NTv2

National Transformation Version 2

User's Guide

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Introduction

The National Transformation Version 2 (NTv2) software and data package provides a national standard for transforming coordinates between the NAD27 and NAD83 reference systems.

Version 2 contains new features which ensure the most reliable results for users seeking compatibility among various data sets. These new features include:

- shifts modelled on more comprehensive control survey networks
- variable grid density to reflect network density
- accuracy estimates for predicted shifts

Shifts between the NAD27 and NAD83 coordinates for control survey markers form the basis for the transformation. They result not only from the adoption of a new reference system, but also vary significantly due to local and regional distortions in NAD27. Recent integration computations have produced NAD83 coordinates for extensive networks, most of which are municipal surveys. With their availability, the transformation is now based on the same control as most municipal GIS data, providing the necessary accuracy and compatibility in areas of large-scale mapping and GIS projects.

Introduction (cont'd)

The density of the NTv2 grid is adapted to the density of control surveys. The base grid density is increased in areas of dense municipal survey control, typically by reducing the spacing from 5 minutes of arc to 30 seconds, or just under 1 km. A hybrid density grid shift file combines all grid areas, and the software automatically selects the correct grid for each point to be transformed. Densified grids allow for improved modelling of local variations in shifts at control survey points, resulting in greater consistency with the local positioning infrastructure.

Accuracies of predicted shifts can be computed, based on the local consistency of the shifts at the control survey markers. Consistent control survey networks result in very accurate predictions of a few centimetres or less, whereas problem networks are reflected in lower accuracy estimates of up to a metre or more. Accuracy estimates enable the user to assess the impact of conversion on the integrity of the GIS data, and allow a tangible contribution to the error budget of the transformed coordinates.

This User's Guide covers the operation of the NTv2 software, and the formats for input and output of coordinate data. The NTv2 is comprised of a suite of three programs, and an automated look-up table called the grid shift file, to which all three programs refer. The structure of the grid shift file and methods to access it are documented in detail in the **NTv2 Developer's Guide**.

The first part of the User's Guide is the **Getting Started Section**. It provides a quick look at how to install and use the software, with sample sessions for the elementary operation of each of the three programs.

The second part of the User's Guide is the **Reference Section**. It contains detailed explanations of all functions and options of the three programs. It also contains complete specifications of the formats for input and output coordinates, along with examples.

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GETTING STARTED: 1) Installation

System Requirements

The National Transformation is a suite of three programs and an accompanying data file that operates on any IBM/PC compatible computer running MS-DOS Version 3.0 or later.

The executable code is not large, and the memory (RAM) requirements for execution are also minimal, since none of the processes hold vast amounts of data in memory during execution.

A math co-processor is not required to run the NTv2 software, but it does speed program execution. Two versions of the executable code are supplied. The first requires a math co-processor, the second will take advantage of a co-processor if it is present, but does not require one.

The **grid shift file**, on which computations are based, does require a large amount of disk space - about 14 megabytes (Mb) for the complete Version 2.0 coverage of Canada. This binary file is constantly accessed during processing, and must be present at all times, but remains on disk and does not require any special memory (RAM) capacity.

Smaller subsets of the grid shift file can be created if the use is concentrated on a more local area, reducing the amount of data required to be kept on disk. Little or no advantage in processing speed is gained by this. Many users may already have received a subset of the complete grid shift file from a provincial government agency.

Additional disk space is required to store the transformed coordinate files. This space is at least equal in size to the input file. A variety of other output files are also created by the suite of programs, such as report listings, tabulations, and an alternate ASCII format of the grid shift file. They range from very small - a few lines for some report listings - to extremely large - 25 megabytes for the complete ASCII grid shift file - depending on the options selected.

Installing the Software and Data

From Compact Disk

If the National Transformation was supplied on a Compact Disk (CD-ROM), the grid shift file and executable programs can simply be copied onto the local hard disk. It is even possible to leave the files on CD-ROM and access it there during execution, but performance will be significantly diminished.

GETTING STARTED: 1) Installation (cont'd)

Installing the Software and Data (cont'd)

From Floppy Disks

If the National Transformation was supplied on PC floppy disks, the first thing to do is write protect the disks, make backup copies, and store the original disks in a safe location. The copies can be used to install the software and data.

The executable programs can simply be copied directly from the NTv2 Programs Disk to the local hard drive.

The grid shift file is too large to fit on one floppy disk, so the DOS COPY command will not work. Instead, the DOS BACKUP command has been used to permit this single file to span several floppy disks. The DOS RESTORE command is used to copy it back onto the local hard disk.

The following DOS (Version 5.0) BACKUP command was used to create the multi-disk copy from the main level hard disk directory:

```
BACKUP C:\NTV2_0.GSB A:
```

To install the grid shift file from this set of floppy disks, the DOS (Version 5.0 or higher) RESTORE command must be used exactly as follows:

```
RESTORE A: C:\*.*
```

The RESTORE command will copy the data file from the **A:** drive to the main level directory of the **C:** drive. Ensure that enough disk space is available before beginning. The only variation permissible on the syntax is the drive letters - any legitimate combination of floppy and hard drive may be used. Do not attempt to restore into another directory - this can be done by moving the file after the restore is complete.

Once the programs and the grid shift file have been copied to your hard disk, it helps to place them in a directory that has been pathed in the AUTOEXEC.BAT file. This can eliminate the use of cumbersome directory paths when supplying programs with file names.

GETTING STARTED: 1) Installation (cont'd)

Checking the Installation

To test the installation of the NTv2 programs and grid shift file, the test data used in the documentation examples is supplied. Results obtained from test runs can be compared with the sample output files which are also supplied.

The programs run in DOS, or in a DOS window. To initiate execution, type the program name at the DOS prompt, while residing in the software directory.

Installing on Platforms Other Than PC

The National Transformation software can be compiled and run on computer platforms other than the PC, such as various UNIX systems, VAX/VMS and Mac/OS.

Refer to the **Reference Section** for program READDA, and to the **Developers' Guide** for more information on porting software and grid shift file.

GETTING STARTED: 2) Menu Conventions

Common Operations for Running Programs

All National Transformation programs use similar menus, providing an interactive dialogue with the user. The menus are based on the command-line interface, in which each line is written sequentially to the screen, and the cursor placed on the next line to await user input in the familiar terminal screen style (see NOTE at the end of this section).

Upon starting a program, a series of brief information screens is displayed. After reading the message on each screen, respond with a carriage return [CR] to view the next screen, or type a [Q] to proceed directly to the main menu, which will appear after the last information screen has been dismissed.

Each line (item) of the menu consists of three elements:

1) A brief description of the menu item
2) A character enclosed in square brackets [ ] which is used to designate the menu item
3) The default or user selected status of the menu item

The menus allow the user to specify options prior to execution of the operation.
The following **sample menu** is from program INTGRID:

Description **Designator** **Status**

```
NTV2 - Program INTGRID - Main Menu
----------------------------------
Input  - Grid Shift File        [G]
Input  - Coordinate File        [C] Keyboard
Output - Report Listing         [R]
Output - Coordinate File        [N]
Output - Coords Not Transformed [M]
----------------------------------
Input  - Coordinate Type        [T] GEO
Input  - from Keyboard          [K] YES
Input  - Formatted/Delimited    [I] GHOST Records
Output - Screen / File / Both   [S] Screen
Output - Formatted/Delimited    [O] GHOST Records
Direction of transformation     [D]
----------------------------------
Go to Analysis Option Menu      [A]
View Header Blocks              [V]
Go to Information Screen        [H]
Quit and exit from program      [Q]
Proceed - Transform coordinates [X]
----------------------------------
Select a menu item
```

GETTING STARTED: 2) Menu Conventions (cont'd)

Common Operations for Running Programs (cont'd)

The user chooses an option by entering the designator character followed by a carriage return [CR]. Some options automatically toggle between two available options, not requiring any further user response. For others, a dialogue is presented to allow the user to make an appropriate selection, to which the user enters a response, followed by a carriage return. For many of these dialogues, the default can be selected by a carriage return only, without the need to enter any designator characters or text. Examples of the various types of dialogues and responses are shown in the following "Getting Started" sections on programs INTGRID, INTTAB, and READDA. After the option has been entered or modified, the revised menu is displayed.

This option selection continues until the user selects the option to proceed with program execution or exits from the program. After execution, the menu is re-displayed, and the entire process repeated. Most option settings are retained.

A special comment about the file specification dialogue that is used to open all new and existing files - the file name alone can be submitted if the file is in the current working directory, or the file path can be used to access files in other directories. The path can either be a relative path from the current working directory (e.g. **`../ntv2data/ntv2_0.gsb`**), or a complete path starting from the drive specification (e.g. **`C:\ntv2/ntv2data/ntv2_0.gsb`**).

NOTE:

The software has been developed with the command-line interface deliberately to avoid any system dependencies, such as would be required for a Windows environment. This facilitates the porting of the software to other platforms and operating systems. The FORTRAN77 source code is ANSI standard, and recompiles easily on most systems (e.g. PC/MS/DOS, UNIX, VAX/VMS, MAC/OS, etc.). For more information on porting, see the **Reference Section** on program READDA, and the **Developer's Guide**.

GETTING STARTED: 3) Program INTGRID

Software for Transforming Coordinates

Program **INTGRID** (**Int**erpolate **Grid**) is used to convert geographic coordinates (latitude & longitude) or transverse Mercator (TM) coordinates (Northing & Easting) from one reference system to another. The program also generates various analytical information, such as coordinate shifts, accuracies of the shifts, and grid cell distortion.

This overview is a quick look at the basic operation of the program. For more complete detail on the variety of functions and their operation, see the **Reference Section** for program INTGRID and the related data formats.

The main menu for program INTGRID appears as follows:

```
NTV2 - Program INTGRID - Main Menu
----------------------------------
Input  - Grid Shift File        [G]
Input  - Coordinate File        [C] Keyboard
Output - Report Listing         [R]
Output - Coordinate File        [N]
Output - Coords Not Transformed [M]
----------------------------------
Input  - Coordinate Type        [T] GEO
Input  - from Keyboard          [K] YES
Input  - Formatted/Delimited    [I] GHOST Records
Output - Screen / File / Both   [S] Screen
Output - Formatted/Delimited    [O] GHOST Records
Direction of transformation     [D]
----------------------------------
Go to Analysis Option Menu      [A]
View Header Blocks              [V]
Go to Information Screen        [H]
Quit and exit from program      [Q]
Proceed - Transform coordinates [X]
----------------------------------
Select a menu item
```

The following is a list of the key menu items for basic operation:

[G] Specifies the **grid shift file** to be used (e.g. **NTv2_0.gsb**)

[T] **Type** of data coordinates (geographic or TM coordinates - **geographic** is default)

[D] **Direction** of transformation (from **NAD27 to NAD83** is default)

[X] Proceed with **execution**.

GETTING STARTED: 3) Program INTGRID (cont'd)

Software for Transforming Coordinates (cont'd)

The **grid shift file** is provided together with the software, and must be opened before any program operations can proceed. It is a binary direct-access file (an elementary type of data base) that contains a table of the shifts and their accuracies (see the **Developer's Guide** for more detailed information).

After opening the grid shift file by selecting the [G] designator and responding with the name of the grid shift file, the user can start to transform coordinates interactively by selecting the [X] designator. INTGRID gives an opportunity to go back to the menu to check the selected options before proceeding with execution. Prompts will appear for any necessary files that have not been opened.

The following is part of a sample session, starting from selection of the [X] option, after specifying the grid shift file (user responses are highlighted in **bold**):

```
  Any last changes?
  -----------------

  Press [CR] to proceed with execution
         [M] to return to Main Menu


     PROCESSING RECORDS

  Enter station number (MAXIMUM 40 CHAR.)
  [CR] to exit
```

ABCD

```
Enter Lat  (dd mm ss.ssssss)
```

45 0 0

```
  Enter Long (ddd mm ss.ssssss)
```

75 0 0

```
  POINT IN SUBFILE #  94   ONottawa


                                Latitude           Longitude
                                --------           ---------
 [IN ] ABCD              45  0   .00000      75  0   .00000
 [OUT] ABCD              45  0   .17527      74 59 58.74103

  Enter station number (MAXIMUM 40 CHAR.)
  [CR] to exit
```

GETTING STARTED: 4) Program INTTAB

Software for Windowing the Grid Shift File

The primary purpose of program **INTTAB** (**Int**erpolation **Tab**le) is to produce a table showing the coordinate shifts and the accuracies of the shifts at the grid points in a user-specified window. INTTAB may also be used to create a smaller sub-set of the **grid shift file** based on the user-specified window.

This overview is a quick look at the basic operation of the program. For more complete detail on the variety of functions and their operation, see the **Reference Section** for program INTTAB.

The menu for program INTTAB appears as follows:

```
 National Transformation
 Program INTTAB V2 Menu
-------------------------------------
 Transformation grid file        [G]
 Output Listing File             [O]
-------------------------------------
 Create a new grid file          [N] NO
 Window grid file                [W] NO
 Print grid table                [P] YES
-------------------------------------
 View header records             [V]
 Proceed - Continue execution    [X]
 Exit from program               [Q]
 Information Screens             [H]
 -------------------------------------
 Select a menu item
 ==================
```

The following is a list of the key menu items for basic operation:

[G] Specifies the **grid shift file** to be used (e.g. **NTv2_0.gsb**)

[O] Specifies the output **listing file** to be opened.

[W] Requests that a **window** of the grid shift file be printed as a table.

[X] Proceed with **execution**.

GETTING STARTED: 4) Program INTTAB (cont'd)

Software for Windowing the Grid Shift File (cont'd)

After specifying the grid shift file and an output file, the user can proceed by selecting the [X] designator. INTTAB gives an opportunity to go back to the menu to check the selected options before proceeding with execution. Prompts will appear for any necessary files that have not been opened, and for the window limits.

The following is part of a sample session, starting from selection of the [X] option, after specifying the grid shift file (user responses are highlighted in **bold**):

```
 Any last changes?
-----------------

Press [CR] to proceed with execution
       [M] to return to Main Menu


WORKING


The program will use the nearest grid points
beyond the limits supplied by the user if the
defining points do not fall on a grid line in
the grid file.

 Enter lower latitude in Deg,Min,Sec
45 0 0
 Enter upper latitude in Deg,Min,Sec
45 30 0
 Enter lower longitude in Deg,Min,Sec
75 0 0
 Enter upper longitude in Deg,Min,Sec
75 30 0



         User entered limits

Lower lat    45  0   .000000
Upper lat    45 30   .000000
Lower long   75  0   .000000
Upper long   75 30   .000000

 Do you want to change any values  [Y/N/Q]
n

                          Window Limits

         User entered limits         Limits used by program

Lower lat   45  0   .000000           45  0   .000000
Upper lat   45 30   .000000           45 30   .000000
Lower long  75  0   .000000           75  0   .000000
Upper long  75 30   .000000           75 30   .000000
```

GETTING STARTED: 4) Program INTTAB (cont'd)

Software for Windowing the Grid Shift File (cont'd)

```
           2 Subfile(s) have been selected

 Subfile  Num  Include   Lower/Upper Lat     Lower/Upper Long   Lat/Long Int.

 CAeast     1   Yes      40  0   .000000     44  0   .000000     0  5   .000000
                         60  0   .000000     88  0   .000000     0  5   .000000

 ONottawa  94   Yes      44 15   .000000     74 20   .000000     0  0 30.000000
                         45 55   .000000     76 10   .000000     0  0 30.000000


 Do you want all selected files [Y/N/Q]

n

 CAeast     1   Yes      40  0   .000000     44  0   .000000     0  5   .000000
                         60  0   .000000     88  0   .000000     0  5   .000000

 Do you wish to use this subfile   Yes     [CR]
                                   No      [N]

n

 ONottawa  94   Yes      44 15   .000000     74 20   .000000     0  0 30.000000
                         45 55   .000000     76 10   .000000     0  0 30.000000

 Do you wish to use this subfile   Yes     [CR]
                                   No      [N]


           2 Subfile(s) have been selected

 Subfile  Num  Include   Lower/Upper Lat     Lower/Upper Long   Lat/Long Int.

 CAeast     1   No       40  0   .000000     44  0   .000000     0  5   .000000
                         60  0   .000000     88  0   .000000     0  5   .000000

 ONottawa  94   Yes      44 15   .000000     74 20   .000000     0  0 30.000000
                         45 55   .000000     76 10   .000000     0  0 30.000000


 Do you want all selected files [Y/N/Q]

y


 WORKING

   JOB HAS COMPLETED. DO YOU WISH TO RUN ANOTHER
   EXIT                  [CR]
   RETURN TO MAIN MENU   [Y]
```

GETTING STARTED: 4) Program INTTAB (cont'd)

Software for Windowing the Grid Shift File (cont'd)

The following is part of the table created representing the shifts and accuracies in the user-selected window:

```
                                Natural Resources Canada                                        PAGE    2
                                Geodetic Survey Program INTTAB Version 2                        DATE  7-Jul-95
                               ==========================================

          Add shifts to NAD27    to get NAD83                          Grid File  : NTv2_0.gsb
          Upper value is Latitude Shift, Accuracy                      Subfile    : ONottawa
          Lower value is Longitude Shift, Accuracy                     Lat int.   :   0 00 30
          ** indicates a densified cell                                Long int.  :   0 00 30
```

LONGITUDE ->	75 03 00		75 02 30		75 02 00		75 01 30		75 01 00		75 00 30		75 00 00	
LATITUDE	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)	Shift (sec)	+/- (m)
45 06 00	.176	.008	.176	.008	.176	.008	.176	.008	.176	.007	.176	.007	.176	.007
	-1.256	.003	-1.257	.003	-1.258	.003	-1.259	.003	-1.260	.003	-1.261	.003	-1.262	.003
45 05 30	.176	.008	.176	.008	.176	.008	.176	.008	.176	.007	.176	.007	.176	.005
	-1.256	.003	-1.257	.003	-1.258	.003	-1.259	.003	-1.260	.003	-1.261	.003	-1.261	.005
45 05 00	.176	.008	.176	.008	.176	.007	.176	.006	.176	.005	.176	.005	.176	.005
	-1.255	.003	-1.256	.003	-1.257	.004	-1.258	.005	-1.258	.005	-1.259	.005	-1.260	.005
45 04 30	.175	.004	.176	.004	.176	.004	.176	.004	.176	.005	.176	.004	.176	.005
	-1.254	.005	-1.255	.005	-1.256	.004	-1.257	.004	-1.258	.004	-1.259	.002	-1.260	.002
45 04 00	.176	.003	.176	.003	.176	.004	.176	.004	.176	.004	.176	.004	.176	.005
	-1.254	.001	-1.255	.001	-1.256	.002	-1.257	.002	-1.258	.002	-1.259	.002	-1.260	.002
45 03 30	.175	.003	.176	.003	.175	.003	.176	.004	.176	.004	.176	.004	.176	.004
	-1.253	.001	-1.254	.001	-1.256	.001	-1.257	.002	-1.258	.002	-1.259	.002	-1.259	.002
45 03 00	.175	.004	.175	.004	.175	.003	.175	.004	.176	.004	.176	.004	.176	.004
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.002	-1.257	.002	-1.258	.002	-1.259	.002
45 02 30	.175	.003	.175	.003	.175	.003	.175	.003	.175	.004	.175	.004	.176	.004
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.002	-1.258	.002	-1.259	.002
45 02 00	.175	.002	.175	.003	.175	.003	.175	.003	.175	.004	.175	.004	.176	.004
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.002	-1.258	.002	-1.259	.002
45 01 30	.175	.002	.175	.002	.175	.003	.175	.003	.175	.003	.175	.004	.175	.004
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.001	-1.258	.002	-1.259	.002
45 01 00	.175	.002	.175	.002	.175	.002	.175	.003	.175	.003	.175	.004	.175	.005
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.001	-1.258	.002	-1.259	.002
45 00 30	.175	.001	.175	.002	.175	.002	.175	.003	.175	.004	.175	.005	.175	.003
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.002	-1.258	.002	-1.259	.002
45 00 00	.175	.002	.175	.003	.175	.002	.175	.002	.175	.005	.175	.003	.175	.002
	-1.253	.001	-1.254	.001	-1.255	.001	-1.256	.001	-1.257	.002	-1.258	.001	-1.259	.001

GETTING STARTED: 5) Program READDA

Software for Migrating the Grid Shift File

The primary use for program **READDA** (**Read D**irect **A**ccess File) is to convert the Grid Shift File from binary to ASCII format and then back again. This is usually only done when porting the Grid Shift File from one computer platform to another, such as from DOS to UNIX. It is mainly a developers' tool, and most users will not have any need for it.

READDA will also provide a summary list of file contents, or perform some rudimentary integrity checks on the sub-files.

The FORTRAN source code for programs INTGRID, INTTAB, and READDA is provided, and must be compiled on the destination platform. After doing this, use READDA to convert the Grid Shift File from binary to ASCII format. Then copy it to the new platform, and convert it back to binary format using READDA in that location.

This overview is a quick look at the basic operation of the program. For more complete detail on the variety of functions and their operation, see the **Reference Section** for program INTTAB.

Upon starting the program, a series of brief information screens is displayed. After reading the message on each screen, respond with a carriage return [CR] to view the next screen, or type a [Q] to proceed directly to the main menu, which will appear after the last information screen has been dismissed.

The menu for program READDA appears as follows:

```
National Transformation
Program READDA V2 FILE Menu

----------------------------------------
Input Grid Shift File (      )       [G]
Output Listing File                  [O]
----------------------------------------
List Header Information              [L] No
Convert Binary to ASCII              [C] No
----------------------------------------
View Header Information              [V]
Execute READDA                       [X]
Exit from program                    [Q]
Information Screens                  [H]
----------------------------------------
Select a menu item
```

GETTING STARTED: 5) Program READDA (cont'd)

Software for Migrating the Grid Shift File

The following is a list of the key menu items for basic operation:

[G] Specifies the **grid shift file** to be used (e.g. **NTv2_0.gsb**)

[O] Specifies the output **listing file** to be opened.

[C] **Converts** the grid shift file between binary and ASCII formats.

[X] Proceed with **execution**.

When the [G] option is selected, a prompt will appear requesting the user to indicate whether the grid shift file to be opened is binary or ASCII format, as follows:

```
Opening Grid Shift File
=======================

Is this file Binary   [CR]
             ASCII    [1]
```

After specifying the grid shift file and the output file, the user can proceed by selecting the [X] designator. READDA gives an opportunity to go back to the menu to check the selected options before proceeding with execution. Prompts will appear for any necessary files that have not been opened.

Reference Section

Detailed Information

on

Programs

and

Data Formats

REFERENCE: 1) Data Formats

Input Formats for Program INTGRID

The National Transformation program **INTGRID** will accept input either from the **Keyboard** or from a **File**.

Keyboard input can be in the form of geographic coordinates (latitude & longitude) in degrees, minutes, and seconds or transverse Mercator (TM) coordinates (Northing & Easting) in metres. Prompts are issued to enter coordinate information. As with menu items, responses are entered in free format, with commas as separators if necessary, followed by a carriage return to complete the entry.

File input must be in one of the built-in formats that INTGRID recognizes. Formats may not be mixed in the same file. The following five record formats are available:

1) GHOST format geographic coordinate records (degrees, minutes, seconds) **(Default)**
2) GHOST format transverse Mercator coordinate records (metres)
3) Delimited ASCII geographic coordinate records (degrees, minutes, seconds)
4) Delimited ASCII geographic coordinate records (decimal degrees)
5) Delimited ASCII transverse Mercator coordinate records (metres)

Users wishing to accommodate other formats may modify the INTGRID source code to their own specifications (see **Developer's Guide** for more information).

For **GHOST formatted records**, if column one is non-blank then the record is treated as a comment or other data, and written "as is" to the output file. Program INTGRID also looks for blanks and data in specific columns to validate a record. Although the GHOST format is very strict, this requirement only applies to the coordinate fields - all other fields are treated as descriptive information, and are reproduced on the output record.

Delimited ASCII records have fields in strings with separators between them, and are not required to be in specific column ranges. This permits greater freedom and flexibility for handling data from other systems. All fields must be supplied on the delimited ASCII record, and separated by one of the standard FORTRAN delimiters, such as:

- comma ' , '
- slash ' / '
- blanks ' '

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

Alpha (character) fields must be enclosed by single quotes for input. This applies only to the Station ID field (first field) for each of the three delimited ASCII formats. If the Station ID is completely numeric, the quotes may be omitted. Extra blank spaces may be inserted for readability, as done by INTGRID on the output records. No comment records are permitted with the delimited ASCII file formats.

Each of the five formats is described in more detail on the next few pages, followed by a summary of the possible combinations of input and output formats.

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

1) GHOST format geographic coordinate record

GHOST is the least-squares survey network adjustment system of the Geodetic Survey Division. The coordinate record used here is the standard one used by all GHOST library routines. Some users may wish to modify the format specifications in the source code to suit their own data.

Although the complete record specification is given, **only the latitude and longitude fields are used to transform the point**. All other column ranges (i.e. columns 1-40 and 71-80) are reproduced on output, and are given only for completeness of the GHOST format specification**.** Latitude and longitude must be in the stipulated columns or the record will not be processed. Decimal points should be included in the "seconds" fields to prevent misinterpretation based on the default decimal offset.

Columns	Field Description
2 - 3	Coordinate record type (Default is 04)
4 - 6	Coordinate data type
7 - 15	Station number (unique identifier of point)
16 - 30	Station name (descriptive)
32	Station classification (survey accuracy)
33 - 38	Associated network (survey project)
40	Latitude North/South indicator (Default is North)
41 - 42	**Latitude degrees**
43 - 45	**Latitude minutes**
46 - 54	**Latitude seconds**
55	Longitude East/West indicator (Default is West)
56 - 58	**Longitude degrees**
59 - 61	**Longitude minutes**
62 - 70	**Longitude seconds**
71 - 79	Station elevation (sea-level or ellipsoidal height)
80	Elevation type indicator

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

1) GHOST format geographic coordinate record (cont'd)

Example Records:

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
  4   A9423                           50 58 19.85940 114 00 01.98630
  4   538134                          62 10 57.36448 136 18 09.96039
  4   D23865                          44 54 36.46115  79 46 24.05018
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

2) GHOST format transverse Mercator coordinate record

The GHOST format transverse Mercator (TM) coordinate record is the same as used by the Geodetic Survey GHOST library program GSRUG, which converts coordinates between geographic and TM expressions. In addition to the Northing and Easting coordinates, the record has a field for the zone number, which facilitates the use of the two common standard forms of the TM projection:

i) **Universal Transverse Mercator** (UTM)
- global application
- 6 degree zone widths
- standard zone numbers
- standard central meridians of zones
- scale factor at central meridian is 0.9996
- false Easting is 500 000 metres
- false Northing is 0 metres

ii) **Modified Transverse Mercator** (MTM or 3TM)
- unique Canadian application
- 3 degree zone widths
- standard central meridians of zones
- scale factor at central meridian is 0.9999
- false Easting is 304 800 metres
- false Northing is 0 metres

For other non-standard forms of the TM projection, the zone number is not used, and the Zone field may be left blank. All of the projection parameters must be specified explicitly in the INTGRID Transverse Mercator sub-menu (see Reference Section on program INTGRID for more details).

Although the complete record specification is given, **only the Zone, Easting, and Northing fields are used to transform the point**. All other column ranges (i.e. columns 1-50) are reproduced on output, and are given only for completeness of the GHOST format specification. Northing and Easting must be in the stipulated columns or the record will not be processed. Decimal points should be included to prevent misinterpretation based on the default decimal offset.

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

2) GHOST format transverse Mercator coordinate record (cont'd)

Columns	Field Description
2 - 3	Coordinate record type (Default is 04)
4 - 6	Coordinate data type
7 - 15	Station number (unique identifier of point)
16 - 30	Station name (descriptive)
51 - 52	**Zone number**
57 - 68	**Easting (metres)**
69 - 80	**Northing (metres)**

Example Records:

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
  4   A9423                                      11      710583.087 5650796.659
  4   538134                                      8      432173.928 6895003.176
  4   D23865                                     17      596832.904 4973481.600
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

3) Delimited ASCII geographic coordinate record (degrees, minutes, seconds)

Delimited ASCII geographic coordinate records must contain all of the following fields for the sexagesimal (degrees, minutes, seconds) format:

Field	Data Type
Station ID (up to 40 char.)	CHARACTER
Degrees latitude	INTEGER
Minutes latitude	INTEGER
Seconds latitude	REAL
Degrees longitude	INTEGER
Minutes longitude	INTEGER
Seconds longitude	REAL

Example Records:

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423',50,58,19.85940,114,0,1.98630
'538134',62,10,57.36448,136,18,9.96039
'D23865',44,54,36.46115,79,46,24.05018
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423'                                , 50, 58, 19.85940,114,  0,  1.98630
'538134'                               , 62, 10, 57.36448,136, 18,  9.96039
'D23865'                               , 44, 54, 36.46115, 79, 46, 24.05018
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

Note that each record is shown twice - once in compressed form and once expanded for readability. The expanded form is the standard output from INTGRID.

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

4) Delimited ASCII geographic coordinate record (decimal degrees)

Delimited ASCII geographic coordinate records must contain all of the following fields for the decimal degrees format:

Field	Data Type
Station ID (up to 40 char.)	CHARACTER
Latitude (decimal degrees)	REAL
Longitude (decimal degrees)	REAL

Example Records:

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423',50.972183167,114.000551750
'538134',62.182601244,136.302766775
'D23865',44.910128097,79.773347272
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423'                                ,     50.972183167,    114.000551750
'538134'                               ,     62.182601244,    136.302766775
'D23865'                               ,     44.910128097,     79.773347272
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

Note that each record is shown twice - once in compressed form and once expanded for readability. The expanded form is the standard output from INTGRID.

REFERENCE: 1) Data Formats (cont'd)

Input Formats for Program INTGRID (cont'd)

5) Delimited ASCII transverse Mercator coordinate record

Delimited ASCII transverse Mercator coordinate records must contain all of the following fields:

Field	Data Type
Station ID (up to 40 char.)	CHARACTER
Zone Number	INTEGER
Easting (metres)	REAL
Northing (metres)	REAL

Two common standard forms of the TM projection are implemented (see details in *GHOST format transverse Mercator coordinate record*, above). For other non-standard forms of the TM projection, the zone number is not used. The zone field may be left blank, but must be included on the record (blank separators will not work in this case - use a dummy zone number). All of the projection parameters must be specified explicitly in the application program.

Example Records:

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423',11,710583.087,5650796.659
'538134',8,432173.928,6895003.176
'D23865',17,596832.904,4973481.600
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
'A9423'                                ,11,  710583.087, 5650796.659
'538134'                               , 8,  432173.928, 6895003.176
'D23865'                               ,17,  596832.904, 4973481.600
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

Note that each record is shown twice - once in compressed form and once expanded for readability. The expanded form is the standard output from INTGRID.

REFERENCE: 1) Data Formats (cont'd)

Output Formats for Program INTGRID

Coordinate output can be written to the **terminal screen**, a **file**, or **both**, depending on the options selected by the user.

Output coordinate type will always be the same as input type:

i.e. Geographic input gives Geographic output, and
Transverse Mercator input gives Transverse Mercator output.

If output is written to a file, some data format conversion is allowed as indicated by the following table:

INPUT		**OUTPUT**	
Type	Format	Type	Format
Geographic	Keyboard (dms)	Geographic	GHOST format Delimited ASCII (dms) Delimited ASCII (ddeg)
Geographic	GHOST format	Geographic	GHOST format Delimited ASCII (dms) Delimited ASCII (ddeg)
Geographic	Delimited ASCII (dms)	Geographic	GHOST format Delimited ASCII (dms)
Geographic	Delimited ASCII (ddeg)	Geographic	GHOST format Delimited ASCII (ddeg)
TM	Keyboard (metres)	TM	GHOST format Delimited ASCII
TM	GHOST format	TM	GHOST format Delimited ASCII
TM	Delimited ASCII	TM	GHOST format Delimited ASCII

REFERENCE: 1) Data Formats (cont'd)

Output Formats for Program INTGRID (cont'd)

The following examples show the output that corresponds to the examples from the five data formats described in the preceding sections. None of the examples incorporate a change in format between input and output. In each case, some analysis data has been appended to the output. These are only some of the possible combinations.

Example of Format 1: input file: geo_gho.dat
output file: geo_gho.new
appended: accuracies(m)

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
  4   A9423                          50 58 19.85940 114 00 01.98630
  4   538134                         62 10 57.36448 136 18 09.96039
  4   D23865                         44 54 36.46115  79 46 24.05018
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
  4   A9423                          50 58 20.05899 114  0  5.54952              .005      .006
  4   538134                         62 10 56.39768 136 18 17.20148             1.571     1.114
  4   D23865                         44 54 36.64956  79 46 23.43112              .005      .004
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
```

Example of Format 2: input file: utm_gho.dat
output file: utm_gho.new
appended: accuracies(m)

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
  4   A9423                                 11      710583.087 5650796.659
  4   538134                                 8      432173.928 6895003.176
  4   D23865                                17      596832.904 4973481.600
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
  4   A9423                                 11      710506.330 5651018.486      .006      .005
  4   538134                                 8      432071.338 6895176.579     1.114     1.571
  4   D23865                                17      596843.538 4973704.707      .004      .005
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
```

Example of Format 3: input file: geo_dms.dat
output file: geo_dms.new
appended: shifts(sec) & accuracies(m)

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
'A9423',50,58,19.85940,114,0,1.98630
'538134',62,10,57.36448,136,18,9.96039
'D23865',44,54,36.46115,79,46,24.05018
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
A9423                           , 50, 58, 20.05899,114,  0,  5.54952,    .19959,   3.56322,      .005,      .006
538134                          , 62, 10, 56.39768,136, 18, 17.20148,   -.96680,   7.24109,     1.571,     1.114
D23865                          , 44, 54, 36.64956, 79, 46, 23.43112,    .18841,   -.61906,      .005,      .004
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
```

REFERENCE: 1) Data Formats (cont'd)

Output Formats for Program INTGRID (cont'd)

Example of Format 4: input file: geo_ddeg.dat
output file: geo_ddeg.new
appended: shifts(m) & accuracies(m)

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
'A9423',50.972183167,114.000551750
'538134',62.182601244,136.302766775
'D23865',44.910128097,79.773347272
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
A9423                                ,     50.972238608,    114.001541534,     6.168,    69.524,      .005,      .006
538134                               ,     62.182332689,    136.304778190,   -29.931,   104.768,     1.571,     1.114
D23865                               ,     44.910180432,     79.773175312,     5.816,   -13.580,      .005,      .004
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
```

Example of Format 5: input file: utm_asc.dat
output file: utm_asc.new
appended: shifts(m) & accuracies(m)

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
'A9423',11,710583.087,5650796.659
'538134',8,432173.928,6895003.176
'D23865',17,596832.904,4973481.600
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
A9423                               ,11,  710506.330, 5651018.486,   -76.757,   221.827,      .006,      .005
538134                              , 8,  432071.338, 6895176.579,  -102.590,   173.403,     1.114,     1.571
D23865                              ,17,  596843.538, 4973704.707,    10.634,   223.107,      .004,      .005
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8----+----9----+----0----+----1----+----2
```

REFERENCE: 2) Program INTGRID

Function

Program **INTGRID** (**INT**erpolate **GRID**) is used to convert geographic coordinates (latitude & longitude) or transverse Mercator (TM) coordinates (Northing & Easting) from one reference system to another.

To accomplish this, it refers to a **grid shift file**, which contains the coordinate shifts (differences) between the two systems for points at regular intervals of latitude and longitude. After determining which grid cell a point to be transformed falls within, the program looks up the shifts at the four corners of the cell, and uses bilinear interpolation to estimate the shift at the supplied point. The shifts have been modelled by a previous external procedure, and the model has been sampled at regular intervals to produce the grid shift file.

This type of procedure is appropriate for conversion between reference systems that do not have a simple systematic relationship, and thus cannot be computed by a geometric formula, such as the seven-parameter geodetic datum transformation (ΔX, ΔY, ΔZ, rX, rY, rZ, ΔS). By employing a table, shifts that are irregular, with significant local and regional variation, can be accommodated.

Transverse Mercator coordinates are handled by a multi-step procedure. The grid shift file contains shifts in arc seconds of latitude and longitude, and can only be applied directly to geographic coordinates. On input, TM coordinates are converted to geographic coordinates using the projection specifications selected by the user, and the ellipsoid parameters for the "from" reference system. The shifts are computed and applied to the geographic coordinates as described above. Then the transformed geographic coordinates are converted back to TM using the same projection specifications, but the ellipsoid parameters for the "to" reference system.

In addition to the shifts, estimated accuracies are provided for each point in the grid shift file. These accuracies are based on the consistency of the shifts at the control survey network points nearby each grid point. If the agreement among the surrounding control points is good, then good accuracy can be expected, reflected by low numerical values. If the agreement is poor, then poor accuracy can be expected, reflected by high numerical values. Like the grid shifts, the accuracy at the point to be transformed is estimated by bilinear interpolation within the four corners of the cell.

REFERENCE: 2) Program INTGRID (cont'd)

Function (cont'd)

Another type of analytical function is also available - the maximum distortion for any selected cell. The distortion is determined by computing the gradient of the plane defined by three of the four corners of the cell. Four such planes can be defined, and the steepest gradient is used to characterize the greatest distortion that might be encountered in the grid shifts. A similar distortion computation is performed for the accuracies of the shifts, which may be interpreted as the rate of change of the accuracies for the selected cell.

Analytical data, such as shifts and accuracies, are optionally appended to the output coordinate record. Either the shifts and accuracies may be appended, or the distortion of the shifts and accuracies.

Operation

Program INTGRID will do batch processing from a file or interactive processing from the keyboard. In either case, control of the many options and functions is provided by an interactive menu.

The menu and dialogue screens are based on the command line interface. The complete main menu is displayed, and the user selects a menu item by typing the indicated character, followed by a carriage return [CR]. After responding to any query generated by the selection, the user is returned to the main menu where the change is reflected, and another item may be selected. Once satisfied with all settings, the user proceeds with the computations by selecting the execute item [X].

The **main menu** provides operational control for all items necessary to specify the files and the functions to be performed. The **analysis options menu**, which is accessed as a function from the main menu, allows the user to select the type of data to be written to the output record.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu

The main menu is broken down into three sections: **File Selection**, **Data Options**, and **Action Items**. Each is described in detail. The main menu appears as follows when the program is launched:

```
NTV2 - Program INTGRID - Main Menu
----------------------------------
Input  - Grid Shift File        [G]
Input  - Coordinate File        [C] Keyboard
Output - Report Listing         [R]
Output - Coordinate File        [N]
Output - Coords Not Transformed [M]
----------------------------------
Input  - Coordinate Type        [T] GEO
Input  - from Keyboard          [K] YES
Input  - Formatted/Delimited    [I] GHOST Records
Output - Screen / File / Both   [S] Screen
Output - Formatted/Delimited    [O] GHOST Records
Direction of transformation     [D]
----------------------------------
Go to Analysis Option Menu      [A]
View Header Blocks              [V]
Go to Information Screen        [H]
Quit and exit from program      [Q]
Proceed - Transform coordinates [X]
----------------------------------
Select a menu item
```

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

File Selection Section

This section of the main menu controls the selection of all input and output files. The program can operate completely in interactive mode without any files, with the exception of the grid shift file, which is mandatory input. If an output file is requested for transformed coordinates and analysis data, all three output files must be specified. When proceeding with execution, the program will prompt the user for any required file that has not been opened.

Input files are opened as read-only and left unaltered after execution. Output files are opened as new files. The user is given the opportunity to re-use existing file names by appending to or over-writing the existing file.

The details of the file selection section are as follows:

```
-----------------------------------
Input  - Grid Shift File        [G]
Input  - Coordinate File        [C] Keyboard
Output - Report Listing         [R]
Output - Coordinate File        [N]
Output - Coords Not Transformed [M]
-----------------------------------
```

[G] Specifies the ***grid shift file***, which must be opened before any transformation computations can be performed. It is a binary file containing the shifts and accuracies between two coordinate reference systems, and is supplied with this software.

[C] Specifies the ***input coordinate file***, from which coordinates to be transformed are submitted if data entry from the keyboard is not selected. **Default** is **Keyboard**.

Coordinate records may be in any of the formats described in the Data Formats topic of the Reference Section, but the formats may not be mixed. Format selection is made in the Data Options section of the main menu.

The root of this file name (i.e. the part before the extension) will be used as a base file name with the appropriate extensions as suggested file names in subsequent prompts for output files to be created. Using a common name helps to identify all of the output files from one run of INTGRID. This is for convenience only, and any file names may be used as desired.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

File Selection Section (cont'd)

[R] Specifies the ***report listing file***, to which all messages and tabulations generated during the execution of INTGRID are written. It must be opened if file output is selected. The **default extension** applied to the base file name is **.lis**.

[N] Specifies the ***output coordinate file***, to which the transformed coordinate records are written. It must be opened if file output is selected. Any of the formats described in the Data Formats topic of the Reference Section may be selected in the Data Options section of the main menu. The **default extension** applied to the base file name is **.new**.

[M] Specifies the ***output missing coordinate file***, to which all coordinate records are written for points that are not transformed because they fall outside the limits of the grid shift file. This file is deleted if empty at the end of execution. It must be opened if file output is selected. The record format will be the same as selected for the output coordinate file. The **default extension** applied to the base file name is **.mis**.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

Data Options Section

This section of the main menu controls the formatting and disposition of input and output files.

The details of the data options section are as follows:

```
-----------------------------------
Input  - Coordinate Type        [T] GEO
Input  - from Keyboard          [K] YES
Input  - Formatted/Delimited    [I] GHOST Records
Output - Screen / File / Both   [S] Screen
Output - Formatted/Delimited    [O] GHOST Records
Direction of transformation     [D]
-----------------------------------
```

[T] Toggles between the two input coordinate types: **GEO** for geographic coordinates, or **TM** for transverse Mercator coordinates. If TM is selected, a sub-menu is presented to specify the projection parameters. This sub-menu is described in detail below. Output coordinates will be the same type. **Default** is **GEO.**

[K] Toggles between the two options for data entry: **YES** for keyboard input, or **NO** for file input. This option changes automatically to NO when an input coordinate file is specified (see File Selection Section, above). A previously opened input coordinate file is closed when this option is switched back to keyboard. **Default** is **YES**.

[I] Toggles between the two input record formats, **GHOST records** or **Delimited ASCII**. Delimited ASCII format for geographic coordinate input can be either **Sexagesimal** (degrees, minutes and seconds) or **Decimal Degrees** - a prompt is given to provide the choice, which applies to both input and output files. **Default** is **GHOST records.**

[S] Selects where output data will be written**:** to **File**, to the **Screen**, or to **Both** - a prompt is given to provide the choice. **Default** is **Screen**.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

Data Options Section (cont'd)

[O] Toggles between the two output record formats, **GHOST records** or **Delimited ASCII**. Delimited ASCII format for geographic coordinate input can be either **Sexagesimal** (degrees, minutes and seconds) or **Decimal Degrees** - a prompt is given to provide the choice, which applies to both input and output files. **Default** is **GHOST records.**

[D] Toggles the direction of the transformation, which is expressed in terms of the two reference systems between which the shifts are given (i.e. "from" System A "to" System B). The direction of the transformation is embedded in the grid shift file itself, and is displayed with this option once the grid shift file has been opened (see File Selection Section, above).

The transformation can be applied in the opposite direction (i.e. "from" System B "to" System A) by changing the sign of the shift as a first approximation, and iterating the solution. This is necessary because the shifts are given with respect to System A. The corresponding System B coordinates are different by the amount of the shift, and thus the shift will be slightly different if System B coordinates are used to determine it. **Default** is the **embedded direction from the grid shift file**.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

Transverse Mercator Sub-Menu

When the [T] option is selected to toggle to TM coordinates, a sub-menu is presented to specify the projection parameters.

The default values initially displayed are for the standard **Universal Transverse Mercator** (UTM) projection, which is a family of zones in six degree bands of longitude around the globe. The other standard embedded in this program is the 3-degree **Modified Transverse Mercator** (MTM or 3TM) projection. Both have standard zone numbers which must be submitted on input along with the Northing and Easting coordinates. Any other specification must supply the central meridian in this menu in lieu of submitting the zone on coordinate input.

When transverse Mercator coordinates are processed, there are actually two projection conversions that take place in addition to computing the shifts between reference systems. First, the input coordinates are converted to the corresponding geographic expression using the ellipsoid parameters of the "from" system. The shifts are computed and applied to the geographic coordinates. The transformed geographic coordinates are then converted back to the transverse Mercator projection using the new ellipsoid parameters of the "to" system.

The details of the transverse Mercator options are as follows:

```
Select options

Zone width                [W]            6
Scale factor              [S]    0.9996000
False easting             [E]    500000.00
False northing            [N]         0.00
Central meridian          [C]
Keep original zone        [K]          Yes

End selection         [CR][Q]
```

[W] Specifies the **Zone Width**, in degrees of longitude. If the central meridian has not been specified, 6 degrees automatically selects UTM and 3 degrees automatically selects MTM. **Default** is **6 degrees**.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

Transverse Mercator Sub-Menu (cont'd)

[S] Specifies the **Scale Factor** at the central meridian. The scale factor changes automatically to the standard value of 0.9996 for UTM if the zone width is 6 degrees, or to 0.9999 for MTM if the zone width is 3 degrees. **Default** is **0.9996**.

[E] Specifies the **False Easting** at the central meridian. The false easting changes automatically to the standard value of 500 000 metres for UTM, or to 304 800 metres for MTM. **Default** is **500 000 metres**.

[N] Specifies the **False Northing** at the central meridian. The false northing changes automatically to the standard value of 0 metres for UTM if the zone width is 6 degrees, and also to 0 metres for MTM if the zone width is 3 degrees. **Default** is **0 metres**.

[C] Specifies the longitude for **Central Meridian** of the zone. The central meridian changes automatically to the standard value for the UTM zone supplied with each coordinate if the zone width is 6 degrees, or to the standard value for the MTM zone if the zone width is 3 degrees. If a value is specified for the central meridian, it overrides the standard values and any zone specification supplied with the coordinates is ignored. **Default** is **blank**, i.e. no central meridian specified.

[K] Toggles between **keeping (Yes)** and **not keeping (No)** the same zone on output as on input, when standard projections (UTM or MTM) are used. After the shift is applied to the geographic coordinates, some points that are near zone boundaries may be shifted into the adjacent zone. This option permits either forcing the projection to take place on an extension of the original zone, or allowing it to be computed in the new default zone. The appropriate zone number is output with the coordinates. **Default** is **Yes**, i.e. keeping the original zone.

REFERENCE: 2) Program INTGRID (cont'd)

Main Menu (cont'd)

Action Items Section

Rather than selecting options, this group of commands allows the user to indicate to the program what action is to be taken next. After performing any of these actions, control of the program is always returned to the main menu. Each has its own set of dialogues and prompts.

The details of the action items section are as follows:

```
-----------------------------------
Go to Analysis Option Menu      [A]
View Header Blocks              [V]
Go to Information Screen        [H]
Quit and exit from program      [Q]
Proceed - Transform coordinates [X]
-----------------------------------
```

[A] Activates the **Analysis Options Menu**, which controls the data written to the output records, such as shifts and accuracies. This sub-menu is described in detail below.

[V] Activates the **Header Records Viewer**. It first displays the contents of the Overview Header Block, which contains data common to the entire grid shift file. It then displays a list of all the sub-file names and sequence numbers, and prompts for which Sub-file Header Block is to be viewed next. The Sub-file Header Blocks contain specific data about the contents of each sub-file. This second step is repeated until no more displays are requested.

[H] Re-activates the series of **Information Screens** that are displayed when the program starts up. They provide a basic description of the program functions and operations.

[Q] **Quits** and exits the program and returns control to the operating system after saving any relevant files that have been created.

[X] Instructs the program that all option selection is complete, and to proceed to **Execute** the specified operations. Prompts will be issued for any required files that remain unopened. If coordinate input is from a file, the entire file will be processed before control is returned to the main menu.

REFERENCE: 2) Program INTGRID (cont'd)

Analysis Options Menu

The coordinate records that are output to file each have four fields at the end into which analytical data may be written. This applies to both GHOST formatted and delimited ASCII record types (see Reference Section on Data Formats). The fields are filled in pairs, corresponding to latitude and longitude. One or two pairs of data may be appended. **Default** is **Nothing added**.

Analytical data available include the coordinate shifts, accuracies of the shifts, and cell distortion. (See the Function description at the beginning of this INTGRID reference section for more information).

There is also a provision to output the same coordinates as input, which may be useful when only the analytical data is required at the input points, and not the transformed coordinates. **Default** is transformed coordinates (**Trans**).

The Analysis Options Menu is divided into two main sections, dealing with the analytical data and the output coordinates. In each section, selection of a menu item supersedes the previous selection, and the result is displayed at the top of the section. The details are as follows:

```
Analysis Option Menu
-----------------------------------
Append to Coordinate Record        Nothing added
    (units)
    Accuracy                   [A]
    Grid Shifts                [S]
    Both Shifts and Accuracy   [B]
    Cell Gradients             [G]
    Remove Append Option       [R]
-----------------------------------
Output Coordinate Record            Trans
    Transformed Record         [T]
    Input Record               [I]
-----------------------------------
Exit to Main Menu              [X]
-----------------------------------
```

[A] Appends the **accuracies** of the latitude and longitude shifts at the input point. The accuracies are expressed in metres at the one-sigma (one standard deviation) level.

REFERENCE: 2) Program INTGRID (cont'd)

Analysis Options Menu (cont'd)

[S] Appends the coordinate **shifts** at the input point. For geographic coordinates, the shifts may be expressed in either seconds or metres. For transverse Mercator coordinates, the shifts are expressed in metres.

Note: Geographic coordinate shifts in metres are converted from arc seconds, and are merely an alternate expression of the shifts in latitude and longitude. They are not the same as the shifts in transverse Mercator coordinates at the same point. These differences arise from various properties of the projection which change when the reference ellipsoid is changed, including relative orientation of the plane grid due to convergence of the meridians, and the distance along the meridian from the equator on which the Northing is based.

[B] Appends **both** the coordinate shifts and accuracies at the input point, as described above.

[G] Appends the maximum distortion of latitude and longitude in the form of **cell gradients**, expressed in parts-per-million (ppm), for the grid cell in which the input point resides.

[R] Cancels the selected option for appending analytical data, and reverts to the **default** of **Nothing added**.

[T] Selects the **default** of **transformed** coordinates for output.

[I] Selects the **input** coordinates for output.

[X] **Exits** the Analysis Options Menu and returns to the Main Menu.

REFERENCE: 3) Program INTTAB

Function

Program **INTTAB** (**INT**erpolation **TAB**le) produces a tabular view of the **grid shift file**. For an area within a user-specified window, a table of coordinate shifts and shift accuracies at the grid points is formatted into pages with row and column headings for reference. The table is useful for gaining an appreciation of the magnitude and variability of the shifts and their accuracies over a small area of concern, and for estimating the shifts in instances where the automated form of NTv2 is not available.

The user-specified window feature of INTTAB may also be used to create a sub-set of the grid shift file. Such a sub-set has all of the properties of the original, and can be used in the same way with all of the NTv2 software. This allows a reduction in the size of the grid shift file for situations where the user's activities are concentrated in a local area. This feature has also been used by the provincial control survey agencies, partners in the development and distribution of the NTv2, to produce sub-sets just large enough to cover their provincial territory. The provincial sub-sets are more easily distributed on floppy disk.

Operation

The functions of program INTTAB are essentially a batch process, with an interactive menu which provides operational control for all items necessary to specify the files and the functions to be performed.

The menu and dialogue screens are based on the command line interface. The complete main menu is displayed, and the user selects a menu item by typing the indicated character, followed by a carriage return [CR]. After responding to any query generated by the selection, the user is returned to the main menu where the change is reflected, and another item may be selected. Once satisfied with all settings, the user proceeds with the computations by selecting the execute item [X].

After proceeding with execution, the program will prompt for the limits of the window to be used. If a user-specified limit does not fall exactly on a row or column of the grid shift file, INTTAB will automatically round the limit value up (for an upper limit) or down (for a lower limit). The specified limits must also be within the limits of the input grid shift file. The results are presented for user acceptance or modification before processing continues.

REFERENCE: 3) Program INTTAB (cont'd)

Operation (cont'd)

Once the window limits have been established, INTTAB determines which sub-files of the grid shift file are affected. If any part of a sub-file falls within the window, that portion of the data will be included. For the print table option only, any of the sub-files may be specifically omitted by the user. A summary of the affected sub-files is presented, with the option to accept all of them or to modify the list. This feature is not available for creating a sub-set of the grid shift file, since the omission of any of the sub-files will result in a loss of compatibility with the standard.

WARNING:

1) The size of the window for a tabulation and the sub-files to be included should be carefully selected to avoid producing unreasonably large listing files. For a grid with 5 minute intervals, a one-degree by one-degree quad takes two pages to present. For a densified grid with 30 second intervals, the same one-degree quad takes two hundred pages.

2) When using a table to determine shifts, careful attention is required to ensure that the proper sub-file is being used. If further densification is available, a pair of asterisks (**) appears in the table to indicate that the four grid points adjacent to the asterisks enclose a densified cell. In such a case, the table is presenting the parent grid, which is useful for a general impression only. The table for the densified grid is required for the greater detail necessary to maintain compatibility with the standard, as established by the grid shift file.

REFERENCE: 3) Program INTTAB (cont'd)

Main menu

The main menu is broken down into three sections: **File Selection**, **Function Selection**, and **Action Items**. Each is described in detail. The main menu appears as follows when the program is launched:

```
 National Transformation
 Program INTTAB V2 Menu
-------------------------------------
 Transformation grid file        [G]
 Output Listing File             [O]
-------------------------------------
 Create a new grid file          [N] NO
 Window grid file                [W] NO
 Print grid table                [P] YES
-------------------------------------
 View header records             [V]
 Proceed - Continue execution    [X]
 Exit from program               [Q]
 Information Screens             [H]
-------------------------------------
 Select a menu item
 ==================
```

REFERENCE: 3) Program INTTAB (cont'd)

Main menu (cont'd)

File Selection Section

This section of the menu controls the selection of the input and output files. The program requires the grid shift file as input, an output listing file for writing the job summary and the tabulation, and a second output file for the grid shift file sub-set. When proceeding with execution, the program will prompt the user for any required file that has not been opened.

The input file is opened as read-only and left unaltered after execution. Output files are opened as new files. The user is given the opportunity to re-use existing file names by appending to or over-writing the existing file.

The details of the file selection section are as follows:

```
-------------------------------------
 Transformation grid file        [G]
 Output Listing File             [O]
 New grid file name              [F]
-------------------------------------
```

[G] Specifies the ***grid shift file***, which must be opened before any functions can be performed. It is a binary file containing the shifts and accuracies between two coordinate reference systems, and is supplied with this software.

[O] Specifies the ***output listing file***, to which all messages and tabulations generated during the execution of INTTAB are written. The **default file name** is **INTTAB.lis**.

[F] Specifies the ***new grid shift file***, to which the windowed grid shift file is written. This option line only appears in the menu if the **Create a new grid file** option **[N]** has been selected.

REFERENCE: 3) Program INTTAB (cont'd)

Main menu (cont'd)

Function Selection Section

This section of the menu controls which of the two INTTAB functions are to be performed. Either option [N] or option [P] can be selected, but not both. This avoids generating unwanted large listing files when creating a subset of the grid shift file (see WARNING above). Option [W] works with either.

The details of the function selection section are:

```
-------------------------------------
 Create a new grid file          [N] NO
 Window grid file                [W] NO
 Print grid table                [P] YES
-------------------------------------
```

[N] Toggles the function to create a **new grid shift file** which is a subset of the input grid shift file. **Default** is **NO**.

[W] Toggles the application of a user-specified window to control the output generated by INTTAB. This option is automatically set to **YES** when option **[N]** is selected. After option **[X]** has been selected from the action items**,** the user is prompted for the window limits and which grid shift sub-files to include (see description with WARNING in Operation Section above). **Default** is **NO**.

[P] Toggles the function to **generate a print table** of the coordinate shifts and their accuracies. **Default** is **YES**.

REFERENCE: 3) Program INTTAB (cont'd)

Main menu (cont'd)

Action Items Section

Rather than selecting options, this group of commands allows the user to indicate to the program what action is to be taken next. After performing any of these actions, control of the program is always returned to the main menu. Each has its own set of dialogues and prompts.

The details of the action items section are as follows:

```
-------------------------------------
 View header records             [V]
 Proceed - Continue execution    [X]
 Exit from program               [Q]
 Information Screens             [H]
-------------------------------------
 Select a menu item
 ==================
```

[V] Activates the **Header Records Viewer**. It first displays the contents of the Overview Header Block, which contains data common to the entire grid shift file. It then displays a list of all the sub-file names and sequence numbers, and prompts for which Sub-file Header Block is to be viewed next. The Sub-file Header Blocks contain specific data about the contents of each sub-file. This second step is repeated until no more displays are requested.

[X] Instructs the program that all option selection is complete, and to proceed to **Execute** the specified operations. Prompts will be issued for any required files that remain unopened. Once processing is complete, control is returned to the main menu.

[Q] **Quits** and exits the program and returns control to the operating system after saving any relevant files that have been created.

[H] Re-activates the series of **Information Screens** that are displayed when the program starts up. They provide a basic description of the program functions and operations.

REFERENCE: 4) Program READDA

Function

Program **READDA** (**READ D**irect **A**ccess File) was originally conceived as a utility to check the contents of the grid shift file, which is a FORTRAN binary direct-access format that cannot be viewed with a normal text editor. It performs this function in two ways: first, the information from the overview header block and all of the sub-file header blocks can be written to the output listing; and second, the entire binary file can be converted to an equivalent ASCII sequential file.

It is this second feature that makes READDA beneficial to users who wish to run NTv2 on a computer system other than the IBM/PC (MS-DOS) compatible platform for which it is delivered. The ASCII file can be easily migrated to the destination platform, where READDA can again be used to convert it back into the binary direct-access format that is usable by other NTv2 software.

NOTE: Even though it is possible to transfer binary files to other platforms that are binary-compatible with DOS (e.g. FTP/binary to UNIX), the grid shift file data will not be accessible by FORTRAN direct-access procedures. READDA must be used for this purpose.

Operation

The functions of program READDA are essentially a batch process, with an interactive menu which provides operational control for all items necessary to specify the files and the functions to be performed.

The menu and dialogue screens are based on the command line interface. The complete main menu is displayed, and the user selects a menu item by typing the indicated character, followed by a carriage return [CR]. After responding to any query generated by the selection, the user is returned to the main menu where the change is reflected, and another item may be selected. Once satisfied with all settings, the user proceeds with the computations by selecting the execute item [X].

REFERENCE: 4) Program READDA (cont'd)

Operation (cont'd)

In addition to converting the grid shift file for migration using READDA, the NTv2 software must also be converted. For this purpose, source code for the programs is supplied for compilation on the destination platform. This must be done for READDA before the grid shift file can be converted back to binary in that location. The source code is FORTRAN ANSI77 compliant. It has been compiled and tested on several platforms, including various UNIX systems, VAX/VMS and Mac/OS.

There are some differences that the ANSI standard does not address, such as time and date functions, and record size specification. The source code contains descriptive comments at the end of every line which is known to require changes between platforms. The comments begin with the two characters **!***, followed by a list of the platforms to which they apply. Alternate lines of code are already included for systems that have been tested.

The source code is converted by searching for the characters **!***, removing the disabling comment character **C** from the beginning of the each line for the destination platform, and placing a **C** at the beginning of each corresponding line of the original platform to disable it. The software is supplied originally as IBM/PC (MS-DOS) compatible.

The supplied changes may also be compiler-dependent, and may not work with compilers other than those tested. Consult the compiler reference manuals if problems arise. For modifications beyond porting the software "as-is" to a new platform, see the **Developer's Guide** for more information.

REFERENCE: 4) Program READDA (cont'd)

Main Menu

The main menu is broken down into three sections: **File Selection**, **Function Selection**, and **Action Items**. Each is described in detail. The main menu appears as follows when the program is launched:

```
National Transformation
Program READDA V2 FILE Menu

----------------------------------------
Input Grid Shift File (      )       [G]
Output Listing File                  [O]
----------------------------------------
List Header Information              [L] No
Convert Binary to ASCII              [C] No
----------------------------------------
View Header Information              [V]
Execute READDA                       [X]
Exit from program                    [Q]
Information Screens                  [H]
----------------------------------------
Select a menu item
```

REFERENCE: 4) Program READDA (cont'd)

Main menu (cont'd)

File Selection Section

This section of the menu controls the selection of the input and output files. The program requires the grid shift file as input, an output listing file for writing the job summary and the header block data, and a second output file for the converted grid shift file, either binary or ASCII. When proceeding with execution, the program will prompt the user for any required file that has not been opened.

The input file is opened as read-only and left unaltered after execution. Output files are opened as new files. The user is given the opportunity to re-use existing file names by appending to or over-writing the existing file.

The details of the file selection section are as follows:

```
----------------------------------------
Input Grid Shift File (binary)       [G]
Output Listing File                  [O]
Converted file (ASCII )              [T]
----------------------------------------
```

[G] Specifies the ***grid shift file***, which must be opened before any functions can be performed. Before it can be opened, the user must respond to a prompt inquiring whether it is a binary or an ASCII file. The binary file containing the shifts and accuracies between two coordinate reference systems is supplied with this software. An ASCII file would be one that the user has created from the binary file using READDA on another type of computer platform. The file type appears in the menu after the file has been opened.

[O] Specifies the ***output listing file***, to which all messages and data summaries generated during the execution of READDA are written. The **default file name** is **READDA.lis**.

[T] Specifies the ***converted file***, to which the ASCII (or binary) counterpart of the input grid shift file is written. This option line only appears in the menu if the **Convert binary to ASCII** option **[C]** has been selected.

REFERENCE: 4) Program READDA (cont'd)

Main menu (cont'd)

Function Selection Section

This section of the menu controls which of the two READDA functions are to be performed. Either option [L] or option [C] can be selected but not both. When one is selected, the other is deselected.

The details of the function selection section are:

```
----------------------------------------
List Header Information              [L] No
Convert Binary to ASCII              [C] No
----------------------------------------
```

[L] Toggles the function to list the information from the overview header block and all of the sub-file header blocks. **Default** is **NO**.

[C] Toggles the function to convert the grid shift file between its binary and ASCII equivalents. If the input file is binary, the output will be ASCII, and vice versa. **Default** is **NO**.

REFERENCE: 4) Program READDA (cont'd)

Main menu (cont'd)

Action Items Section

Rather than selecting options, this group of commands allows the user to indicate to the program what action is to be taken next. After performing any of these actions, control of the program is always returned to the main menu. Each has its own set of dialogues and prompts.

The details of the action items section are as follows:

```
----------------------------------------
View Header Information              [V]
Execute READDA                       [X]
Exit from program                    [Q]
Information Screens                  [H]
----------------------------------------
```

[V] Activates the **Header Records Viewer**. It first displays the contents of the Overview Header Block, which contains data common to the entire grid shift file. It then displays a list of all the sub-file names and sequence numbers, and prompts for which Sub-file Header Block is to be viewed next. The Sub-file Header Blocks contain specific data about the contents of each sub-file. This second step is repeated until no more displays are requested.

[X] Instructs the program that all option selection is complete, and to proceed with the specified operations. Prompts will be issued for any files necessary for basic operation that remain unopened, and a final prompt allows the user to return to the menu.

[Q] **Quits** and exits the program and returns control to the operating system after saving any relevant files that have been created.

[H] Re-activates the series of **Information Screens** that are displayed when the program starts up. They provide a basic description of the program functions and operations.