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General Cartographic Transformation Package (GCTP), Version II

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Rockville, MD
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U.S. DEPARTMENT OF COMMERCE
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U.S. DEPARTMENT OF COMMERCE
Secretary of Commerce

National Oceanic and Atmospheric Administration
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National Ocean Service
Paul M. Wolff, Assistant Administrator

Charting and Geodetic Services
R. Adm. Wesley V. Hull. Director

For sale by the National Geodetic Information Center, NOAA, Rockville, MD 20852

AVAILABILITY

This documentation of the General Cartographic Transformation Package (GCTP) Version 11, accompanies GCTP/II software sold by the National Geodetic Information Branch, Charting and Geodetic Services, NOAA, Rockville, Maryland 20852.

A list of the organizations and individuals who acquire the package will be maintained by NOAA. Future enhancements, corrections, or updates to the GCTP/II will be announced and made available to those on the list, as NOAA intends to maintain and upgrade the software.

Price is based on reproduction and distribution costs. NOAA regulations require that payment be received before shipment can be made. Payment may be made by check payable.to NOAA, National Geodetic Survey. The purchaser will receive the following items:

- A copy of GCTP/II documentation which describes all the information necessary fer utilizing the GCTP/II software.

- A nine-track magnetic tape which contains three data files. The tape is unlabeled and contains ASCII logical records of eight-character length. The physical record size is 480 characters. (Each physical record contains 6 of the 80-character logical records). The recording is done at 1600 bpi. The first file on the tape contains the FORTRAN source code for GCTP. The second file contains the parameters necessary to support State plan projections for NAD 27. The third file contains the parameters necessary to support State plane projections for NAD 83.

CONTENTS

GENERAL CARTOGRAPHIC TRANSFORMATION PACKAGE (GCTP), VERSION II

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ABSTRACT. The General Cartographic Transformation Package (GCTP), Version II, contains software and documentation supporting forward and inverse transformations for the most commonly used map projections, plus some specialized map projections. State plane projections are supported for either the North American Datum of 1927 (NAD 27) or North American Datum of 1983 (NAD 83). However, GCTP cannot be used for transforming points between the two reference spheroids defined for NAD 27 or NAD 83.

INTRODUCTION

General Cartographic Transformation Package (GCTP), Version II, is a software package that supports forward and inverse transformations for the following map projections:

1. Universal Transverse Mercator (UTM)
2. State plane
3. Albers conical equal-area
4. Lambert conformal conic
5. Mercator
6. Polar stereographic
7. Polyconic
8. Equidistant conic
9. Transverse Mercator
10. Stereographic
11. Lambert azimuthal equal-area
12. Azimuthal equidistant
13. Gnomonic
14. Orthographic
15. General vertical near-side perspective
16. Sinusoidal
17. Equirectangular
18. Miller cylindrical
19. Van der Grinten I
20. Oblique Mercator (Hotine)

State plane projections are supported for either NAD 27 or NAD 83. The GCTP must not be used for the transformation of points between the two reference spheroids defined for NAD 27 and NAD 83.

INTRODUCTION

The GCTP was developed at the U.S. Geological Survey (USGS) in 1980 to meet the need for an integrated subroutine package to handle map projection computations in several automated cartographic programs. The package was the result of the joint effort of John P. Snyder, who was responsible for the mathematical analysis, and Atef A. Elassal, who was responsible for software engineering and programming. The package has been widely distributed to many Federal Government, State, and local governments, universities, and private industry organizations. Except for minor changes to correct for some coding errors, the USGS version of GCTP (referred to as GCTP/I) has stayed unchanged since its creation in 1980.

In 1984, GCTP/I was used by the National Oceanic and Atmospheric Administration to provide map projection services to its Integrated Digital Photogrammetric Facility. Several enhancements were found to be both necessary and desirable. These were significant enough to warrant the designation of GCTP/II for the newly modified package. The primary area of enhancements were:

- o Improved architecture of the software to make the package easier to use and maintain.
- o Conformance to FORTRAN 77 standards.
- o Modifications to the State plane projection section of the package to allow for changes in the reference spheroid definition. For instance, both NAD 27 an NAD 83 can be readily accommodated in GCTP/II.
- o An improved error reporting facility and codes.

This documentation is written for system integrators who wish to use the facilities offered by GCTP/II. It describes in sufficient detail the specifications of the software interfaces. Those interested in the mathematical formulations of most of the map projection transformations can consult Bulletin 1532, Map projections used by the C.S. Geological Survey (Snyder 1982).

USER INSTRUCTIONS FOR GCTP/II

General

GCIP/II is written in the FORTRAN programming language. The package contains 41 subroutines. Besides the main entry subroutine (GTRNZ0), there are 20 subroutines supporting the individual map projection transformations. The remaining 20 subroutines are support functions, which are of no particular interest to the user. All external references by this package (subroutine, function, and COMMON names) are made using six-character names. The last two characters of a name are always the two characters (Z0). When formulating a program, the user should avoid using six-character names terminating with the characters (Z0) in his or her program to name subroutines, functions, or COMMON areas. This will protect against naming conflicts between the user's programs and the GCTP/II subroutines.

Main Interface with GCTP/II

The main entry to GCTP/II is done by calling the subroutine GTRNZ0. The calling sequence for this subroutine is:

Call GTRNZ0 (CRDIN, INDEF, TPARIN, CRDIO, IODEF, TPARIO, IPFILE, IFLG)

Input data in the calling list are:

CRDIO — Two-element array containing coordinates (easting-northing, longitude-latitude) in input reference system (R/DP) (R/DP is an abbreviation for real double precision.)

INDEF: — Three-element array containing definition of input reference system (I). (I is an abbrev1at1on for integer).:

Element No. 1 is the code number of map projection. Permissible codes are 0 through 20. (See appendix A.)

Element No. 2 is the zone number. (See appendix B.)

Element No. 3 is the code for coordinate units of measure. (See appendix C.)

TPARIN: — Thirteen-element array containing parameters of input map Projection system (R/DP). (See appendix D.)

IODEF: — Three element array containing definitions of target reference system (I):

Element No. 1 is the code number of map projection. (See Appendix A.)

Element No. 2 is the zone number. (See appendix B.)

Element No. 3 is the code for coordinate unit of measure. (See appendix C.)

TPAR1O: — Thirteen-element array containing parameters of target map projection reference system (R/DP).

IPFILE: — Logical identification of listing data set. This data set must be opened by the calling program. All listings and error messages will be directed to this data set. If IPFILE is less than or equal to zero, then all listings and error messages will be suppressed.

Output data in calling list are:

CRDIO — Two-element array containing computed coordinates in the target reference system (R/DP).

IFLG: — Return flag (I). A value of zero will indicate normal return. A nonzero value will indicate error return. (See appendix E.)

A direct access file is required to provide GCTP/II with parameters of the 135 zones for the State plane projection system. The FORTRAN logical identification of this file is 99. The data in the file must be stored unformatted in 108-byte fixed length records. Each record contains the parameters for one State plane zone in the following format:

Byte	Item	Format
1-32	Zone name	Character
33-36	Projection identification code number	Integer *4
37-108	9 Projection parameters	REAL *8

The State plane projection parameters are available on the GCTP/II distribution tape for both NAD 27 and NAD 83. (See appendix F.)

Interface with individual map projection subroutines:

As mentioned before, a user who is not interested in using the complete capabilities of GCTP/II may select individual projections. In doing so, the· user will lose the feature allowing automatic conversion of units of measure. However, this will allow for an individually tailored support that fits particular computer resources.

The 20 map projection subroutines are all structured in a similar fashion. Each subroutine is named PJ**Z0 where the two characters ** take on the value of the code number for the particular map projection. (See appendix A.) The value of the code is right justified with zero left fill. For example, the subroutine that performs computations for Lambert conformal conic map projection is named PJ04Z0. There are three entry points for each subroutine to support initialization, forward transformation, and inverse transformation. Entry point for initialization is named IS**Z0. The value of the two characters ** is the same as described above. The calling sequence for initialization entry point is:

Call IS**Z (ZONE. DATA, IPFILE, IFLG)

where

ZONE: Zone number (I) for the particular projection. (See appendix B.)

DATA: Thirteen-element array containing parameters of the map projection. (See Appendix D.)

IPFILE: Logical identification (I) of listing data set. If IPFILE is less than or equal to zero, then all listings and error messages will be suppressed.

IFLG: Return flag (I). A zero value indicates normal return. Nonzero value indicates error return. (See appendix E.)

The initialization entry point serves two purposes:

1. For map projections where predefined zone numbers exist (UTM and State plane), the input zone number is used either to compute (in case of UTM) or extract from an on-line file (in case of State Plane) the parameters of the particular map projection that support the indicated zone. There is only one exception to this rule. For the UTM map projection, a zero zone number in the projection initialization entry point will indicate a user request for

computation of the zone number by the subroutine. The zone number computations will be based on the geographic coordinates (longitude and latitude) which are provided in elements 3 and 4, respectively, of the array DATA.

2. For map projections where predefined zone numbers do not exist, the zone number is an arbitrary number which must be positive and greater than sixty. This user-assigned number serves the purpose of preventing the initialization computations from being repeated for all subsequent calls to the same map projection which specify the same user-defined zone number. The zone number in this case can, therefore, be viewed as a means for the user to specify a special zone for a certain projection. This definition remains in effect during a single computer run, until another user-defined zone for the same map projection is attempted.

Entry point for forward transformation is named PF**Z0. The value of the two characters ** is the same as described above. The calling sequence for forward transformation entry point is:

```
Call PF**Z0 (GEOG, PROJ, IFLG)
```

Where

GEOG: Two-element array (R/DP) which contains the input longitude and latitude, of a point, respectively. The longitude and latitude must be in radians.

PROJ: Two-element array (R/DP) which contains the output computed easting and northing for the transformed point in meters.

IFLG: Return flag (I). A zero value indicates normal return. Nonzero value indicates error return. (See appendix E.)

Entry point for inverse transformation is named PI**Z0. The value of the two characters** is the same as described above. The calling sequence for inverse transformation entry point is:

```
Call PI**ZO (PROJ, GEOG, IFLG)
```

where

PROJ: Two-element array (R/DP) which contains input easting and northing of a point, respectively. Easting and northing must be in meters.

GEOG: Two-element array (R/DP) which contains output computed longitude and latitude of the point in radians.

IFLG: Return flag (I). A zero value indicates normal return. Nonzero value indicates error return. (See appendix E.)

REFERENCE

Snyder, Jchn P., 1982: Map projections used by the U.S. Geological Survey Bulletin 1532.U.S. Geological Survey, National Center, Reston, VA 22092, 313 pp.

APPEXDIX A.--REFERENCE SYSTEMS SUPPORTED BY GCTP/II

The GCTP/II supports transformations between any 2 of 21 two-dimensional reference systems. Each reference system is identified in the package by a code number (0 through 20). The following 21 reference are systems supported by GCTP/II:

Code No.	Reference System Name
1.	Geographic (longitude and latitude)
2.	Universal transverse Mercator
3.	State plane
4.	Albers conical equal-area
5.	Lambert conformal conic
6.	Mercator
7.	Polar stereographic
8.	Polyconic
9.	Equidistant conic
10.	Transverse Mercator
11.	Stereographic
12.	Lambert azimuthal equal-area
13.	Azimuthal equidistant
14.	Gnomonic
15.	Orthographic
16.	General Vertical near-side perspective
17.	Sinusoidal
18.	Equirectangular
19.	Miller cylindrical
20.	Van der Grinten I
21.	Oblique Mercator (Hotine)

APPENDIX B.--PREDEFINED MAP PROJECTION ZONES FOR GCTP/II

The GCTP/II supports predefined zones for the UTM and State plane reference systems. A zone within these two reference systems is identified by a zone code number. For UTM reference systems, there are 60 predefined zones. Similarly, the State plane reference system has several predefined zones. By using a zone code number, a user is relieved from supplying the map projection parameters for that zone.

UTM zone code numbers

UTM zone code	longitude of central meridian (degrees)	range of longitude (degrees)	UTM zone code	longitude of central meridian (degrees)	range of longitude (degrees)
1	-177	-180 to -174	31	3	0 to 6
2	-171	-174 to -168	32	9	6 to 12
3	-165	-168 to -162	33	15	12 to 18
4	-159	-162 to -156	34	21	18 to 24
5	-153	-156 to -150	35	27	24 to 30
6	-147	-150 to -144	36	33	30 to 36
7	-141	-144 to -138	31	39	36 to 42
8	-135	-138 to -132	36	45	42 to 48
9	-129	-132 to -126	37	51	48 to 54
10	-123	-126 to -120	40	57	54 to 60
11	-117	-120 to -111	41	63	60 to 66
12	-111	-114 to -108	42	69	66 to 72
13	-105	-108 to -102	43	75	72 to 78
14	-99	-102 to -96	44	81	78 to 84
15	-93	-96 to -90	45	87	84 to 90
16	-87	-90 to -84	46	93	90 to 96
17	-81	-84 to -78	47	99	96 to 102
16	-75	-78 to -72	48	105	102 to 108
19	-69	-72 to -66	49	111	108 to 114
20	-63	-66 to -60	50	117	114 to 120
21	-57	-60 to -54	51	123	120 to 126
22	-51	-54 to -48	52	129	126 to 132
23	-45	-48 to -42	53	135	132 to 138
24	-39	-42 to -36	54	141	138 to 144
25	-33	-36 to -30	5S	147	144 to 150
26	-27	-30 to -24	•56	153	150 to 156
27	-21	-24 to -18	57	159	156 to 162
28	-15	-18 to -12	58	165	162 to 168
29	-9	-12 to -6	59	171	168 to 174
30	-3	-6 to 0	60	177	174 to 180

State plane zone code numbers for NAD 27

Zone code	Zone name	Zone code	Zone name
101	Alabama East	1301	Indiana East
102	Alabama West	1302	Indiana West
5001	Alaska zone No. 1	1401	Iowa North
5002	Alaska zone No. 2	1402	Iowa South
5003	Alaska zone No. 3	1501	Kansas_ North
5004	Alaska zone No. 4	1502	Kansas South
5005	Alaska zone No. 5	1601	Kentucky North
5006	Alaska zone No. 6	1602	Kentucky South
5007	Alaska zone No. 7	1701	Louisiana North
5008	Alaska zone No. 8	1702	Louisiana South
5009	Alaska zone No. 9	1703	Louisiana Offshore,
5010	Alaska zone No. 10	1801	Maine East
201	Arizona East	1802	Maine West
202	Arizona Central	1900	Maryland
203	Arizona West	2001	Massachusetts Mainland
301	Arkansas North	2002	Massachusetts Island
302	Arkansas South	2101	Michigan East
401	California I	2102	Michigan Central1
402	California II	2103	Michigan West_
403	California 111	2111	Michigan North
404	California IV	2112	Michigan Central2
405	California V	2113	Michigan South
406	California VI	2201	Minnesota North
407	California VII	2202	Minnesota Central
501	Colorado North	2203	Minnesota South
502	Colorado Central	2301	Mississippi East
503	Colorado South	2302	Mississippi West
600	Connecticut	2401	Missouri East
700	Delaware	2402	Missouri Central
901	Florida East	2403	Missouri West
302	Florida West	2501	Montana North
903	Florida North·	2502	Montana Central
1001	Georgia East	2503	Montana South
1002	Georgia West	2701	Nevada East
5400	Guam	2702	Nevada Central
5101	Hawaii 1	2703	Nevada West
5102	Hawaii 2	2800	New Hampshire
5103	Hawaii 3	2900	New Jersey
5104	Hawaii·4	3001	New Mexico East
5105	Hawaii 5	3002	New Mexico Central
1101	Idaho East	3003	New Mexico West
1102	Idaho Central	3101	New York East
1103	Idaho West	3102	New York Central
1201	Illinois East	3103	New York West
1202	Illinois West	3104	New York Long Island

[1]Transverse Mercator Projection. With Michigan E and Michigan W, this constitutes the obsolete Michigan zone system.

[2]Lambert·conformal conic projection. With Michigan N and Michigan S, this constitutes the current Michigan zone system.

Zone code	Zone name
3200	North Carolina
3301	North Dakota North
3302	North Dakota South
3401	Ohio North
3402	Ohio South
3501	Oklahoma North
3502	Oklahoma South
3601	Oregon North
3602	Oregon South
3701	Pennsylvania North
3702	Pennsylvania South
5301	Puerto Rico
3800	Rhode Island
5302	Samoa
3901	South Carolina North
3902	South Carolina South
4001	South Dakota North
4002	South Dakota South
5202	St. Croix
4100	Tennessee
4201	Texas North
4201	Texas North Central
4203	Texas Central
4204	Texas South Central
4205	Texas South
4301	Utah North
4302	Utah Central
4303	Utah South
4400	Vermont
5201	Virgin Islands
4501	Virginia North
4502	Virginia South
4601	Washington North
4602	Washington South
4701	West Virginia North
4702	West Virginia South
4801	Wisconsin North
4802	Wisconsin Central
4803	Wisconsin South
4901	Wyoming East
4902	Wyoming East Central
4903	Wyoming West Central
4904	Wyoming West

State plane zone code numbers for NAD 83

Zone code	Zone name	Zone code	Zone name
101	Alabama East	1502	Kansas South
102	Alabama West	1601	Kentucky North
5001	Alaska zone No. 1.	1602	Kentucky South
5002	Alaska zone No. 2	1701	Louisiana North
5003	Alaska zone No. 3	1702	Louisiana South
5004	Alaska zone No. 4	1703	Louisiana Offshore
5005	Alaska zone No. 5	1801	Maine East
5006	Alaska zone No. 6	1802	Maine West
5007	Alaska zone No. 7	1900	Maryland
5006	Alaska zone No. 8	2001	Massachusetts Mainland
5009	Alaska zone No. 9	2002	Massachusetts Island
5010	Alaska zone No. 10	2101	Michigan East
201	Arizona East	2102	Michigan Central
202	Arizona Central	2103	Michigan West
203	Arizona West	2111	Michigan North
301	Arkansas North	2112	Michigan Central
302	Arkansas South	2113	Michigan South
401	California I	2201	Minnesota North
402	California II	2202	Minnesota Central
403	California III	2203	Minnesota South
404	California IV	2301	Mississippi East
405	California V	2302	Mississippi West
406	California VI	2401	Missouri East
407	California VII	2402	Missouri Central
501	Colorado North	2403	Missouri West
502	Colorado Central	2501	Montana North
503	Colorado South	2502	Montana Central
600	Connecticut	2503	Montana South
700	Delaware	2701	Nevada East
901	Florida East	2702	Nevada Central
902	Florida West	2703	Nevada West
903	Florida North	2800	New Hampshire
1001	Georgia East	2900	New Jersey
1002	Georgia West	3001	New Mexico East
5400	Guam	3002	New Mexico Central
5101	Hawaii 1	3003	New Mexico West
5102	Hawaii 2	3101	New York East
5103	Hawaii 3	3102	New York Central
5104	Hawaii 4	3103	New York West
5105	Hawaii 5	3104	New York Long Island
1101	Idaho East	3200	North Carolina
1102	Idaho Central	3301	North Dakota North
1103	Idaho West	3302	North Dakota South
1201	Illinois East	3401	Ohio North
1202	Illinois West	3402	Ohio South
1301	Indiana East	3501	Oklahoma North
1302	Indiana West	3502	Oklahoma South
1401	Iowa North	3601	Oregon North
1402	Iowa South	3602	Oregon South
1501	Kansas North	3701	Pennsylvania North

3702	Pennsylvania South
5301	Puerto Rico
3800	Rhode Island
5302	Samoa
3901	South Carolina North
3902	South Carolina South
4001	South Dakota North
4002	South Dakota South
5202	St. Croix
4100	Tennessee
4201	Texas North
4202	Texas North Central
4203	Texas Central
4204	Texas South Central
4205	Texas South
4301	Utah North
4302	Utah Central
4303	Utah South
4400	Vermont
5201	Virgin Islands
45Ql	Virginia North
4502	Virginia South
4601	Washington North
4602	Washington South
4701	West Virginia North
4702	West Virginia South
4801	Wisconsin North
4802	Wisconsin Central
4803	Wisconsin South
4901	Wyoming East
4902	Wyoming East Central
4903	Wyoming West Central
4904	Wyoming West

APFENDIX C -- UNITS OF MEASURE IN GCTP/II

The GCTP/II supports automatic conversion of units of measure for point coordinates. Five units of measure are provided for linear and angular parameters. The following code numbers apply for these five units of measure:

Code No.	Unit of measure	Type
1	feet	linear
2	meters	linear
3	seconds of arc	angular
4	degrees of arc	angular
5	packed DMS1	angular

[1]Packed degrees-minutes-seconds (DMS) has the following format:

±DDDMMSS.sssss

Where

DDD is the degrees portion of the angle,
MM is the minutes portion of the angle
SS.SSSSS is the seconds portion of the angle.

The plus sign (+) is optional. Leading and trailing zeros are optional but embedded zeros must be supplied.

APPENDIX D. -- PARAMETERS REQUIRED FOR DEFINITION OF REFERENCE SYSTEM

The GCTP/II provides for transformation of coordinates between any 2 of the 21 supported reference systems. The parameters necessary to define a reference system are passed to the package in a double precision real array of numbers. The number and nature of these parameters vary depending on the individual reference system. The following is a list of the parameters which must be provided by the user for each reference system. All linear parameters must be provided in meters. Angular parameters are expected to be in packed DMS units.

1. Geographic reference system (code No. 0)

   No parameters are required for this reference system.

2. Universal Transverse Mercator reference system (code No. 1)

   Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

   Parameter No. 2: Eccentricity squared of ellipsoid (e2). If field is zero, this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

   Parameter No. 3: Longitude of any point within the zone

   Parameter No. 4: Latitude of any point within the UTM zone

   Parameters 3 and 4 will be used to determine the zone when the user enters a zero zone number.

3. State plane reference system (code No. 2)

   Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

   Parameter No. 2: Eccentricity squared of ellipsoid (e2). If field is zero, this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

4. Albers conical equal area reference system (code No. 3)

   Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

   Parameter No. 2: Eccentricity squared of ellipsoid (e2). If field is zero, this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Latitude of first standard parallel

Parameter No. 4: Latitude of second standard parallel

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of projection's origin

Parameter No. 7: False easting

Parameter No. 8: False northing ·

5. Lambert conformal conic reference system. (code No. 4·)

   Parameter No. 1: Semimajor axis of ellipsoid. If this field is- left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

   Parameter No. 2: Eccentricity squared of ellipsoid (e2). If field is zero, this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

   Parameter No. 3: Latitude of first standard parallel

   Parameter No: 4: Latitude of second standard parallel

   Parameter No. 5: Longitude of central meridian

   Parameter No. 6: Latitude of projection's origin

   Parameter No. 7: False easting

   Parameter Ne. 8: False northing

6. Mercator reference system (code No. 5)-

   Parameter No. 1: Semimajor axis of ellipsoid.
   If this field is left blank (=0), the value for Clarke's 1866 spheroid in meters will be assumed.

   Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=O), this will indicate a sphere. If the field is greater than l, this field will be interpreted as containing the semiminor axis of the ellipsoid.

   Parameter No. 5: Longitude of central meridian

   Parameter No. 6: Latitude of true scale

   Parameter No. 7: False easting

   Parameter No. 8: False. northing

7. Polar stereographic reference system: (code No. 6)

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=0), the value for Clarke's 1866 spheroid in meters will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=O), this will indicate a sphere. If this field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Longitude directed straight down below pole of map

Parameter No. 6: ·Latitude of true scale

Parameter No. 7: False easting

Parameter No. 8: False northing

8. Polyconic reference system (code No. 7)

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=0), the value of Clarke's 1866 spheroid in meters will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=O), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 5: Longitude of central meridian

Parameter Ne. 6: Latitude of projection's origin

Parameter No. 7: False easting

Parameter No. 8: False northing

9. Equidistant conic reference system (code No. 8)

Case A: Single Standard Parallel

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank·(=O), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Latitude of standard parallel

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of projection's origin·

Parameter No. 7: False easting

Parameter No. 8: False northing

Parameter No. 9: Zero

Case B: Two Standard Parallels

Parameter No. 1: Semimajor axis of ellips9id. If this field is left blank (=O), the value for Clarke's 1866 spheroid in meters will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=0), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Latitude of first standard parallel

Parameter No. 4: Latitude of second standard parallel.

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of projection's origin

Parameter No. 7: False easting

Parameter No. 8: False northing

Parameter No. 9: Any non-zero number

10. Transverse mercator reference system (code No. 9)

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=0), the value for Clarke's 1866 spheroid in meter will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=O), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Scale factor at central meridian

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of origin

Parameter No. 7: False easting

Parameter No. 8: False northing

11. Stereographic reference system (code No. 10)

    Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed. This is the radius of a sphere with surface area equal to that of Clarke's 1866 ellipsoid

    Parameter No. 5: Longitude of center of projection

    Parameter No. 6: Latitude of center of projection

    Parameter No. 7: False easting

    Parameter No. 8: False northing

12. Lambert azimuthal equal-area reference system (code No. 11)

    Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

    Parameter No. 5: Longitude of center of projection

    Parameter No. 6: Latitude of center of projection

    Parameter No. 7: False easting

    Parameter No. 8: False northing

13. Azimuthal equidistant reference system (Code No. 12)

    Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

    Parameter No. 5: Longitude of center of projection

    Parameter No. 6: Latitude of center of projection

    Parameter No. 7: False easting

    Parameter No. 8: False northing

14. Gnomonic reference system (code No. 13)

    Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997. meters will be assumed.

    Parameter No. 5: Longitude of center of projection

    Parameter No. 6: Latitude of center of projection

    Parameter No. 7: False easting

    Parameter No. 8: False northing

15. Orthographic Reference system (code No. 14)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 5: Longitude of center of projection

Parameter No. 6: Latitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

16. General vertical near-side perspective (code No. 15)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 3: Height of perspective point above sphere

Parameter No. 5: Longitude of center of projection

Parameter No. 6: Latitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

17. Sinusoidal reference system (code No. 16)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 5: Longitude of center of projection

Parameter No. 6: Latitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

18. Equirectangular (Plate Caree) reference system (code No. -11)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 5: Longitude of center of projection

Parameter No. 6: Latitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

19. Miller cylindrical reference system (code No. 18)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 5: Longitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

20. Van der Grinten I reference system (code No. 19)

Parameter No. 1: Radius of the sphere of reference. If this field is left blank, the value 6,370,997.0 meters will be assumed.

Parameter No. 5: Longitude of center of projection

Parameter No. 7: False easting

Parameter No. 8: False northing

21. Oblique mercator reference system (code No. 20)

Format A:

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=0), the value for Clarke's 1866 spheroid in meter will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=0), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Scale factor at central meridian

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of origin

Parameter No. 7: False easting

Parameter No. 8: False northing

Parameter No. 9: Longitude of first point defining central geodetic line of projection

Parameter No. 10: Latitude of first point defining central geodetic line of projection

Parameter No. 11: Longitude of second point defining central geodetic line of projection

Parameter No. 12: Latitude of second point defining central geodetic line of projection

Parameter No. 13: Zero

(Oblique Mercator cont.)

Format B:

Parameter No. 1: Semimajor axis of ellipsoid. If this field is left blank (=0), the value for Clarke's 1866 spheroid in meter will be assumed.

Parameter No. 2: Eccentricity squared of ellipsoid (e2). If this is left blank (=O), this will indicate a sphere. If the field is greater than 1, this field will be interpreted as containing the semiminor axis of the ellipsoid.

Parameter No. 3: Scale factor at central meridian

Parameter No. 5: Longitude of central meridian

Parameter No. 6: Latitude of origin

Parameter No. 7: False easting

Parameter No. 8: False northing

Parameter No 13: Any nonzero number

APPENDIX E. -- ERROR CODES AND MESSAGES

Exceptional conditions are communicated by GCTP to the user through a coded error flag. Upon discovery of an error condition, GCTP. sets this error flag to an appropriate unique value. It then issues an appropriate message to the listing data set (IPFILE). Naturally, the listed data set must be defined and opened by the user upon entry into GCTP. Otherwise, the message will not be recorded.

A list of error flag codes produced by GCTP follows. Each error code will be followed by the name of the issuing subroutine, enclosed between parenthesis. The exact wordings of the error message will then follow in upper-case letters.

1 (GTRNZO) : ILLEGAL SOURCE REFERENCE SYSTEM CODE = iiiiii

2 (GTRNZO) : ILLEGAL TARGET-REFERENCE SYSTEM CODE = iiiiii

3 (GTRNZ0) : ILLEGAL SOURCE UNIT CODE = iiiiii

4 (GTRNZ0) : ILLEGAL TARGET UNIT CODE = iiiiii

5 (GTRNZ0) : ILLEGAL SOURCE ZONE NUMBER = iiiiii

6 (GTRNZ0) : ILLEGAL TARGET ZONE NUMBER = iiiiii

10 (GTRNZ0) : ILLEGAL PACKED DMS FIELD = aaaaaaaaaaaa.aaa

11 (UNTFZ0) : ILLEGAL SOURCE or TARGET UNIT CODE = iiiiii/jjjjjj

12 (UNTFZ0) : INCONSISTENT UNIT CODES = iiiiii/jjjjjj

13 (SPAKZO) : ANGLE G.T. 360 DEGREES = aaaaaaaaaaaa.aaa

21 (PHI1ZO) : LATITUDE FAILED TO CONVERGE

22 (PHI2ZO) : LATITUDE FAILED TO CONVERGE

23 (PHI3ZO) : LATITUDE FAILED TO CONVERGE

24 (PHI4ZO) : LATITUDE FAILED to CONVERGE'

100 (PJOlZO) : UNINITIALIZED TRANSFORMATION

101 (PJOlZO) : ILLEGAL ZONE NO. = iiiiii

200 (PJ02ZO) : UNINITIALIZED TRANSFORMATION

201 (PJ02ZO) : ILLEGAL ZONE NO. = iiiiii

300 (PJ03ZO) : UNINITIALIZED TRANSFORMATION

301 (PJ03ZO) : EQUAL LATITUDES FOR ST. PARALLELS ON OPPOSITE SIDES OF EQUATOR

400 (PJ04ZO) : UNINITIALIZED TRANSFORMATION

401 (PJ04Z0) : EQUAL LATITUDES FOR ST. PARALLELS ON OPPOSITE SIDES OF EQUATOR

402 (PJ04Z0) : POINT CANNOT BE PROJECTED

500 (PJ05Z0) : UNINITIALIZED TRANSFORMATION

501 (PJ05Z0) : TRANSFORMATION CANNOT BE COMPUTED AT THE POLES

600 (PJ06Z0) : UNINITIALIZED TRANSFORMATION

700 (PJ07Z0) : UNINITIALIZED TRANSFORMATION

800 (PJ08Z0) : UNINITIALIZED TRANSFORMATION

801 (PJ08Z0) : EQUAL LATITUDES FOR ST. PARALLELS ON OPPOSITE SIDES OF EQUATOR

900 (PJ09Z0) : UNINITIALIZED TRANSFORMATION

901 (PJ09Z0) : POINT PROJECTS INTO INFINITY

1000 (PJ10Z0) : UNINITIALIZED TRANSFORMATION

1001 (PJ10ZC) : POINT PROJECTS INTO IFINITY

1100 (PJ11Z0) : UNINITIALIZED TRANSFORMATION

1101 (PJ11Z0) : POINT PROJECTS INTO A CIRCLE

1102 (PJ11Z0) : IMPROPER PARAMETER

1200 (PJ12Z0) : UNINITIALIZED TRANSFORMATION

1201 (PJ12Z0) : POINT PROJECTS TO A CIRCLE

1202 (PJ12Z0) : IMPROPER PARAMETER

1300 (PJ13Z0) : UNINITIALIZED TRANSFORMATION·

1301 (PJ13Z0) : POINT PROJECTS INTO INFINITY

1400 (PJ14Z0) : UNINITIALIZED TRANSFORMATION

1401 (PJ14Z0) : POINT CANNOT BE .PROJECTED

1402 (PJ14Z0) : IMPROPER PARAMETER ·

1500 (PJ15Z0) : UNINITIALIZED TRANSFORMATION

1501 (PJ15Z0) : POINT CANNOT BE PROJECTED

1502 (PJ15Z0) : IMPROPER PARAMETER

1600 (PJ16Z0) : UNINITIALIZED TRANSFORMATION

1600 (PJ16Z0) : IMPROPER PARAMETER

1700 (PJ17Z0) : UNINITIALIZED TRANSFORMATION

1701 (PJ17Z0) : IMPROPER PARAMETER

1800 (PJ18Z0) : UNINITIALIZED TRANSFOMATION

1900 (PJ19Z0) : UNINITIALIZED TRANSFORMATION

1901 (PJ19Z0)·: IMPROPER PARAMETER

1902 (PJ19Z0) : LATITUDE FAILED to CONVERGE

2000 (PJ20Z0) : UNINITIALIZED TRANSFORMATION

2001 (PJ20Z0) : POINT PROJECTS INTO INFINITY

2002 (PJ20Z0) : IMPROPER PARAMETER

APPENDIX F.--DISTRIBUTION MEDIUM FOR THE GCTP/II

The distribution medium for GCTP/II is magnetic tape. The tape is unlabeled and contains three ASCII files. Recording is done at 1600 bpi density and consists of fixed length, 80-character logical records. The logical records are blocked into 480-character physical records. The first file on the tape contains the FORTRA. source code for GCTP/II. The second file contains the State plane projection parameters for NAD 27. The third file contains the State plane projection parameters for NAD 83. The data for each State plane zone in the second and third data files are given in four consecutive logical records as follows:

RECORD 1

Character	Item
1-32	Zone name
40	Projection identification code number
61-65	Identification of reference system (NAD 27 or NAD 83)
72-75	Zone code number

RECORD 2

Character	Item
1-25	Projection parameter No. 1
26-50	Projection parameter No. 2
51-75	Projection parameter No. 3

RECORD 3

Character	Item
1-25	Projection parameter No. 4
26-50	Projection parameter No. 5
51-75	Projection parameter No. 6

RECORD 4

Character	Item
1-25	Projection parameter No. 7
26-50	Projection parameter No. 8
51-75	Projection parameter No. 9