiiiaffffdfffdaacccccaacccccccccccaaa
```

42 RIVER/VALLEY CROSSING RECORD

Submit this record for each river/valley crossing along the leveling line.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

42 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *42*.
CC 11-16	Date of crossing. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 17-20	Starting station serial number (SSN). Integer. Must be same as SSN on the corresponding *30* record.
CC 21-24	Ending station serial number (SSN). Integer. Must be same as SSN on the corresponding *30* record.
CC 25	Time zone–see Annex H.
CC 26-29	Local starting time of crossing–hours and minutes (HHMM). Integer.
CC 30-33	Local ending time of crossing–hours and minutes (HHMM). Integer.
CC 34-58	Blank.
CC 59-60	Units of length–see *30* record.
CC 61-65	Total length of the river/valley crossing in the units indicated. Constant.
CC 66-67	Units of elevation difference–“MT”, “FT”, or “YD”.
CC 68-77	Elevation difference. Constant. The observed, uncorrected elevation difference determined by the crossing.
CC 78-80	Blank.

Column numbers and example data, *42* RECORD

```
0000000001111111111222222222233333333334444444445555555556666666666777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
nnnnnn*42*75101801130114R10251100                          KM0.75 MT0.61874
iiiiiisiisiiiiiiiiiiiiiaiiiiiiiibbbbbbbbbbbbbbbbbbbbbbbbbaacccccaacccccccccccbbb
```

43 CORRECTION/REJECTION RECORD

Submit this record for each running or river/valley crossing when 1) temperature profiles were measured in the field, 2) a rod correction can be determined using detailed rod calibrations traceable to the National Institute of Standards and Technology, or 3) the running or river/valley crossing is to be rejected.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

43 FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Increment by 10 on successive records to allow for insertions. Optional.
CC 07-10	Data code. Must be *43*.
CC 11-16	Date of running or river/valley crossing. Integer. Year, month, day (yymmdd). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
CC 17-20	Starting station serial number (SSN). Integer.
CC 21-24	Ending station serial number (SSN). Integer.
CC 25-28	Local starting time of crossing–hours and minutes (HHMM). Integer.
CC 29-35	Refraction Correction in mm. Constant with explicit decimal point.
CC 36	Field/office rejection. “F” = field rejection; “O” = office rejection. Blank = not rejected.
CC 37-43	Rod correction in mm. Constant with explicit decimal point.
CC 44	Temperature scale. “C” = Celsius; “F” = Fahrenheit.
CC 45-49	Mean temperature for upper probe. Constant with explicit decimal point.
CC 50-54	Mean temperature for lower probe. Constant with explicit decimal point.
CC 55-59	Mean temperature for middle probe. Constant with explicit decimal point.
CC 60	Temperature code. “O” = observed, “P” = predicted.
CC 61-71	Blank.
CC 72-80	Partial Refraction Correction. Constant with explicit decimal point in cc 77.

Column numbers and example data, *43* RECORD

```
000000000111111111122222222233333333334444444445555555555666666666677777777778
1234567890123456789012345678901234567890123456789012345678901234567890123456789
nnnnnn*43*990914012201231452-1.21   -0.81  C19.1 20.1 19.4 P
iiiiiisiisiiiiiiiiiiiiiiiiccccccacccccccacccccccccccccccabbbbbbbbbbbccccccccc
```

aa DATA SET TERMINATION RECORD

This must be the last record of every data set submitted.

The job code used in this record must be identical to the job code in both the *aa* Data Set Identification Record--the first record in the VERT OBS data set--and the companion description data set.

Unless otherwise noted, data fields are required and are of type alpha (left-justified). See Data Field Types on p. 6-25 ff. for requirements of the six data types (alpha, blank, constant, floating-point, integer, and specific character) with the details of justification, decimal point placement, etc.

aa FORMAT

Card col.	
CC 01-06	Sequence number. Integer. Optional.
CC 07-10	Job code. Must be *aa*, where "aa" denotes the two-character code assigned by the submitting organization.
CC 11-80	Blank

Column numbers and example data,*aa* RECORD

```
00000000011111111112222222222333333333344444444455555555556666666666777777777 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
nnnnnn*CX*
iiiiiisiisbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbb
```

Data Set Structure

aa Data Set Identification Record

10-series records	
20-series records, if any	FIRST
30 records	LINE
40-series records	
10-series records	
20-series records, if any	SECOND
30 records	LINE
40-series records	
::::	::::
::::	::::
10-series records	
20-series records, if any	LAST
30 records	LINE
40-series records	

aa Data Set Termination Record