STANDARD FOR EXCHANGE OF TOPOGRAPHIC DATA ON MAGNETIC TAPE*

Paper presented by Australia

This paper consists of a brief description of a standard for exchange of topographic data on magnetic tape adopted for use by federal mapping agencies and recommended by the National Mapping Council as a guideline for all Australian mapping agencies. Copies of the standard (17 pages) will be made available upon request.

AIM OF THE STANDARD

This standard has been devised for the exchange between survey organizations of digitized topographic data on magnetic tape. The introduction of this standard will reduce costs in two ways: it will permit the digitized data held by mapping organizations to be considered a single entity, thus minimizing duplication of work; and it will minimize the cost of exchanging digitized data between organizations.

It is not foreseen that survey organizations will necessarily store or operate on data in this exchange format. Most organizations will have a working format determined first by the machines they use; and, secondly, on how they wish to manipulate their data; and for storage of large masses of data, some form of compression may be desirable. This standard is for exchanging data, and each organization is likely to need two programmes: one to convert data from its working format into this standard exchange format; and one to convert data received from other organizations in this exchange format into its own preferred working format.

PRINCIPLES ON WHICH THE STANDARD HAS BEEN DESIGNED

Distribution of work between donor and receiver

Where there is a choice, the donor should be required to do as little work as possible. The recipient is, in some sense, getting something for nothing and should be expected to do the bulk of any work that has to be done.

Satisfaction of requests by supersets or subsets

Information will normally be exchanged as a result of a request from the receiver to the donor. This request may be satisfied by the donor passing the exact set, several subsets or a superset of the information requested, according to the mode of operation of the donor organizations.

Data deemed to be error free

Since the exchange tape will need to be especially prepared by the donor, all errors should be eliminated from it, and the data on the exchange tape should be deemed to be error free. The standard contains no provision for correction codes.

Comprehensibility more important than compression

It is not foreseen that masses of digitized data will be stored in the exchange format. It is more likely to be stored in the working format of the donor organization or in some compressed form. The prime requirement of an exchange tape for the receiver organization is not that the data shall be tightly packed but that they shall be readily comprehensible. For this reason, the opening blocks in the exchange format are 80 bytes long so that they can be readily interpreted, without any programming, on a line-printer.

No specially compacted data

Similarly, the standard makes no provision for the inclusion on exchange tapes of data packed, for example, in STARBURST form or in special grids or arrays. Special attention is, however, given to arrays of spot heights as a means of depicting the topography.

Feature codes

Although feature codes should be allocated on some logical system, they should be capable of great expansion in order to cope with the needs peculiar to individual organizations and with unforeseen demands in the future. The system adopted is based on the specifications for the national topographic map series, and should be suited for any topographic map. Some codes for bathymetric features and some for common hydrographic features have been added (they appear in annex A to the standard).

The coding system is capable of almost indefinite expansion in two ways. First, no less than 10,000 codes are available, of which less than 200 have been allocated to date. Secondly, each feature header contains not only a feature code but a "modifier" of a further four digits. In the case of height features, such as contours (but excluding spot heights), the modifier contains the height of the feature; but the modifier more generally is at the disposal of the donor organization. For example, feature code 1203 defines "Building or shed", and if the modifier which follows it contains four zeros, that is all that it means; but the donor may say that if the modifier contains 0001, the building is a post office; that if the modifier contains 0002, it is a church; and so on. By this means, no less than 10,000 options are available for modiying each of the 10,000 possible feature codes, and expansion is therefore virtually limitless. Each feature header is followed by either a single pair, or a string of pairs, of horizontal co-ordinates, defining the position of the feature.

Volume and file headers

Many items of information that the recipient of a tape needs to know are more or less standard, and it is convenient to have a fixed format to remind the donor what these items are and to ensure that he shall consider

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whether they are applicable. In addition, in almost every case, the donor will need to explain some peculiarity in his data or to define some feature codes or feature modifiers, and ample space has been provided for this purpose.

Nine blocks of 80 characters called User Volume Labels (UVL 1-9) are available in free format to say what a volume or tape contains (given in the standard, section 5). A further nine blocks called User Header Labels (UHL 1-9) contain, in fixed format, room for information which is foreseen to be necessary for nearly all data; and the donor has the option of up to 26 further blocks of 80 characters, free format (UHL A-Z), for explaining the peculiarities of each individual file to the recipient (in the standard, section 6).

Dates

It is desirable to have a standard method of expressing dates. In the system adopted, five digits, "yyddd", give the last two digits of the year and the serial number of the day of the year, which is now given in most desk diaries. For example, 31 December 1974 is coded as 74365.

Negative numbers

Owing to the difficulty of reading arithmetical signs in numerical fields, no plus or minus signs are required by the standard. Specific feature codes are allocated to negative heights or depths; and unless otherwise defined by the donor, all latitudes are measured southwards from the equator, and all longitudes are measured eastwards from Greenwich. The standard can, of course, be used for areas north of the equator; the donor simply specifies in a user header label that in this particular file unsigned latitudes are measured northwards from the equator.

Co-ordinate system

Although data may be digitized in any system and stored in compressed forms on any arbitrary co-ordinate system convenient to the user, it is convenient to have a standard system of co-ordinates for exchange tapes. Australia is fortunate in having at its disposal two such systems; longitudes and latitudes on the Australian geodetic datum; and eastings and northings on the Australian map grid. The standard requires the donor to convert all co-ordinates into one or the other of these two forms when making the exchange tape.

For topographic mapping, co-ordinates to the nearest metre should always suffice, and it is foreseen that co-ordinates will usually be listed in integral metres on the Australian map grid or in hundred thousandths of a degree (0.00001°) on the Australian geodetic datum. To save space on the tape, provision is made for a constant amount to be subtracted from co-ordinates before they are recorded. For example, near Canberra, 149° might be subtracted from all longitudes and 35° might be subtracted from all latitudes; or 600,000 m might be subtracted from all eastings and 6 million m might be subtracted from all northings. These figures and the number of digits remaining for each co-ordinate—in this case, 5—are specified by the donor in the file header. These constants, once defined, remain constant for the whole file.

No specific provision is made for co-ordinates in units other than integral metres or 0.000001°. However, it is always open to a donor to define in the file header that all co-ordinates in a file are in units, for example, of decimetres or millionths of a degree.

Heights

For topographic mapping, heights to be nearest metre will nearly always be adequate; and no mountain attains 10,000 m. Unless otherwise specified in the user header label, heights are therefore given as an unsigned four-digit number with no decimal point, which is the height of the point in metres. The datum will nearly always be the Australian height datum, except in the case of bathymetric or hydrographic work. The datum is specified in the box provided for the purposes in one of the user header labels. The difference between a strange datum and the Australian height datum should be stated by the donor. Special feature codes have been allocated for heights and depths in decimetres; as with co-ordinates, provision is made for a constant to be subtracted from all heights before they are recorded.

Spot heights

Individual spot heights can be considered control data; they are then referred to in this standard as "spot elevations" and a special feature code has been allocated in the control data section. But in large arrays, spot heights form a method of depicting the topography as an alternative to contours. In this case, it would be wasteful to repeat the feature code, with the modifier containing the height of the point, for every spot height. Four feature codes have therefore been allocated which, instead of being followed by strings of co-ordinate pairs, are followed by strings of triplets—two horizontal co-ordinates and a height. The number of characters in the height can differ from the number in each co-ordinate and is defined in the file header. The most common code is for positive heights in metres. The other three are for positive heights in decimetres, for negative heights in metres and for negative heights in decimetres. All feature codes apart from these four are followed by strings of co-ordinate pairs.

Binary code

As binary codes change from machine to machine and are not readily understood by other machines, they are not suited for use on exchange tapes. The standard adopts the set of 128 binary-coded decimal characters adopted in Australian Standard XI of 1969. ASXI-1969 is identical with the seven-bit set defined in ISO recommendation R646-1967, with the addition of national selections. The set defined by the standard is identical with that specified in the Americal Standard USASX 3.4-1967.

Tapes

Although seven-track tape has been much used in the past the advantages of nine-track tape are being increasingly recognized and the standard requires the use of

nine-track tape at the medium density of 32 rows per millimetre—800 bytes per inch.

Size of file—"page size"

The standard requires that data shall be exchanged in files that correspond to any one of the standard map-sheets, on any scale, approved by the National Mapping Council, or multiples of such sheets. Calculations revealed that a standard sheet, whether at 1 : 10,000 or at 1 : 100,000 scale, will nearly always fit comfortably inside a single 2,400-foot reel of tape. Owing to the difficulties of uncorrected edge comparisons, the standard does not provide for the exchange of data by photogrammetric models.