

GEOPAK COGO CONCEPTS COURSE

The Coordinate Geometry (COGO) Concepts Course was developed as a self help program to aid employees of NCDOT Roadway Design Unit in the development of their knowledge of GEOPAK COGO syntax.

We found that many people experience difficulty understanding the syntax lines of COGO command lines, especially in converting existing alignments or data into input files.

The course is provided in four sections:

- (1) Points
- (2) Curves
- (3) Spirals
- (4) Chains and Alignments

By using the GEOPAK general term conventions, the exercises in each section build a foundation for understanding by assembling the various parts of a command line in the correct sequence. We feel confident that this course will be beneficial to anyone experiencing difficulties with COGO.

NOTICE!

This course material is available to anyone who wants it. However the offer for support and evaluation, as mentioned in the instruction documents, is restricted to employees of NCDOT Roadway Design Unit and Division DDC's.

Other design units of the Division of Highways may request and possibly receive support and evaluation.

COORDINATE GEOMETRY CONCEPTS

General Conventions Used in the GEOPAK Manual

Throughout the coordinate geometry portion of the manual, several conventions are used to assist the user to understand the inherent flexibility associated with the various command lines.

()	Denotes an optional item which may be included in the Command line.
<u>abcdef</u>	the underbar represents the <u>required</u> input of a given command. In the cases where the underbar does not underline an entire keyword, the part not underlined is optional.
<i>na, nb, ni</i>	points to be stored that have not been used before (new)
<i>pa, pb, pc</i>	previously stored points
angle	a numerical angle can be given in any one of the following forms: degrees minutes seconds degrees minutes degrees
P/M angle	the backsight direction, plus or minus the given angle. P is clockwise and M is counter-clockwise.
P/M DEF angle	the forward direction, plus or minus the given angle. P for clockwise and M is for counter-clockwise
Offset value	OFF (P/M) distance. P means to the right in the forward direction as implied by the statement. M is to the left. If the optional (P/M) is not given, PLUS is assumed.
station	A plus sign may be used, embedded in the numerical value. If no plus sign is used, the system parameters will be utilized. No spaces are allowed before and after the plus (+) sign.
DB	DIRECTION BACK: applies to the back tangent on curves and spirals.
DA	DIRECTION AHEAD: applies to the ahead tangent on curves and spirals.
CC	CENTER OF CURVE
Distance	(DIS) value (P/M/MUL/DIV value2) (DIS (FROM) pa TO pb (P/M/MUL/DIV value2) (DIS) R curvename

COORDINATE GEOMETRY CONCEPTS

Direction

Allowable formats:

- angle (P/M angle)
- N/S angle E?W (P/M-)
- (AZ) angle (P/M-)
- pa to pb (P/M angle)
- pa, pb [optional short for pa TO pb]

examples:

120 34 57
N 44 08 14.3 W P 90
S 17 50 E M 2 13 25

Command continuation

continuation line is not required in GEOPAK for lines up to 256 characters. If the statement is more than 80 characters, keep typing, the line will move to the left as you type to a maximum of 256 characters.

NOTE that the input file, however, is formatted to 80 characters. If the line is over 256 characters, the minus sign (-) placed at the end of the line will indicate to the software that the rest of the command will be found on the next line. It is not necessary to be in the 256th column, just at the end of the command.

NOTE any GEOPAK command can be split at any point in the line without splitting the actual words.

Pa-pi

a hyphen between two stored points implies reading those points consecutively.

COORDINATE GEOMETRY CONCEPTS

ALPHANUMERIC POINT NUMBERS

GEOPAK supports alphanumeric point numbers. Alphanumeric point numbers can be utilized in any command where a point number is required. This includes storing points in the locate or intersect commands, and in the profile commands if the point has been previously stored with an elevation.

Alphanumeric point numbers should have an alpha prefix, then a number suffix, rather than a numeric prefix, alpha suffix. For example, 123abc is not acceptable, while abc123 is supported. The number portion must be greater than zero, i.e., abdc0 or abc000 are not supported. Special characters, such as %, *<, #, should also be avoided. Since the hyphen (-) symbol is utilized for point range in several commands, a point number should not use hyphens.

However, the following COGO keywords should not be used as point names if no numeric characters are utilized. For example the word SHIFT is in the list, it means that the words SHIFT, SHUF, SHI, SH, and S cannot be used as point names. However, the words S1, SH1, SHIF1, and SHIFT1 can be used as point names.

Be aware that there may be other COGO keywords to avoid!

ALL	ARC	AREA	ASEC
AZIMUTH	BEARING	CC	CC1
CC2	CELL	CHAIN	CHORD
CON	COPY	CS	CURVE
DEFLECTION	DEGREE	DELETE	DELTA
DA	DB	DI	D2
ELEVATION	EQUATE	EX	FIX
FROM	GAP	LC	LENGTH
LINE	LIST	LOCATE	LS
LT	NEAR	M	OFFSET
ON	PARCEL	PC	PI
PIS	PISCS	PIZ	POINT
PRINT	PROJECT	PROFILE	PT
RADIUS	REDEFINE	RT	SC
SCS	SEGMENT	SEST	SHIFT
SHOW	SPIRAL	ST	STATION
STORE	SYSTEM	TANGENT	THRU

COORDINATE GEOMETRY CONCEPTS

TL TO TRANSPORT TS

NOTE: The software was developed utilizing the EFB point naming convention. I.e. alphabetic prefix + numeric suffix. In that case, only the keywords that should be used are CC1, CC2, D1, AND D2.

When utilizing alphanumeric point numbers within the store point key-in command, the keyword POINT must be included. For example, when storing point SH3, the command syntax is :

S POI SH3 X 12345 Y 12345

NOTE that when strictly point numbers are utilized, the keyword point is not required.

S 3 X 12345 Y 12345

COORDINATE GEOMETRY CONCEPTS

The Coordinate Geometry (COGO) Concepts Course was developed as a self help program to aid employees in the development of their knowledge of GEOPAK coordinate geometry syntax.

We found many of our employees have difficulty in the implementation of syntax lines or command lines, especially in converting existing alignments or given data into input files.

The course was developed to help a person write a line of syntax by breaking it down into its components. The course is broken down into four sections (1) Points; (2) Curves, (3) Spirals, and (4) Chains and Alignments.

By using the GEOPAK general term conventions, the exercises in each section build a foundation for understanding by assembling the various parts of a command line in the correct sequence. We feel confident that the course will benefit anyone who is having difficulty in a GEOPAK Course or with a GEOPAK Test.

COORDINATE GEOMETRY CONCEPTS

Instruction for part one Points

It is important that the information be read. The exercises in this part are based on the information that it contains.

WRITE OUT ALL SYNTAX LINES

1. All problems are to be answered by writing out the lines of syntax. You are not to use the machine GEOPAK.
2. Exercises 1 through 4 on sheet 8, require four solutions each, one solution for each format (A, B, C & D)
3. Exercises 5 through 8 require only one solution or one (1) line of syntax (format A).
4. Special attention to sheet 11 for Intrinsic Precision* values
5. Each line of the exercise on sheet 12 is all parts of the same group input. This will require two input files one in format A and one in format B.
6. Complete exercises on page 13 with one line syntax.

Your written solutions can be mailed or faxed to Glenn Plott in Roadway Design CADD Support for evaluation. Your solutions will be evaluated and returned to you with suggestions for correcting any mistakes if any. You will then be advised to go to the next unit.

FOR QUESTIONS (919) 250 4016 EXT 313 for Glenn

Glenn Plott
Roadway Design Unit
P O Box 25201
Raleigh, NC 27611
Fax (919) 250-4036

Courier # 51 31 00

*(a special packet on Intrinsic Precision, not part of this course is available by request)

COORDINATE GEOMETRY CONCEPTS

General Conventions Used in the GEOPAK Manual

Throughout the coordinate geometry portion of the manual, several conventions are used to assist the user to understand the inherent flexibility associated with the various command lines.

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<i>na, nb, ni</i>	points to be stored that have not been used before (new)
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P/M angle	the backsight direction(direction back), plus or minus the given angle. P is clockwise and M is counter-clockwise.
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DB	DIRECTION BACK: applies to the back tangent on curves and spirals.
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COORDINATE GEOMETRY CONCEPTS

CC	CENTER OF CURVE
Distance	(DIS) value (P/M/MUL/DIV value2) (DIS (FROM) pa TO pb (P/M/MUL/DIV value2) (DIS) R curvename
Direction	Allowable formats: <ul style="list-style-type: none">• angle (P/M angle)• N/S angle E?W (P/M-)• (AZ) angle (P/M-)• pa to pb (P/M angle)• pa, pb [optional short for pa TO pb]
Examples:	120 34 57 N 44 08 14.3 W P 90 S 17 50 E M 2 13 25
Command continuation	continuation line is not required in GEOPAK for lines up to 256 characters. If the statement is more than 80 characters, keep typing, the line will move to the left as you type to a maximum of 256 characters. NOTE that the input file, however, is formatted to 80 characters. If the line is over 256 characters, the minus sign (-) placed at the end of the line will indicate to the software that the rest of the command will be found on the next line. It is not necessary to be in the 256 th column, just at the end of the command. NOTE any GEOPAK command can be split at any point in the line without splitting the actual words.
Pa-pi	a hyphen between two stored points implies reading those points consecutively.

COORDINATE GEOMETRY CONCEPTS

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However, the following COGO keywords should not be used as point names if no numeric characters are utilized. For example the word SHIFT is in the list, it means that the words SHIFT, SHUF, SHI, SH, and S cannot be used as point names. However, the words S1, SH1, SHIF1, and SHIFT1 can be used as point names.

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AZIMUTH	BEARING	CC	CC1
CC2	CELL	CHAIN	CHORD
CON	COPY	CS	CURVE
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DA	DB	DI	D2
ELEVATION	EQUATE	EX	FIX
FROM	GAP	LC	LENGTH
LINE	LIST	LOCATE	LS
LT	NEAR	M	OFFSET
ON	PARCEL	PC	PI
PIS	PISCS	PIZ	POINT
PRINT	PROJECT	PROFILE	PT
RADIUS	REDEFINE	RT	SC
SCS	SEGMENT	SEST	SHIFT
SHOW	SPIRAL	ST	STATION
STORE	SYSTEM	TANGENT	THRU
TL	TO	TRANSPORT	TS

COORDINATE GEOMETRY CONCEPTS

NOTE: The software was developed utilizing the EFB point naming convention. I.e. alphabetic prefix + numeric suffix. In that case, only the keywords that should be used are CC1, CC2, D1, AND D2.

When utilizing alphanumeric point numbers within the store point key-in command, the keyword POINT must be included. For example, when storing point SH3, the command syntax is :

S POI SH3 X 12345 Y 12345

NOTE that when strictly point numbers are utilized, the keyword point is not required.

S 3 X 12345 Y 12345

COORDINATE GEOMETRY CONCEPTS

Part 1- Points

- a. Store point
- b. Print point
- c. Delete point
- d. List point
- e. Equate point
- f. Locate point

Part 2- Simple Curves

Part 3- Spirals

Part 4- Chains

COORDINATE GEOMETRY CONCEPTS

STORING POINTS

FORMAT A IS THE PREFERRED METHOD FOR ROADWAY DESIGN

Format A

- [1] Store (POInt) number [2] North northing East easting
[3] (STAtion station) [4] (ELEvation elevation) [5] (FEAture feature)
[6] (DEScRIPTION description)

- [1] The “number” is the alphanumeric identification for the point to be stored. The POI is only required if the point is designated with an alpha character instead of a number.
- [2] the northing and easting represent the point coordinate location, with N and E prefixing the coordinates.
- [3] The point can be assigned a station
- [4] Elevation if it is required.
- [5] Feature (i.e. CB, DI, MH, Tree, etc.)
- [6] Description (i.e. PI of curve RMP6, however, use of the inch symbol (“’)) is NOT supported.

Example:

Point 117 or A117, is a 48” oak tree located at N 10923.8766 E 51230.9797 with a station of 28+91.44 and an elevation of 137.2’.

STORE 117 NORTH 10923.8766 EAST 51230.9797 STATION 28+91.44
ELEVATION 137.2

OR

S 117 N 10923.8766 E 51230.9797 STA 28+91.44 EL 137.2

STORE POINT A117 NORTH 10923.8766 EAST 51230.9797 STATION 28+91.44

OR

S POI A117 N 10923.8766 E 51230.9797 STA 28+91.44

STORE POINT 117 NORTH 10923.8766 EAST 51230.9797 STATION 28+91.44
FEATURE TREE DESCRIPTION “48 INCH OAK TREE”

OR

S 117 N 10923.8766 E 51230.9797 STA 28+91.44 FEA TREE DES “48 INCH OAK
TREE”

COORDINATE GEOMETRY CONCEPTS

Format B

THIS FORMAT REQUIRES GEOPAK COORDINATE USER PREFERENCE DISPLAY SET TO X/Y.

[1] Store (POInt) number [2] X easting Y northing [3] ((STAtion station)
[4] (ELEvation elevation) [5] (FEAture feature) [6] (DEScrition description)

Example: Y X

Point 117 or A117, is a 48” oak tree located at N 10923.8766 E 51230.9797 with a station of 28+91.44 and an elevation of 137.2’.

S 117 X 51230.9797 Y 10923.8766 STA 28+91.44 EL 137.2

OR

S POI A117 Y 10923.8766 X 51230.9797 STA 28+91.44 EL 137.2

Format C

THIS FORMAT REQUIRES GEOPAK COORDINATE USER PREFERENCE DISPLAY SET TO N/E.

[1] Store (POInt) number [2] northing easting [3] (STAtion station)
[4] (ELEvation elevation) [5] (FEAture feature) [6] (DEScrition description)

Example:

Point 117 or A117, is a 48” oak tree located at N 10923.8766 E 51230.9797 with a station of 28+91.44 and an elevation of 137.2’.

S 117 10923.8766 51230.9797 STA 28+91.44 EL 137.2

OR

S POI A117 10923.8766 51230.9797 STA 28+91.44 EL 137.2

COORDINATE GEOMETRY CONCEPTS

Format D

THIS FORMAT REQUIRES GEOPAK COORDINATE USER PREFERENCE DISPLAY SET TO X/Y.

[1] Store (POInt) number [2] easting northing [3] (STAtion station)
[4] (ELEvation elevation) [5] (FEAture feature) [6] (DEScRiption description)

Example:

Y

X

Point 117 or A117, is a 48" oak tree located at N 10923.8766 E 51230.9797 with a station of 28+91.44 and an elevation of 137.2.

S 117 51230.9797 10923.8766 STA 28+91.44 EL 137.2

OR

S POI A117 51230.9797 10923.8766 STA 28+91.44 EL 137.2

EXERCISE

USE FORMATS A, B, C AND D TO STORE EACH OF THE FOLLOWING POINTS.

Point 112 is located N 186343.6870 E 2329416.6145 with a station of 10+00.00

Point AA2 is a PI for curve 18 located at N 186329.6949 E 2330106.4726

Point 333zzz is a proposed right-of way monument located at N 184990.2510 E 2332774.0729 with a station of 247+000.000 and an elevation of 205.000 m

Point 771 is the corner of a brick house in parcel 45 located at N 185746.4795 E 2340503.2782 with station 158+00.00

Point jjj000 is a 60" pine tree located at N 185489.2395 E 2342643.1720 with a station of 10+00.00

Point PIZ is a light pole located at N 181737.9727 E 2343658.5224 with a station of 21+00.00.

Point SH7 is located N 181138.3111 E 2344748.5640 with an elevation of 128.71'.

Point 8 is a 48" oak tree located at N 280492.2598 E 2345916.7146 with a station of 175+00 .00.

COORDINATE GEOMETRY CONCEPTS

PRINTING DATA FROM STORED POINTS

Where *pa*, *pb*, *pc*, *pk*, etc are the identification number of the stored point.

FORMAT A

PRInt POInts *pa (pb, pc, pk)*

PRI POI 10, 20, 40, 60

data for points 10, 20, 40, 60

FORMAT B

PRInt POInts *pa thru pk*

PRI POI 10 THRU 50

data for points 10 thru 50

FORMAT C

PRInt POInts *pa-pk*

PRI POI 10-60

data for all points 10-60

OR

PRInt POInts *

PRI POI *

**data for all points stored in the
Gpk file**

DELETING STORED POINTS

FORMAT A

DELete POInts *pa (pb, pc, pk)*

DEL POI 10, 20, 40 and 60

deletes points 10, 20, 40 and 60

COORDINATE GEOMETRY CONCEPTS

FORMAT B

DELete POInts *pa* thru *pk*

DEL POI 10 THRU 50

deletes points 10 thru 50

FORMAT C

DELete POInts *pa-pk*

DEL POI 10-60

deletes all points 10 thru 60

DEL POI *

command** not supported,
would delete all points stored
in the Gpk file

**** NOTE: IF YOU COULD USE THIS COMMAND YOU START
OVER!!!!**

LIST STORED POINTS

FORMAT A

LISt POInts *pa* (*pb*, *pc*, *pk*)

LIS POI 10, 20, 40 and 60

list points 10, 20, 40 and 60

FORMAT B

LISt POInts *pa* thru *pk*

LIS POI 10 THRU 50

list points 10 thru 50

COORDINATE GEOMETRY CONCEPTS

FORMAT C

LIS POInts *pa-pk*

LIS POI 10-60

list all points 10-6

OR

LIS POInts *

list for all store points

LIS POI *

OR

LIS POI ABC*

list all point with prefix ABC

LIS POI *ABC

list all points with suffix ABC

STORE POINT BY EQUATE

Equate POINT number TO (PREVIOUSLY STORED POINT OR INTRINSIC VALUE*)

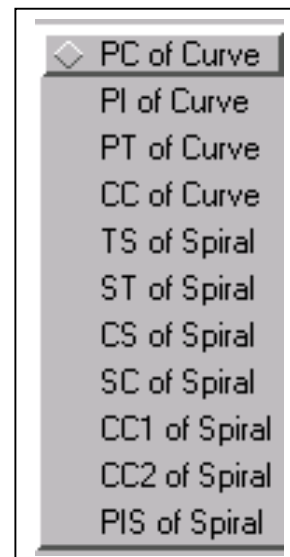
EQ 22 TO 10

OR

EQ 22 TO PC CUR C2

*INTRINSIC VALUE means an unassigned internally computed point inside the .gpk file

Refer to GEOPAK Manual, Volume I, Chapter 6 page 6-13, for a full list of fields and further details.



COORDINATE GEOMETRY CONCEPTS

LOCATE POINT

FORMAT A

LOCate pb (TRAverse) pa (DIStance) distance direction (OFFset offset)

↓ ↓ ↓ ↓ ↓

LOC 22 TRA 20 DIS 1316.2913 N 11 02 28.01 W OFF M 20.5

OR

LOC 22 20 1316.2913 N 11 02 28.01 W M 20.54

FORMAT B

LOCate pb (FROM) pa distance direction (offset)

↓ ↓ ↓ ↓

LOC 22 FROM 20 1316.2913 N 11 02 28.01 W

OR

LOC 22 20 1316.2913 N 11 02 28.01 W

EXERCISE:

USE FORMATS A AND B TO STORE EACH OF THE FOLLOWING POINTS.

Point 10 is located N 481208.1307 E 687892.7730 with a station of 10+00.00

Point 20 is located 1293.2114' from 10 with a bearing of N 16 52 32.01 E

Point 30 is located 1964.4258' from 20 with a bearing of N 11 02 28.01 W

Point 40 is located S 04 34 00.00 W at a distance of 2394.32' from 30

The coordinates for point 50 are N 488831.2969 E 686484.7546. Locate point 70 from 50 using a distance of 2401.77' and a bearing of N 30 26 00.00 W.

Using a distance of 1185.389m and a bearing of S 39 04 29.99 E locate point 60 from point 10.

Point 11 is offset 7 feet to the left of point 10
(Note: *pa to pb supports a distance and/or bearing value*)

COORDINATE GEOMETRY CONCEPTS

WRITE THE COMMANDS TO:

Equate point 100 to any one of the previously stored points (your choice)

Equate point 101 to the PT of curve 75

List all stored points

List all points stored with the prefix ZZZ

List all points stored with the suffix RRR

Print the data for points 20, 100, 11 and 70

Delete points 1-8

Delete all the points in the Gpk file.

FOR ADDITIONAL INFORMATION on STORE and LOCATE refer to the GEOPAK manual, Part II Coordinate Geometry, Chapter 6, Point Commands and Chapter 12, Locate Commands

COORDINATE GEOMETRY CONCEPTS

Instruction for Part Two Curves

It is important that the information be read. The exercises in this part are based on the information that it contains.

WRITE OUT ALL SYNTAX LINES

1. All problems are to be answered by writing out the lines of syntax. You are not to use the machine GEOPAK.
2. The exercises (1 through 5) on sheets 19 & 20 require that you write line(s) of syntax for stored points before you write the syntax lines for the curve. For each exercise, you are to provide the required number of syntax options or combinations for the curve. Points need only be stored one time each exercise.
3. Exercise 4 you can use intrinsic values* to write at least four (4) lines of curve syntax.
4. Finish up with the exercises on sheet 22

Your written solutions can be mailed or faxed to Glenn Plott in Roadway Design CADD Support for evaluation. Your solutions will be evaluated and returned to you with suggestions for correcting any mistakes if any. You will then be advised to go to the next unit.

FOR QUESTIONS (919) 250 4016 EXT 313 for Glenn

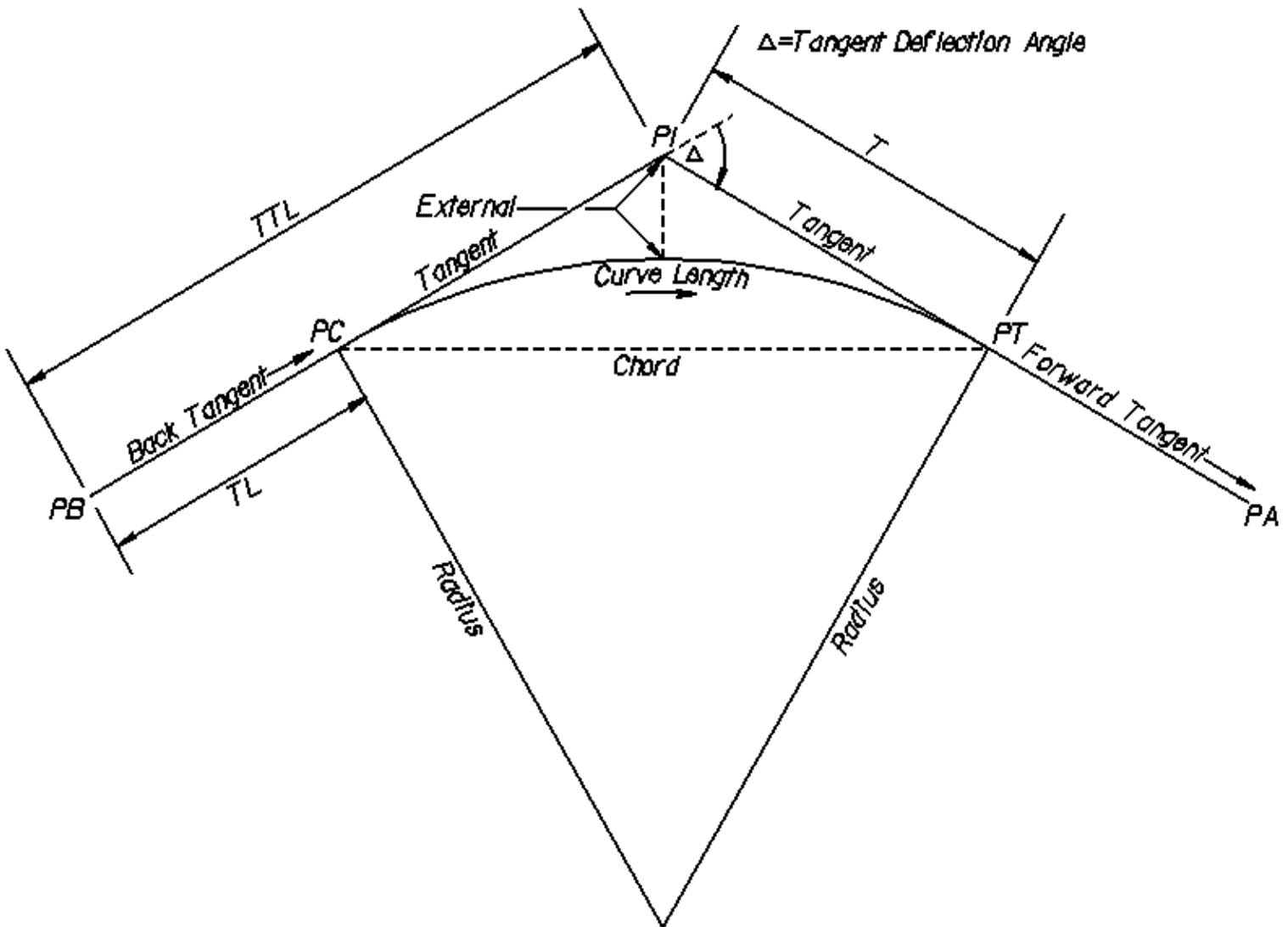
Glenn Plott
Roadway Design Unit
P O Box 25201
Raleigh, NC 27611
Fax (919) 250-4036

Courier # 51 31 00

*(a special packet on Intrinsic Precision, not part of this course is available by request)

COORDINATE GEOMETRY CONCEPTS

CURVE COMMANDS



COMMAND LINE SYNTAX

[1] STOre CURve name [2] Back Tangent Reference [3] Element
[4A or 4B] Ahead Tangent Reference [5] (STATION Station Label station)

- [1] The “name” is a one to nine character alphanumeric identification of the curve to be stored. Such as: C1, C2, C222, ABC123, etc.
- [2] Back Tangent Reference defines the direction and length of the tangent starting the curve.
- [3] Element defines the actual curve itself.
- [4] Ahead Tangent Reference defines the direction and length of the tangent ending the curve.
- [5] Station Label attaches a station to the curve if needed.

COORDINATE GEOMETRY CONCEPTS

[1] STORe CURve name

STO CUR C222

[2] Back Tangent Reference

Use ONE of the options to define the Back Tangent .
Remember: *px, pb, pa*, etc. are previously stored points.

OPTION 1:

The point of curvature (PC) and direction back (DB) defines tangent.

PC px DB direction

PC 22 DB N 11 02 28.01 E

OPTION 2:

The point of intersection (PI) and direction back (DB) defines tangent.

PI pd DB direction

PI 30 DB N 11 02 28.01 E

OPTION 3:

The beginning point for the back tangent (PB), direction back (DB) and the back tangent length (TL) defines tangent.

PB pa DB direction TL distance

PB 10 DB N 11 02 28.01 E TL 648.1345

OPTION 4:

The beginning point for the back tangent (PB), direction back (DB) and the length from (PB) to (PI) , also known as the Total Tangent Length (TTL), defines tangent.

PB pa DB direction TTL distance

PB 20 DB N 11 02 28.01 E TTL 1964.4258

COORDINATE GEOMETRY CONCEPTS

OPTION 5:

The beginning point for the back tangent (PB) and the point of intersection (PI) defines tangent.

PB pa PI pb

PB 20 PI 30

[3] Element

Use ONE of the options to define the element.

OPTION 1:

Use the radius to define the element.

RAD radius

RAD 11459.1559

OPTION 2:

The degree of curve defines the element.

DEG angle (arc deflection)

DEG 0 00 00

OPTION 3:

The length of the tangent from (PC) to (PI) if the radius or degree is not known.

Tangent distance

T 187.236

COORDINATE GEOMETRY CONCEPTS

OPTION 4:

The arc length of the curve from (PC) to (PT) if the radius or degree is not known.

L distance

L 1294.8893

OPTION 5:

Point on curve.

POC *px*

POC 74

[4B] Ahead Tangent Reference

Use ONE of the options to define the ahead tangent reference.

OPTION 1:

The ahead tangent is defined by (DA) direction from (PI) to (PT)

DA direction

DA N 04 34 00.00 W

OPTION 2:

A point on the forward tangent (PA) defines the tangent ahead.

This OPTION can be used ONLY with OPTIONS 2, 4, and 5 of the Back Tangent Reference.

PA *pe*

PA 40

COORDINATE GEOMETRY CONCEPTS

OPTION 3:

The tangent ahead can be defined by the Deflection angle (DEF) and the tangent's direction using either (P) clockwise or (M) counterclockwise. Note that the direction is needed before the angle. If a direction is not given (P) will be assumed.

(P / M) DEFlection angle

P DEF 06 28 28.01

OPTION 4:

The tangent ahead can be defined by using the direction of the Deflection angle (P/M) and the length of the tangent (T) between the (PI) and the (PC). This OPTION can only be used when the radius or degree is used as the Element. If a direction is not given (P) will be assumed.

(P / M) Tangent distance

P T 648.1345

OPTION 5:

The tangent ahead can be defined by using the direction of the Deflection angle (P/M) and the arc length of the curve (L) between the (PC) and the (PT). This OPTION can only be used when the radius or degree is used as the Element. If a direction is not given (P) will be assumed

(P / M) Length distance

P L 1294.8893

COORDINATE GEOMETRY CONCEPTS

OPTION 6:

The tangent ahead can be defined by using the direction of the Deflection angle (P/M) and the chord length of the curve (LC) between the (PC) and the (PT). This OPTION can only be used when the radius or degree is used as the Element. If a direction is not given (P) will be assumed

(P / M) LC distance
P LC 1294.2005

OPTION 7:

The tangent ahead can be defined by using the direction of the Deflection angle (P/M) and the external distance (EX). This OPTION can only be used when the radius or degree is used as the Element. If a direction is not given (P) will be assumed. See curve diagram for help.

(P / M) EXternal distance
P EXT 18.2855

EXERCISE: write out the input files to store the curves, this includes commands for storing points

1. Store Curve C2 - try the various combinations of command line syntax OPTIONS to store this curve (there are more than six combinations that will work)

Curve C2

P. I. Station =	6+48.13	N 484373.7238	E 687891.9708
Delta =	6^28'28.01" RT		
Tangent =	648.1345		
Length =	1294.8893		
Radius =	11459.1559		
External =	18.3147		
Long Chord =	1294.2005		
Mid. Ord. =	18.2855		
PC Station =	00+00.00	N 483737.5863	E 688016.0972
Back =	N 11^02'28.01" W		
Ahead =	N 04^34'00.00" W		

COORDINATE GEOMETRY CONCEPTS

2. Store Curve C4 Use six combinations of appropriate OPTIONS. You are very restricted by the information given.

Curve C4

Point 40 is the beginning of the back tangent.

Point 50 is the point of intersection

5[^]00'00" is the degree of curve

The radius of the curve is 1145.9156'

69[^]39'39.99" to the right is the deflection angle

The tangent length is 795.0733'

Point 60 is a point on the tangent ahead

3. Store these curves. (there are at least 4 ways to store curve L1)

Curve L1

P. I. = N 966039.7097 E 1265551.3080

Delta = 13[^] 25' 25.70" LT

External = 4.9424

Radius = 716.1970

Degree = 8[^] 00' 00.00"

Length = 167.7975

Back = N 3[^] 16' 08.51" W

4. This should be fun

Curve LREV6

P. I. Station = 44+16.06 N 968893.4473 E 1264343.4736

point 102

C. C. * = N 969207.5446 E 1264922.8936

pt 104

P. C. Station = 42+45.47 N 968769.6305 E 1264460.8154

pt 101

P. T. Station = 45+78.81 N 969059.3472 E 1264303.7631

pt 103

P.O.C. = N 968889.6001 E 1264371.3537

pt 105

5. Store this curve using Options 4,5, & 6 of the Ahead Tangent Reference

Curve DW1

Tangent = 23.4623

Radius = 150.00

Degree = 38[^] 11' 49.87"

Delta = 17[^] 46' 47.42" RT

P.I. = N 966903.3282 E 1265227.77098

Length = 46.5475

P.T. = N 966924.9149 E 1265236.9630

Long Chord = 46.3610

Ahead = N 23[^] 03' 54.75" E

* center of curve

COORDINATE GEOMETRY CONCEPTS

PRINTING DATA FROM STORED CURVES

FORMAT A

PRInt CURve name

PRI CUR 20

data for curve 20

FORMAT B

PRInt ALL CURves

PRI ALL CUR

data for all curves in
Gpk file

FORMAT C

PRInt CURve *

PRI CUR *

data for all curves in
Gpk file

DELETING STORED CURVES

FORMAT A

DELete CURve list

DEL CUR 35

deletes curve 35

FORMAT B

DELete CURve *

DEL CUR *

command* not supported
by GEOPAK
must delete by name

COORDINATE GEOMETRY CONCEPTS

LIST STORED CURVES

FORMAT A

LIS CURve

LIS CUR

lists all curves in the
Gpk file

WRITE THE COMMANDS TO:

List all stored curves.

Print all curves in the Gpk file.

Print curve DW1.

Print all curves in the Gpk file with Lrev prefix.

Print all curves in the Gpk file with a 1 suffix.

Delete all curves in the Gpk file.

COORDINATE GEOMETRY CONCEPTS

Instruction for Part Three Spirals

It is important that the information be read. The exercises in this part are based on the information that it contains.

WRITE OUT ALL SYNTAX LINES

1. All problems are to be answered by writing out the lines of syntax. You are not to use the machine GEOPAK.
2. The exercises (beginning on sheets 38) require that you write line(s) of syntax for stored point(s) before you write the syntax line for the spiral.
For each exercise, you are to provide the spiral type and the format you used based on the information provided in the examples.
3. A special note should be taken, refer to sheet 31 intrinsic values*
4. Finish up with the exercise (on sheet 43), which will form an alignment input file from the data given. For point 10 you may assume 10000,10000. Special attention should be taken to address the questions asked.

Your written solutions can be mailed or faxed to Glenn Plott in Roadway Design CADD Support for evaluation. Your solutions will be evaluated and returned to you with suggestions for correcting any mistakes if any. You will then be advised to go to the next unit.

FOR QUESTIONS (919) 250 4016 EXT 313 for Glenn

Glenn Plott
Roadway Design Unit
P O Box 25201
Raleigh, NC 27611
Fax (919) 250-4036

Courier # 51 31 00

*(a special packet on Intrinsic Precision, not part of this course is available by request)

COORDINATE GEOMETRY CONCEPTS

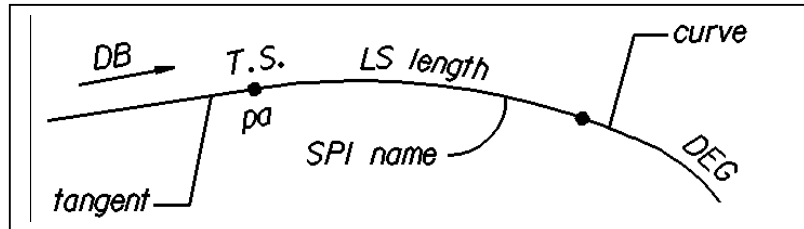
+SPIRAL COMMANDS

This group of store commands stores spiral curves from a tangent to a circular curve define by a degree of curvature or a radius (FORMATS A &B)

NOTE: When the spiral turns to the left from the tangent, a negative length of spiral is entered.

COMMAND LINE SYNTAX FOR TYPE-1 SPIRALS

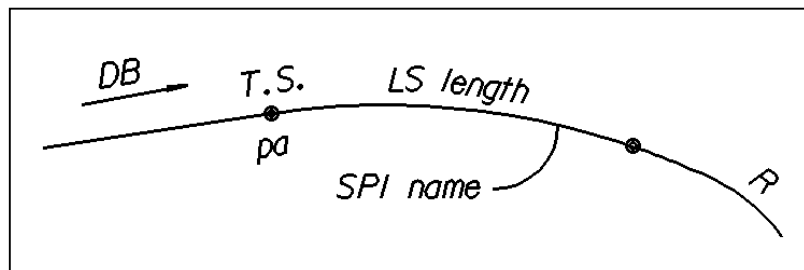
FORMAT A. Spiral name, type 1, stored by way of DB (direction back), TS (tangent-spiral point), LS (length of spiral) and DEG (degree of curvature at the end of the spiral).



[1] STORE SPIRAL name [2] DB direction [3] TS pa [4] LS length
[5] DEGREE angle [6] (sta-label station) [7] (CHORD)

S SPI S13B DB N 16 52 32.01 E TS 15 LS 300 DEG 3 00 TS 16+89.21

FORMAT B. Spiral name, type 1, stored by way of DB (direction back), TS (tangent-spiral point), LS (length of spiral), R (radius of curvature at the end of the spiral)

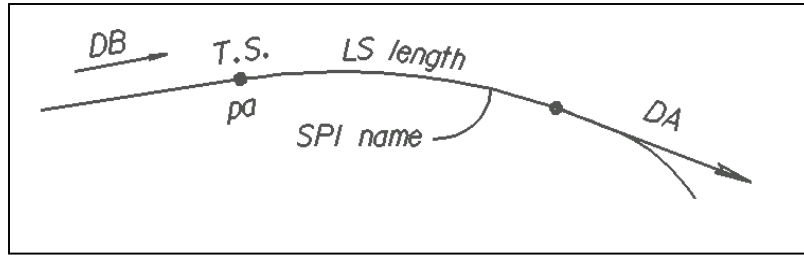


[1] STORE SPIRAL name [2] DB direction [3] TS pa [4] LS length
[5] R radius [6] (sta-label station) [7] (CHORD)

S SPI S13B DB N 16 52 32.01 E TS 15 LS 300 R 1637.0223

COORDINATE GEOMETRY CONCEPTS

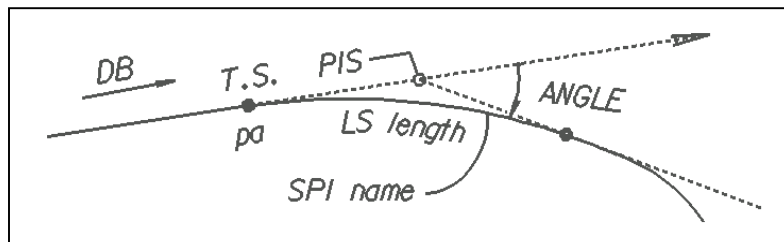
FORMAT C. Spiral name, type 1, stored by way of DB (direction back) , TS (tangent-spiral point), LS (length of spiral) , and DA (direction ahead at the end of the spiral)



[1] STORE SPIRAL name [2] DB direction [3] TS pa [4] LS length
 [5] DA direction [6] (sta-label station) [7] (CHORD)

S SPI S13B DB N 16 52 32.01 E TS 15 LS 300 DA N 11 02 28.01 W

FORMAT D. Spiral name, type 1, stored by way of DB (direction back) , TS (tangent-spiral point), LS (length of spiral) , and ANG (spiral angle).



[1] STORE SPIRAL name [2] DB direction [3] TS pa [4] LS length
 [5] ANG angle [6] (sta-label station) [7] (CHORD)

S SPI S13B DB N 16 52 32.01 E TS 15 LS 300 ANG 7 00 00.00 LT

NOTE: IF there is a previously store point or curve the DB can be defined:

DB 10 15 (stored point 10 to stored point 15)
 Or DB PI CUR C1 PC CUR C1 (from PI of curve C1 to the PC of curve C1)

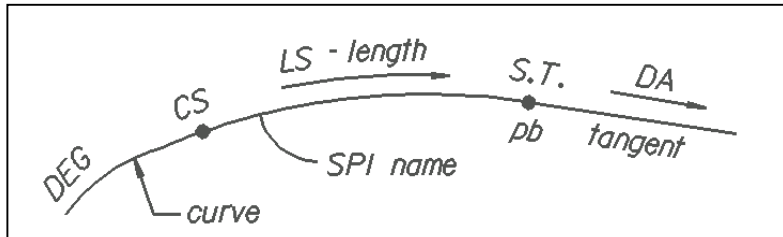
COORDINATE GEOMETRY CONCEPTS

COMMAND LINE SYNTAX FOR TYPE-2 SPIRALS

This group of Store Spiral commands stores spiral curves from a circular curve to a tangent. The circular curve is defined by a degree of curvature or a radius (FORMATS A2 & B2)

NOTE: When the spiral turns to the left from the tangent, a negative length of spiral is entered.

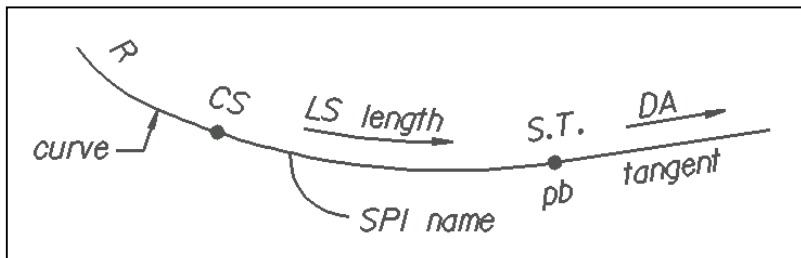
FORMAT A2. Spiral name, type 2, stored by way of DA (direction ahead), ST (spiral-tangent point), LS (length of spiral and DEG (degree of curvature)



[1] STORE SPIRAL name [2] DA direction [3] ST pa [4] LS length
[5] DEGREE angle [6] (sta-label station) [7] (CHORD)

S SPI S13A DA N 05 47 28.01 W ST 16 LS 300 DEG 3 00 STA 28+36.83

FORMAT B2. Spiral name, type 2, stored by way of DA (direction ahead), ST (spiral-tangent point), LS (length of spiral and DEG (degree of curvature)

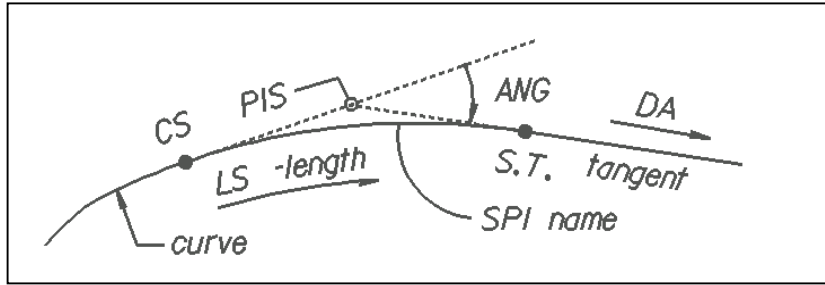


[1] STORE SPIRAL name [2] DA direction [3] ST pa [4] LS length
[5] R radius [6] (sta-label station) [7] (CHORD)

S SPI S13A DA N 16 52 32.01 E ST 15 LS 300 R 1637.0223

COORDINATE GEOMETRY CONCEPTS

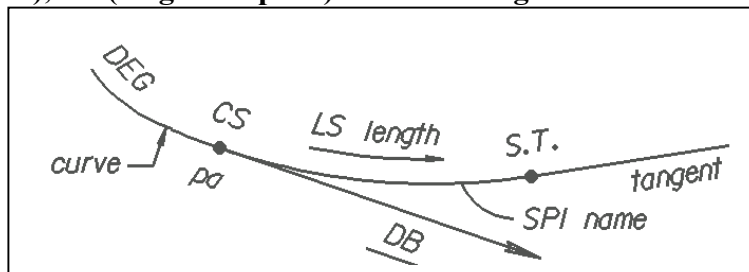
FORMAT C2. Spiral name, type 2, stored by way of DA (direction ahead) , ST (spiral-tangent point), LS (length of spiral) , and ANG spiral angle (clockwise)



[1] STORE SPIRAL name [2] DA direction [3] ST pa [4] LS length
 [5] ANG angle [6] (sta-label station) [7] (CHORD)

S SPI S13A DA N 16 52 32.01 ST 15 LS 300 ANG 5 15 LT

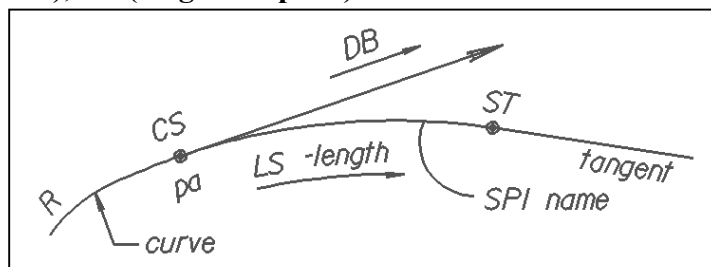
FORMAT D2. Spiral name, type 2, stored by way of CS (curve-spiral point), DB (direction back), LS (length of spiral) and DEG angle



[1] STORE SPIRAL name [2] CS pb [3] DB direction [4] LS length
 [5] DEGREE angle [6] (sta-label station) [7] (CHORD)

S SPI S13A CS 14 DB N 09 52 32.01 E LS -300 DEG 3 30

FORMAT E2. Spiral name, type 2, stored by way of CS (curve-spiral point), DB (direction back), LS (length of spiral) and R radius

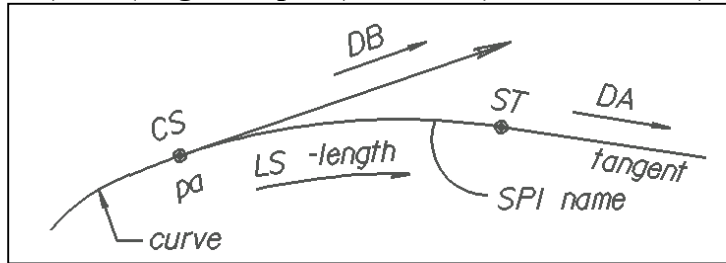


[1] STORE SPIRAL name [2] CS pb [3] DB direction [4] LS length
 [5] R radius [6] (sta-label station) [7] (CHORD)

S SPI S13A CS 14 DB N 09 52 32.01 E LS -300 R 1637.022

COORDINATE GEOMETRY CONCEPTS

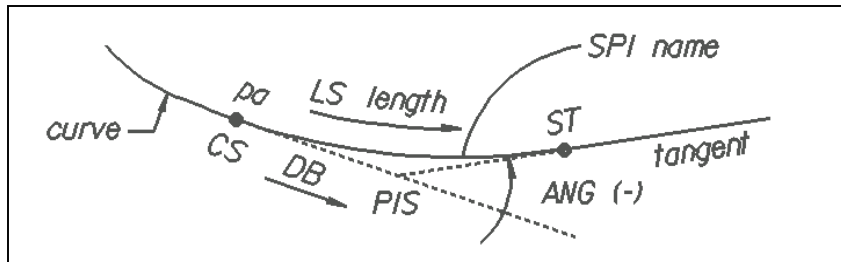
FORMAT F2. Spiral name, type 2, stored by way of CS (curve-spiral point), DB (direction back), LS (length of spiral) and DA (direction ahead)



[1] STORE SPIRAL name [2] CS pb [3] DB direction [4] LS length
 [5] DA direction [6] (sta-label station) [7] (CHORD)

S SPI S13A CS 14 DB N 09 52 32.01 E LS -300 DA N 05 47 28.01 W

FORMAT G2. Spiral name, type 2, stored by way of CS (curve-spiral point), DB (direction back), LS (length of spiral) and DEG angle



[1] STORE SPIRAL name [2] CS pb [3] DB direction [4] LS length
 [5] ANGLE angle [6] (sta-label station) [7] (CHORD)

S SPI S13A CS 14 DB N 09 52 32.01 E LS 300 ANG - 5 15 00.00

NOTE: IF there is a previously store point 10 or curve C1 the DB can be defined:

DB 10 15 (stored point 10 to stored point 15)
 Or DB PI CUR C1 TQ PC CUR C2 (from PI of curve C1 to the PC of curve C2)

IF there is a previously store point or curve the DA can be defined:

DA SPI S13a 20 (PIS of spiral S13a to stored point 20)
 Or DA PI 20 TQ PI 30 (PI of curve to PI of curve or stored point)

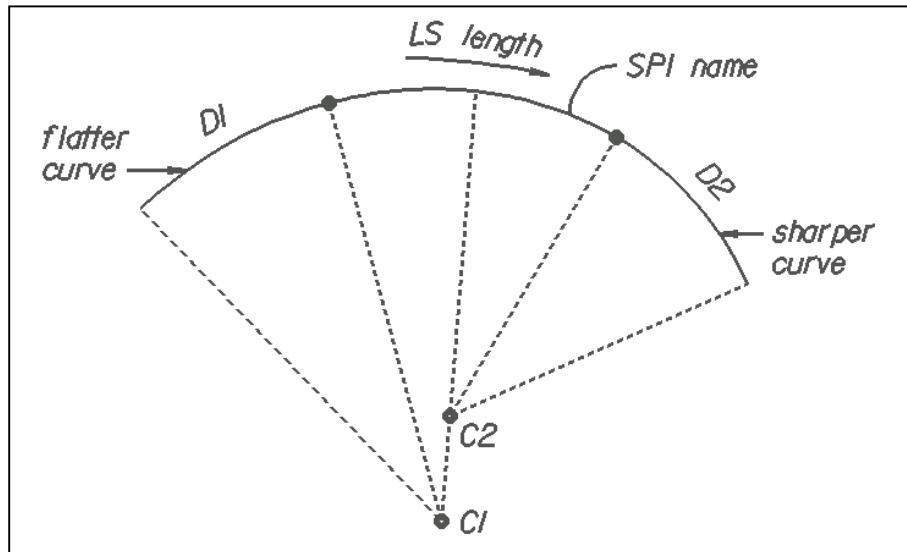
COORDINATE GEOMETRY CONCEPTS

STORE SPIRAL TYPE 3

This group of STORE SPIRAL commands stores spiral curves from a flatter curve (D1) to a sharper curve (D2). NOTE: When the spiral turns to the left from the tangent of the flatter curve to the tangent of the sharper curve, a negative length of spiral is entered.

COMMAND LINE SYNTAX FOR TYPE-3A SPIRALS. Format A3 requires the centers of two curves(C1 and C2)

FORMAT A3. Spiral name, type 3, stored by way of D1 (degree of curvature of the flatter curve), LS (length of spiral), D2 (degree of curvature of the sharper curve, C1 (center point of the flatter curve, and C2 (center point of the sharper curve).



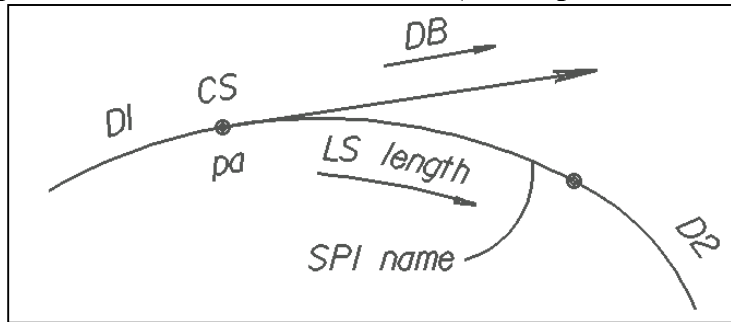
[1] STORE SPIRAL name [2] D1 angle [3] LS length [4] D2 angle
[5] C1 pa C2 pb [6] (sta-label station) [7] (CHORD)

S SPI C4B D1 16 52 00.00 LS 300 D2 54 30 29.99 C1 30 C2 40 CS 16+89.21

COORDINATE GEOMETRY CONCEPTS

COMMAND LINE SYNTAX FOR TYPE-3B and TYPE-3C SPIRALS. When the centers are unknown Formats B3 and C3 are used.

FORMAT B3. Spiral name , type 3, stored by way of D1 (degree of curvature of the flatter curve), LS (length of spiral), D2 (degree of curvature of the sharper curve, C1 (center point of the flatter curve, and C2 (center point of the sharper curve).

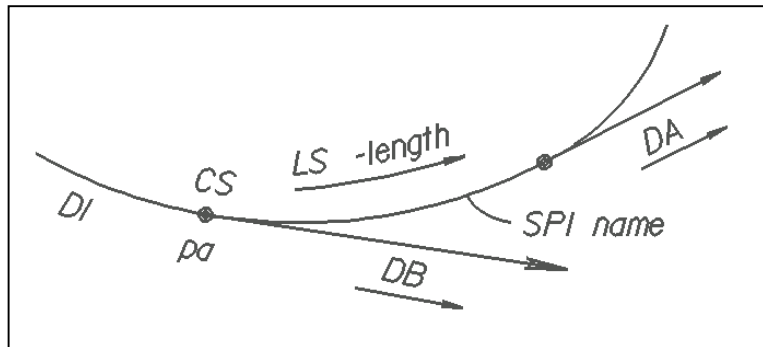


[1] STORE SPIRAL name [2] D1 angle [3] CS pa [4] DB direction [5] LS length
 [6] D2 angle [7] (sta-label station) [8] (CHORD)

S SPI C4B DI 16 52 00.00 CS 28 DB N 30 26 00.00 W LS 300 D2 54 30 29.99

FORMAT C3. Spiral name , type 3, stored by way of D1 (degree of curvature of the flatter curve), LS (length of spiral), D2 (degree of curvature of the sharper curve, C1 (center point of the flatter curve, and C2 (center point of the sharper curve).

[1] STORE SPIRAL name [2] D1 angle [3] CS pa [4] DB direction [5] LS length
 [6] DA direction [7] (sta-label station) [8] (CHORD)

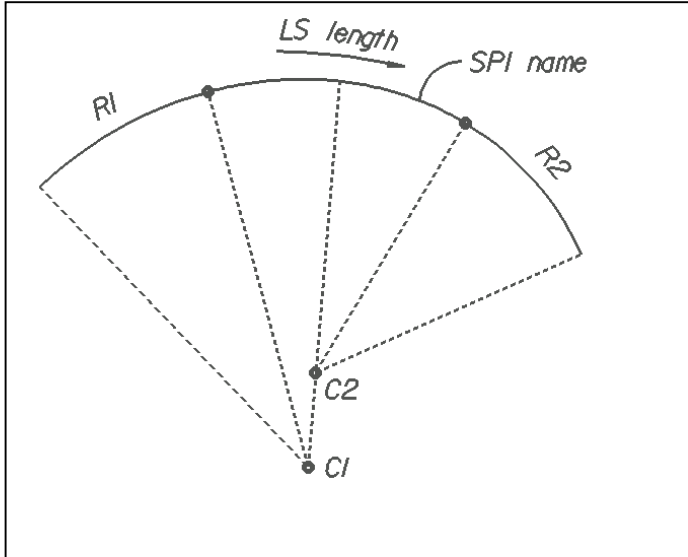


S SPI C4B DI 16 52 00.00 CS N 487005.8122 E 687548.0832 DB N 30 26 00.00 W
 LS -300 DA N 39 04 29.99 E

COORDINATE GEOMETRY CONCEPTS

R1 - COMMAND LINE SYNTAX FOR TYPE-3D THRU TYPE-3F SPIRALS.
Formats D3 thru 3F apply when radius R1 and R2 are given.

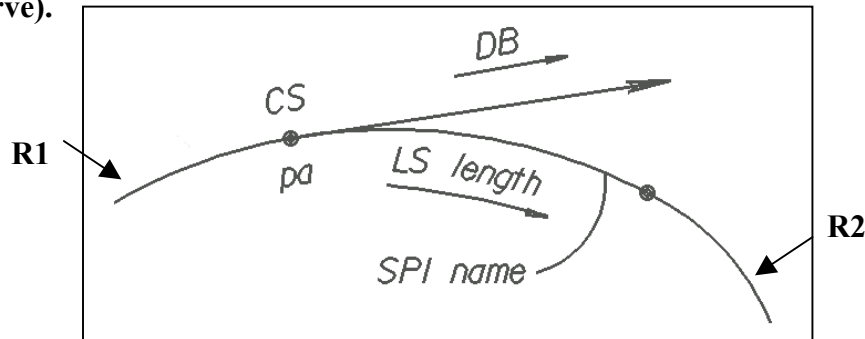
FORMAT 3D. Spiral name, type 3 stored by way of R1 (radius of the flatter curve), LS (length of spiral), R2 (radius of sharper curve), C1 (center point of flatter curve) and C2 (center point of sharper curve).



[1] STORE SPIRAL name [2] R1 radius [3] CS pb [4] LS length [5] R2 radius
 [6] C1 pa C2 pb [7] (sta-label station) [8] (CHORD)

S SPI C4B R1 1909.8593 CS 42 LS -300 LS -300 R2 1145.9156 C1 33 C2 43

FORMAT 3E. Spiral name, type 3, stored by way of R1 (radius of flatter curve) CS (curve-spiral point), DB (direction back), LS (length of spiral), and R2 (radius of sharper curve).

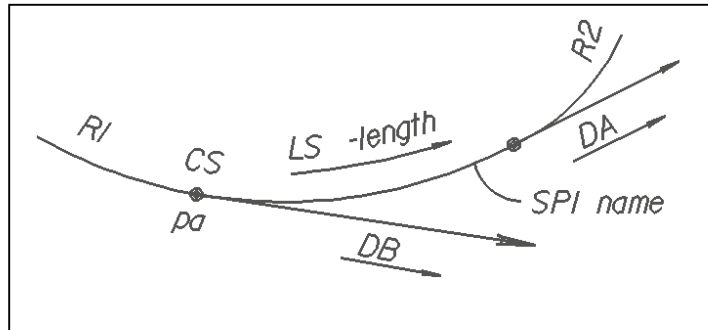


[1] STORE SPIRAL name [2] R1 radius [3] CS pa [4] DB direction [5] LS length
 [6] R2 radius [7] (sta-label station) [8] (CHORD)

S SPI C4B R1 1909.8593 CS 28 DB N 30 26 00.00 W LS 300 R2 1145.9156

COORDINATE GEOMETRY CONCEPTS

FORMAT 3F. Spiral name, type 3, stored by way of R1 (radius of flatter curve), CS (curve-spiral point), DB (direction back), LS (length of spiral and DA (direction ahead).



[1] STORE SPIRAL name [2] R1 angle [3] CS pa [4] DB direction [5] LS length
[6] DA direction [7] (sta-label station) [8] (CHORD)

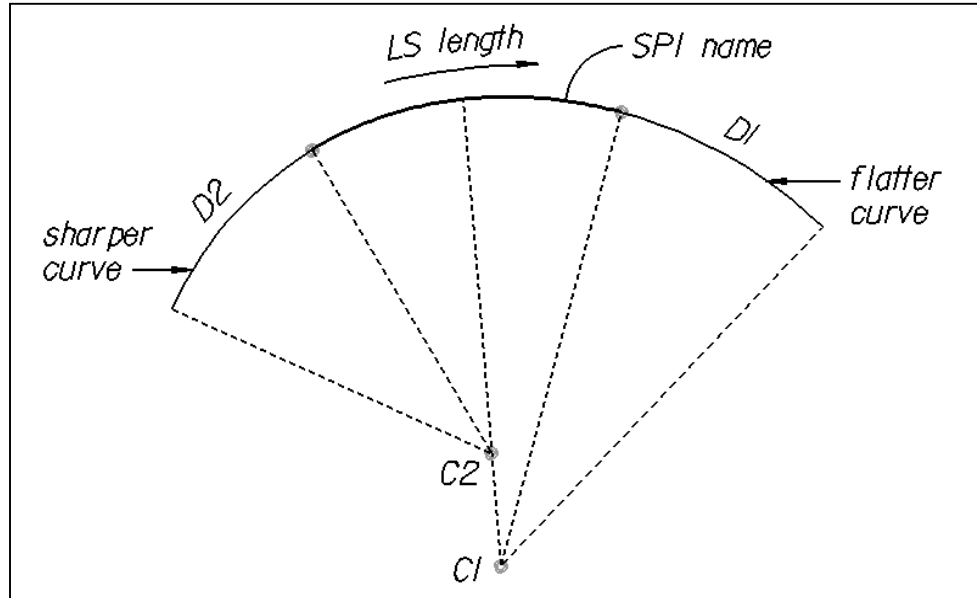
S SPI C4B R1 1909.8593 CS 28 DB N 30 26 00.00 W LS -300 DA N 05 47 28.01 W

COORDINATE GEOMETRY CONCEPTS

COMMAND LINE SYNTAX FOR TYPE-4 SPIRALS. This group of Store Spiral commands stores spiral curves from a sharper curve (D2) to a flatter curve (D1).

FORMAT 4A: This requires the stored center of two curves (C1 and C2).

Spiral name, type 4, stored by way of D2 (degree of curvature of the sharper curve), LS (length of spiral), D1 (degree of curvature of flatter curve), C2 (centerpoint of sharper curve) and C1 (center point of flatter curve). **Use FORMAT 4D to replace degree with radius.**

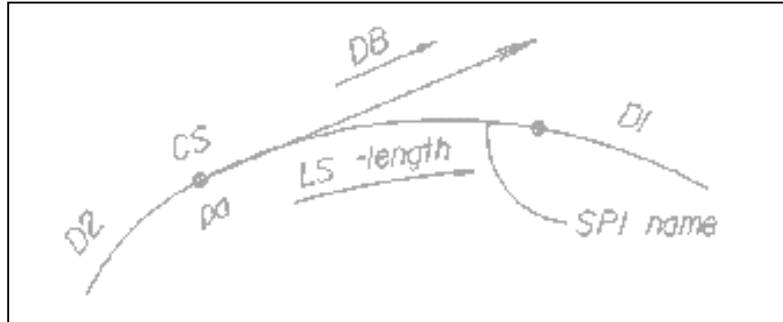


[1] STORE SPIRAL name [2] D2 angle [3] LS length [4] D1 angle [5] C2 pa
[6] C1 pb [7] (sta-label station) [8] (CHORD)

S SPI C4B D2 54 30 39.99 LS 300 D1 16 52 00.00 C2 40 C1 30 CS 16+89.21

COORDINATE GEOMETRY CONCEPTS

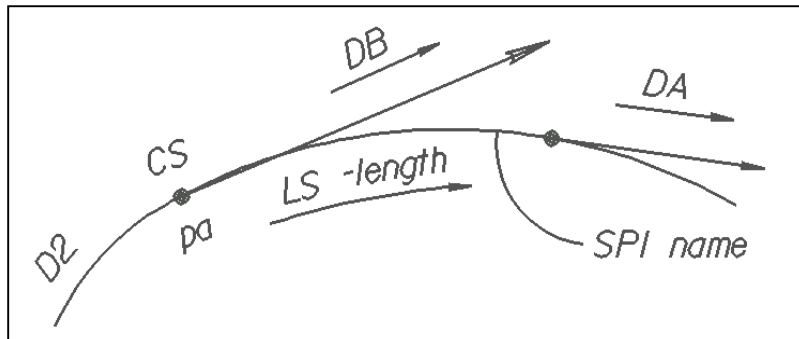
FORMAT 4B. Spiral name, type 4, stored by way of D2 (degree of curvature of sharper curve), CS (curve-spiral point), DB (direction back), LS (length of spiral), and D1 (degree of curvature of the flatter curve). Use FORMAT 4E. to replace degree with radius.



[1] STORE SPIRAL name [2] D2 angle [3] CS pa [4] DB direction [5] LS length
 [6] D1 angle [7] (sta-label station) [8] (CHORD)

S SPI C4B D2 54 30 29.99 CS 28 DB N 30 26 00.00 LS -300 DI 16 52 00.00
 CS 16+89.21

FROMAT 4C. Spiral name, type 4, stored by way of D2 (degree curvature of the sharper curve, CS (curve-spiral point), DB (direction back), LS (length of spiral), and DA (direction ahead).



1] STORE SPIRAL name [2] D2 angle [3] CS pa [4] DB direction [5] LS length
 [6] DA direction

S SPI C4B D2 54 30 29.99 CS 32 DB N 30 26 00.00 W LS -300 DA N 39 04 29.99 E

OR

S SPI C4B D2 54 30 29.99 CS N 487005.8122 E 687548.0832 DB N 30 26 00.00 W LS
 -300 DA N 39 04 29.99 E

COORDINATE GEOMETRY CONCEPTS

FORMAT 4D:

[1] STORE SPIRAL name [2] R2 radius [3] LS length [4] R1 radius [5] C2 pb
[6] C1 pa

FORMAT 4E:

1] STORE SPIRAL name [2] R2 radius [3] CS pa [4] DB direction [5] LS length
[6] R1 radius

Spiral Exercises give type and write a command lines for the for examples

What type is it and which format did you use?

1. Given for spiral S1: TYPE? FORMAT?
Back Tangent or DB is N 40 25 33.00 E (TS to PIs)
TS is stored point 100 N 526687.7617 E 743185.9021 Sta 0+00
LS 400
DEG 4
The spiral angle is 8 00 (RT)
2. Given for spiral S2: TYPE? FORMAT?
Length of spiral 300.00
Back tangent CS to PIs (DB S 10 27 45.00 E)
The curve to the spiral point (STACS) is N 527324.7289 E 742514.4865 Sta 30+00 point 104
Radius is 900.00
The spiral point of intersection is N 527226.1306 E 742532.6939 (105)
Ahead tangent ST is N 527025.8643 E 742535.6861 (106)
(overkill with information choose wisely)
3. Given for spiral S3 TYPE? FORMAT?
Degree of incoming curve C4 is 1 00 00.00
Degree of outgoing curve C5 is 4 00 00.00
Length of spiral is 250
Length of curve is 249.8731
Curve to the spiral is point 115 at N 526712.4057 E 743786.6620 Sta 20+00
Spiral to curve is point 116 at N 526481.5528 E 742691.0402 Sta 22+50

Back tangent (PI of curve C4 to PIs of spiral S3) is S 20 00 00.00 W
Angle 60 15 00 (RT)
DEF 20 29 59.55
LT 150.1194
ST 100.1110
Ahead tangent (PIs of spiral to PI of curve C5) S 26 15 00.00 W

COORDINATE GEOMETRY CONCEPTS

4. given for spiral S4 TYPE? FORMAT?

D1 is 4 46 28.73

D2 is 7 09 43.10

LS 300

R1 1200.00

R2 800.00

Back tangent S 50 00 00.00 W

Ahead tangent S 32 05 42.25 W

CS N 528177.8725 E 741649.2919 Sta 50+00 (point 120)

COORDINATE GEOMETRY CONCEPTS

SPIRAL-CURVE-SPIRAL COMMANDS

Store Spiral-Curve-Spiral Commands create and store three geometric elements: back-spiral, circular curve, and ahead spiral. The following naming convention is used in the output

Back Spiral: *name with a B appended*

Curve: *name*

Ahead Spiral: *name with an A appended*

FORMAT:

[1] STORE SCS name [2] back tangent [3] LS length [4] element [5] ahead tangent

[2] The BACK TANGENT defined by one of 5 options:

OPTION 1. Back tangent defined by point of intersection PISCS and direction

PI pa DB direction

OPTION 2. Back tangent defined by point back PB and point of intersection PISCS

PB pa PI pb

OPTION 3. Back tangent defined by tangent-spiral point TS and direction back DB.

PB pb DB direction

OPTION 4. Back tangent defined by point back PB, direction back DB, distance TL from point back PB to tangent-spiral point TS.

PB pa DB direction TL distance

OPTION 5. Back tangent is defined by point back PB, direction back DB and distance TTL from point back PB to point of intersection PISCS

PB pa DB direction TTL distance

COORDINATE GEOMETRY CONCEPTS

[3] LENGTH OF SPIRAL (LS) (3 OPTIONS)

OPTION 1. Back spiral and ahead spiral at equal lengths.

LS length

LS 300

OPTION 2. For unequal spirals.

LS1 length (back spiral length LS1)

LS2 length (ahead spiral length LS2)

LS1 300 LS2 400

[4]. ELEMENT

RADIUS radius or DEGREE angle

R 1164.456

Or DEG 34 64 35.2

[5] TANGENT AHEAD (4 OPTIONS)

OPTION 1. Ahead tangent is defined by the DA direction ahead

DA direction

DA N 32 25 48.7 E

OPTION 2. Ahead tangent define by point ahead PA

PA pa

PA 40

OPTION 3. Ahead tangent defined by delta angle to right

DEL angle (RT)

DEL 32 34 36.5

OPTION 4. Ahead tangent is defined by delta angle to left

DEL angle (LT)

DEL 25 28 22 LT

COORDINATE GEOMETRY CONCEPTS

ADDITIONAL SPIRAL COMMANDS

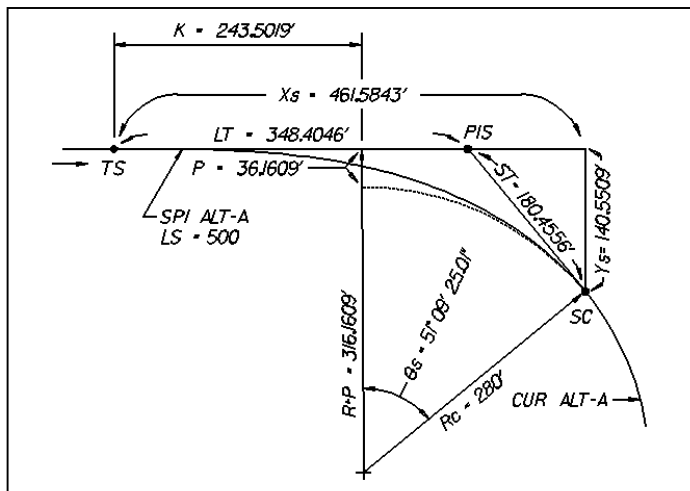
PRINT SPIRAL name. This command displays the spiral point values, coordinates and stations, and spiral element values.

LIST SPIRALS. This command will display names of all stored spirals in alphabetical order.

SPIRAL DATA. This command will calculate the geometric parameters for the named spiral given the length LS, [A] radius of spiral R1 and R2, or [B] degree of curvature D1 and D2.

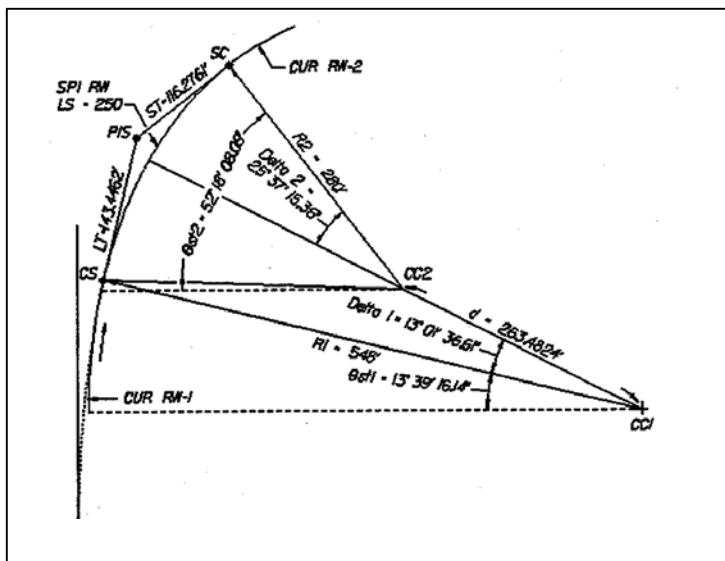
FORMAT A SPIRAL name R1 radius LS length R2 radius

SPI ALTA R1 0 LS 500 R2 280



Format B SPIRAL name D1 angle LS length D2 angle

SP1 S4B D1 10 27 19.56 LS 250 D2 20 27 46



COORDINATE GEOMETRY CONCEPTS

EXERCISE FOR STORING SPIRAL-CURVE SPIRAL (SCS)

WRITE COMMANDS TO SHOW ALL SPIRALS

ASSUMME STORED POINTS 10, 20, 30, 40, 50, and 60

Point 10 is begin point

Point 60 is end point

WRITE STORE COMMANDS USING THE FOLLOWING INFORMATION

Points 20, 30, 40, 50 are points of intersection (PI)

10 to 20	distance 1293.2114	direction N 16 52 32.01 E
20 to 30	distance 1964.4258	direction N 11 02 28.01 W
30 to 40	distance 2394.3203	direction N 04 34 00.00 W
40 to 50	distance 2401.7722	direction N 30 26 00.00 W
50 to 60	distance 1185.3892	direction N 39 04 29.99 E

at 20 store (name=C1) a spiral-curve-spiral with back spiral 400 left, ahead spiral 300 left, degree 3 30, radius 1637.0223 and a total delta of 27 55 00.01

at 30 store (name=C2) a curve with radius 1637.0223 degree of curvature 0 30

at 40 store (name=C3) a spiral-curve-spiral with length of spiral 300, degree of curve 3 00, radius 1909.8593, spiral delta 4 30, and curve delta 16 52 00.00 left

At point of intersection 50, store (name=C4) a spiral curve spiral with length of spirals 300 right, and spiral delta 7 30, degree of curve 5 00, radius at 1145.9156, and curve delta 54 30 29.99 right.

If the SCS STORED at 40 is called C3

WRITE THE COMMAND TO STORE ONLY THE INGOING SPIRAL DATA

The reference to the GEOPAK manual, Part II, coordinate Geometry, Spiral Commands, Section 8

COORDINATE GEOMETRY CONCEPTS

Instruction for Part Four Chain and Alignment Commands

It is important that the information be read. The exercises in this part are based on the information that it contains.

WRITE OUT ALL SYNTAX LINES beginning sheet 44

1. All problems are to be answered by writing out the lines of syntax. You are not to use the machine GEOPAK.
2. The exercise for chains and alignments require that you write line(s) of syntax for stored points before you write the syntax lines
Two (2) OPEN alignment exercise sheet 51
Two (2) INCOMPLETE alignment exercises sheet 58
One (1) INVERSE alignment exercise sheet 63
Final exercise is to write a complete alignment input file for line Y40, sheet 64.
Feel free to use any syntax line(s) you have learned
3. A special note should be take of sheets 11 & 31, intrinsic values*

Your written solutions can be mailed or faxed to Glenn Plott in Roadway Design CADD Support for evaluation. Your solutions will be evaluated and returned to you with suggestions for correcting any mistakes if any. If you are waiting for a test schedule, please advise.

FOR QUESTIONS (919) 250 4016 EXT 313 for Glenn

**Glenn Plott
Roadway Design Unit
P O Box 25201
Raleigh, NC 27611
Fax (919) 250-4036**

Courier # 51 31 00

***(a special packet on Intrinsic Precision, not part of this course is available by request)**

COORDINATE GEOMETRY CONCEPTS

CHAIN COMMANDS

This section will build on the previous sections to make a “chain” of the stored points, curves and spirals. The really fun part is an investigation and explanation of the different ways to “store chain” using this previously stored data and how to “Describe” a chain to see if the alignment gives the desired result.

Included here also is a discussion of storing an open alignment (an alignment with everything known). Then how to print and list stored chains.

STORE CHAIN COMMAND LINE SYNTAX Where the NAME consist of one to nine alphanumeric characters chain which represents a list of stored points (POI), curves (CUR) and spirals (SPI), SCS curves (SCS) and other chains. SPECIAL NOTE: The shift command in the middle of page 9-5.

Store CHAin name list (STation station)

S CHA L 10 SCS C1 CUR C2 SCS C3 SCS C4 60 STA 10+00.00



The following is a sequence of line commands to station a shift (LT & RT) alignment with equations from a main alignment

S CHA SBL 1 SCS S10 SHIFT 4 9 10 SHIFT 11 SCS S11 13

STA CHA SBL BEG 480+00 1 AH

STA CHA SBL BEG 548+46.58 4 AH

STA CHA SBL BEG STA 580+86.34 11 AH

DESCRIBE CHAIN COMMAND LINE SYNTAX. The describe chain command gives a report of the stored chain and describes its geometry including coordinates, stations, distances, bearings, curves, and spiral data.

DEScribe CHAin

DES CHA SBL

ADDITIONAL CHAIN COMMANDS:

PRINT CHAIN. This command displays a list of elements stored for the specified name (where name is the stored chain to be printed).

PRInt CHAin name

PRI CHA Y1

STATION CHAIN. Where name is the stored chain, station is the initial station to start and object is the element to which the element is applied

STation CHAin name BEGin station object (AH) (BK)

STA CHA NC125 BEG 542+21.96 4 AH

STA CHA Y6REV BEG 10+00.00 20 BK

COORDINATE GEOMETRY CONCEPTS

OPEN ALIGNMENT

This section will investigate Open Alignment (alignment where every thing is known) and Incomplete alignment (alignments with something unknown); and how to store a station equation or two.

OPEN ALIGNMENT COMMAND. The open alignment command is the first statement required to generate a new chain or alignment name and activates the open alignment grope of commands.

ALIGNment name OPEN
ALI L1REV OPEN

INITIAL POINT (POT) COMMAND FOR OPEN ALIGNMENT The initial point command represents the starting point of the new alignment or chain name. There is an optional station command which if not used will start at 0+00.00

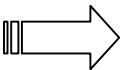
FORMAT A:

POT pa TD direction (STATION station) where pa is a previously stored point
POT 10 TD N 16 52 32 E STA 24+25.36

FORMAT B:

POT n N northing E easting TD direction (STATION station)
POT 100 N 76531.66 E 2094824.90 TD N 16 52 32 E STA 12+00.04

POT n X easting Y northing TD direction (STATION station)
POT 100 X 2094824.66 Y 76531.66 TD N 16 52 32 E STA 12+00.04



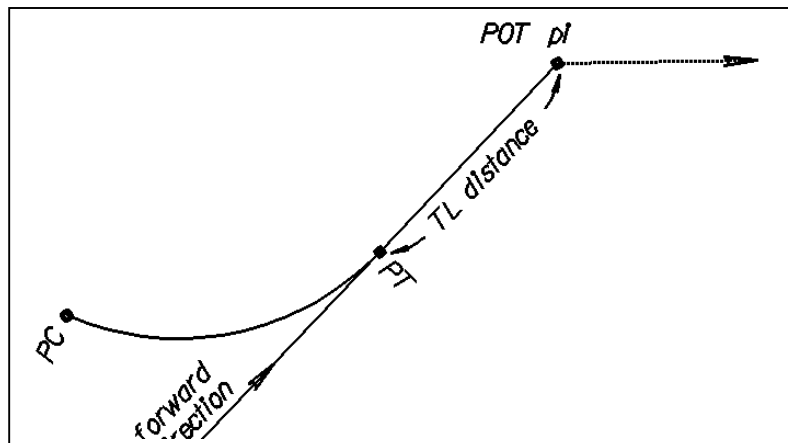
INTERMEDIATE POT COMMAND FOR OPEN ALIGNMENT

The INTERMEDIATE POINT commands represents an intermediate point pi on the open alignment calculated by the distance TL distance and the forward direction from the previous element. **In Format B the direction TL distance is modified by the optional (P/M (DEF) angle).**

FORMAT A

POT pi TL distance

The point pi is calculated
By its TL distance measured
from the previous PT and the
direction given from the
previous element.

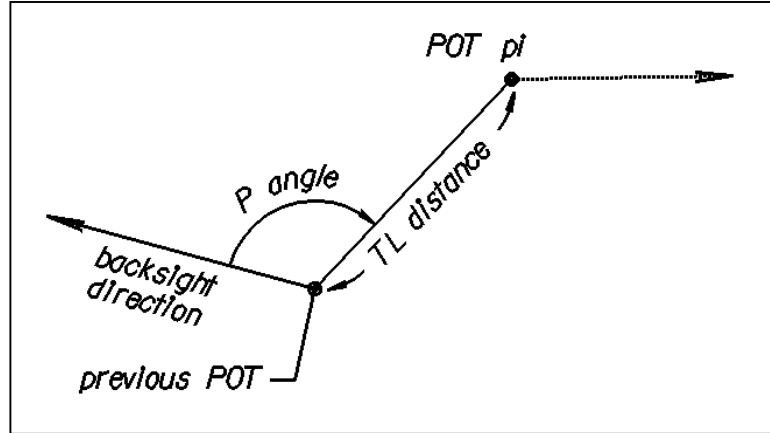


COORDINATE GEOMETRY CONCEPTS

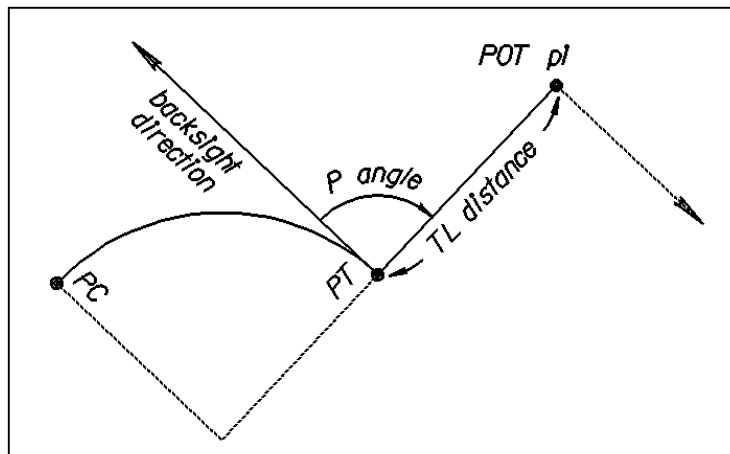
FORMAT B

The point pi is calculated by its TL distance measured from the previous POT and the direction defined via backsight direction plus clockwise angle (P angle)

POT pi (P/M (DEF) angle) TL distance



Or the point pi is calculated by its TL distance measured from the previous PT and the direction defined via backsight direction plus clockwise angle (P angle)



CURVE COMMAND FOR OPEN ALIGNMENT. The curve command creates a new curve name defined by the given data and is linked to the previous element in the chain. There are four FORMATS for curve data.

FORMAT A: The back tangent distance TL, a radius or degree of curve and the (P / M) deflection angle DEF, defines the curve name.

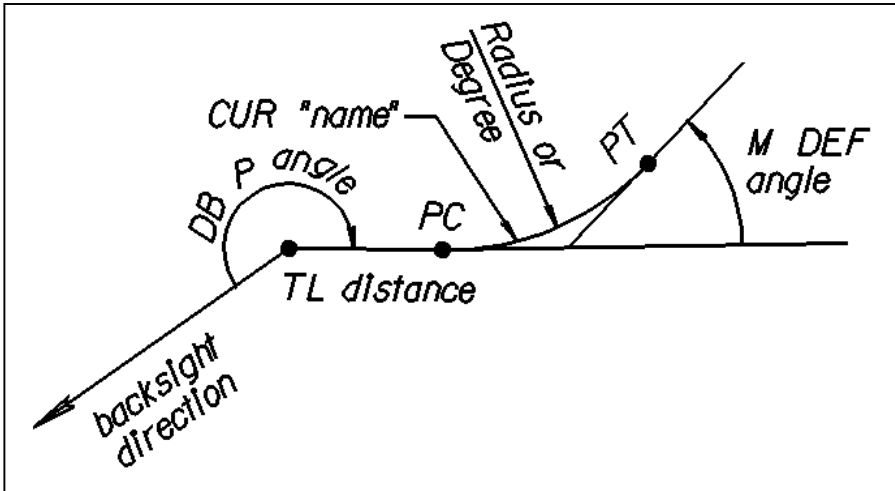
CURve name TL distance [R radius OR D degree] (P / M) DEFLECTION angle
CUR C1 TL 0 R 1909.8593 M DEF 20 05 08.2
CUR C1 TL 0 D 3 00 M DEF 20 05 08.2

Note: TL can be zero if the PC is at the stored point.

COORDINATE GEOMETRY CONCEPTS

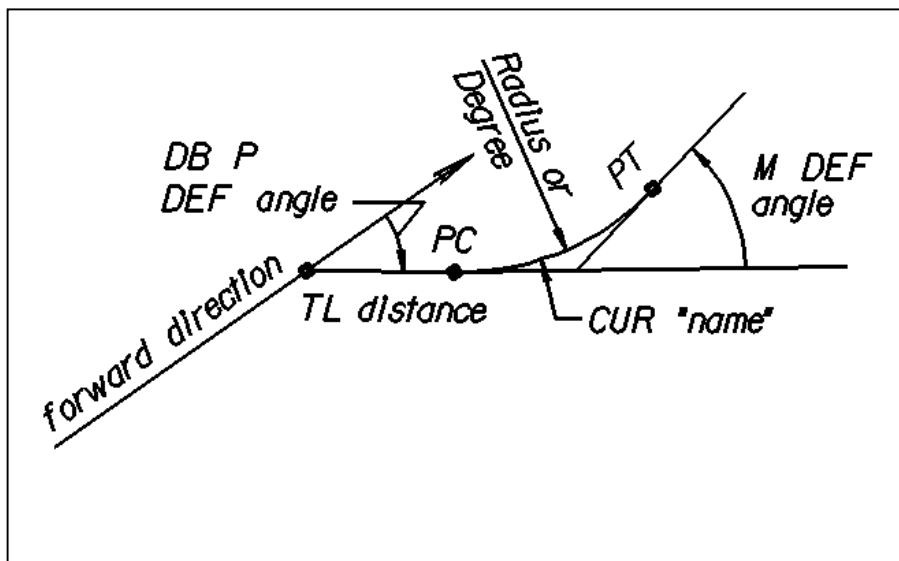
FORMAT B: The curve name is defined by the back tangent distance TL, degree of curve DEG, and minus deflection angle (M DEF angle). The TL is defined via back sight direction to the previous element plus clockwise angle (DB P angle). For further information, refer to drawing on page 9-43, of the manual.

CURve name DB (P/M) DEFlection angle TL distance Radius radius
(P/M) DEFlection angle



FORMAT C: The curve name is defined by the back tangent distance defined by way of forward direction from the previous element plus deflection angle (DB P DEF angle). For information, refer to drawing on page 9-43 of the manual.

CURve name DB (P/M) DEFlection angle TL distance Radius radius (P/M)
DEFlection angle



COORDINATE GEOMETRY CONCEPTS

SPIRAL COMMAND FOR OPEN ALIGNMENT The spiral name commands create a new spiral name defined by the given data. The spiral is then linked to the previous elements of the chain. There are two formats for storing spirals. **FORMAT A: TYPE 2** is the Ahead spiral; **FORMAT B: TYPE 1** is the Back spiral. Refer to drawing pages 9-44 & 45.

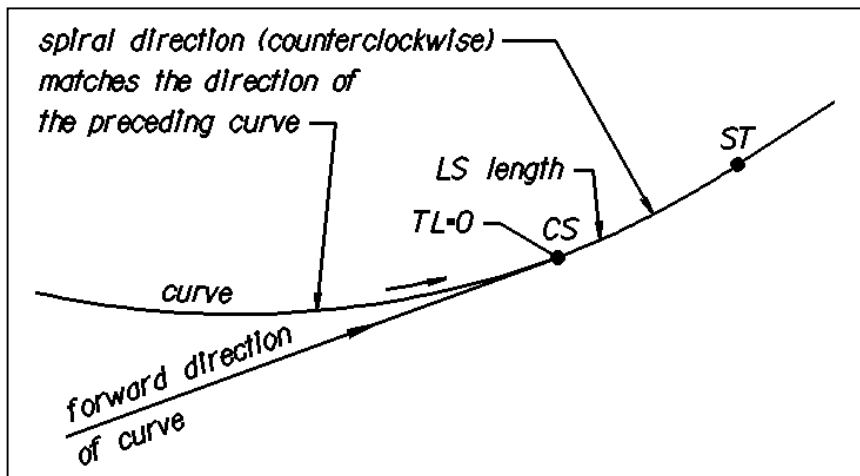
FORMAT A: The back tangent TL, and length of spiral LS, degree DEG of spiral, value TYP value define the spiral name. The direction of TL distance is defined by way of forward direction of previous data (like PI of curve to CS of curve)

SPIral name TL distance LS length (Degree angle TYPe value)

SPI S1 TL 92.67 LS 300 D 2 30 TYP 1 (in spiral)

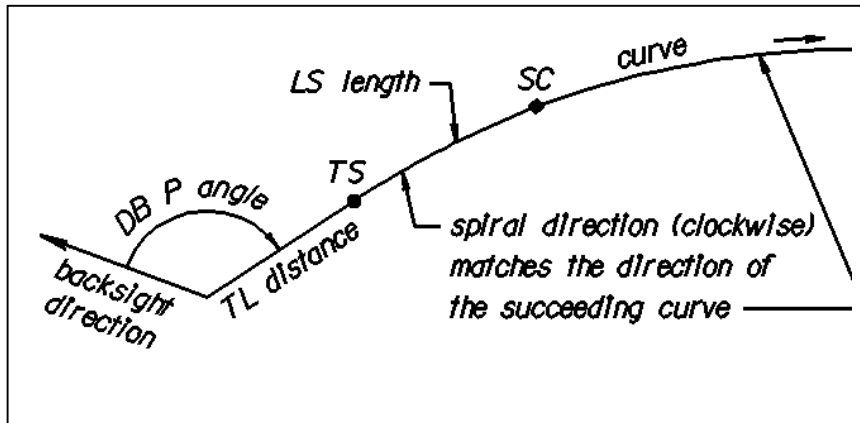
SPI S2 TL 0 LS 300 D 2 30 TYP 2 (out spiral)

Format A



Format B

The back tangent TL and the length of spiral LS define the spiral name. The Direction of TL distance is defined via forward direction of previous data.



The spiral name is defined by the back tangent TL and the length of spiral LS the direction of TL distance is defined via the backsight direction to the previous element plus the clockwise angle (DB P angle).

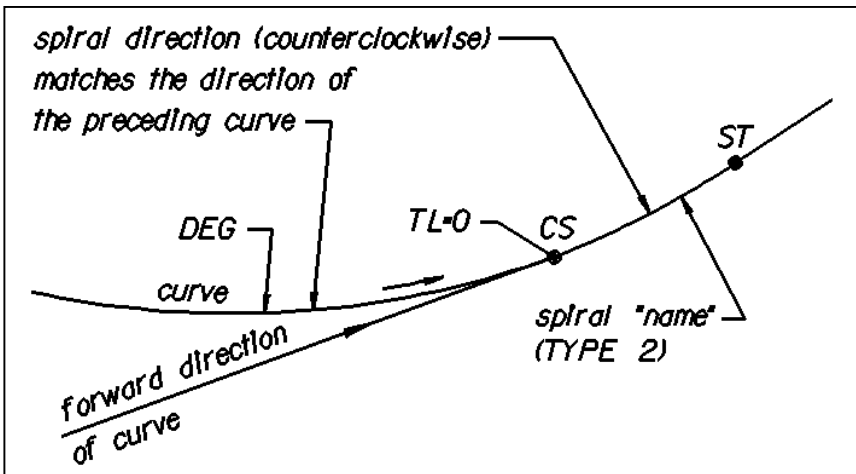
COORDINATE GEOMETRY CONCEPTS

FORMAT B: Optional Degree and Type. The back tangent TL and the length of the spiral LS define the spiral name. The direction of TL distance is defined by way of the back sight direction to the previous element plus the clockwise angle DB P angle.

SPIral name DB (P/M) (DEFlection) angle TL distance LS length
 (Degree angle TYPE value)

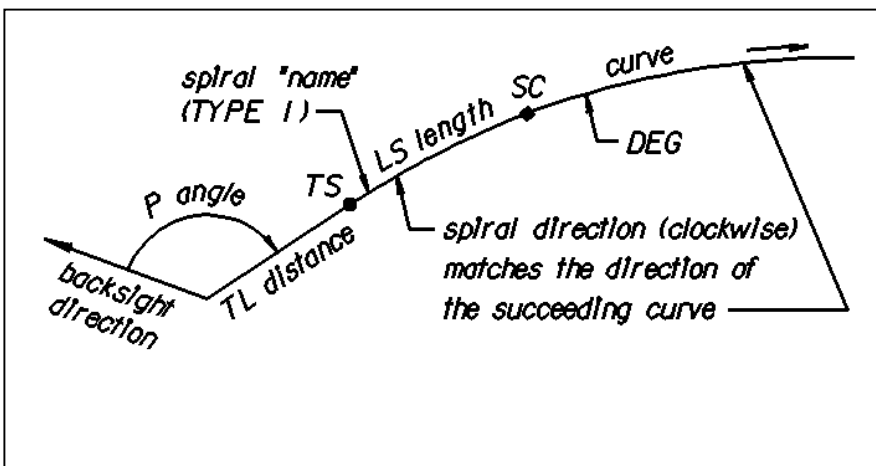
SPI S3 DB 34 45 59 TL 118.87 LS 400 D 2 30 TYP 1 (in spiral)
 SPI S3 DB TL 0 LS 400 D 2 30 TYP 2 (out spiral)

Format A



The back tangent TL, The length of the spiral LS defines the spiral name, the Degree of curvature and type. The direction of TL distance is defined via forward direction of previous data.

Format B



The back tangent TL, the length of the spiral LS defines the spiral name, the Degree of curvature and Type. The direction of the TL distance is defined via the backsight direction to the previous element plus clockwise angle (P angle).

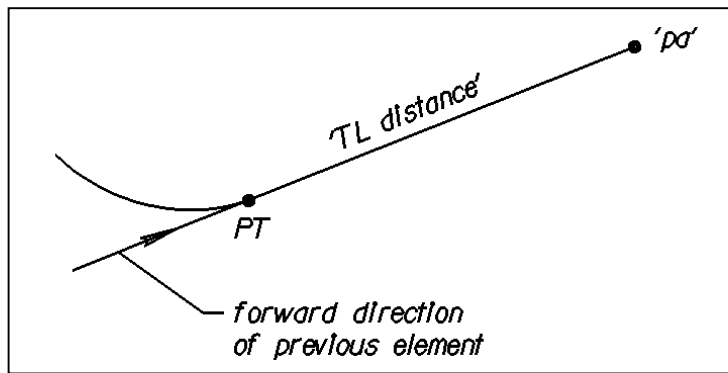
COORDINATE GEOMETRY CONCEPTS

ENDING POT COMMAND FOR OPEN ALIGNMENT The Ending POT command represents the terminal point of the open alignment calculated by its distance TL distance and the forward direction from the previous element.

FORMAT A: the point *pa* is calculated by TL distance measured from the previous PT and direction is defined by way of forward direction from the previous element.

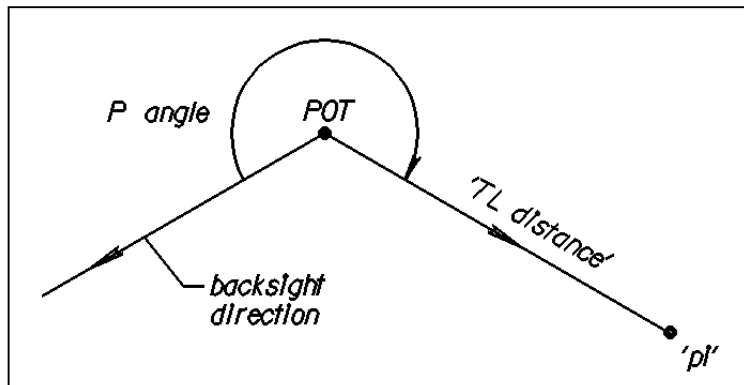
POT pa ((P/M (DEF) angle) TL distance
POT 200 TL 1022.98

POT pi N northing E easting (P/M (DEF) angle) TL distance
POT 200 N 311485.8014 E 2127353.5442 TL 1002.9800



FORMAT B: the point *pi* is calculated by TL distance measured from the previous PT and direction is defined by way of forward direction from the previous element

POT pa TL distance TD direction
POT 200 TL 1022.98 n 67 29 22 w



END ALI COMMAND FOR OPEN ALIGNMENT The end alignment statement is the last statement required in an alignment.

END ALI alignment (name) (DEscribe)
END ALI SURVEY DES

COORDINATE GEOMETRY CONCEPTS

EXERCISES WRITE OPEN ALIGNMENTS FOR THE FOLLOWING

EXERCISE 1 use spiral types

ALIGNMENT "HWY49"

POINT 100 IS N 311046.263 E 2117853.186

THE DISTANCE TO THE SPIRAL IS 3133.8718 N 39 34 53 E

SPIRAL NAME IS S11 AND THE LENGTH IS 500

THERE IS A CURVE C12 AT THE END OF THE SPIRAL WITH A DEG OF 2 30

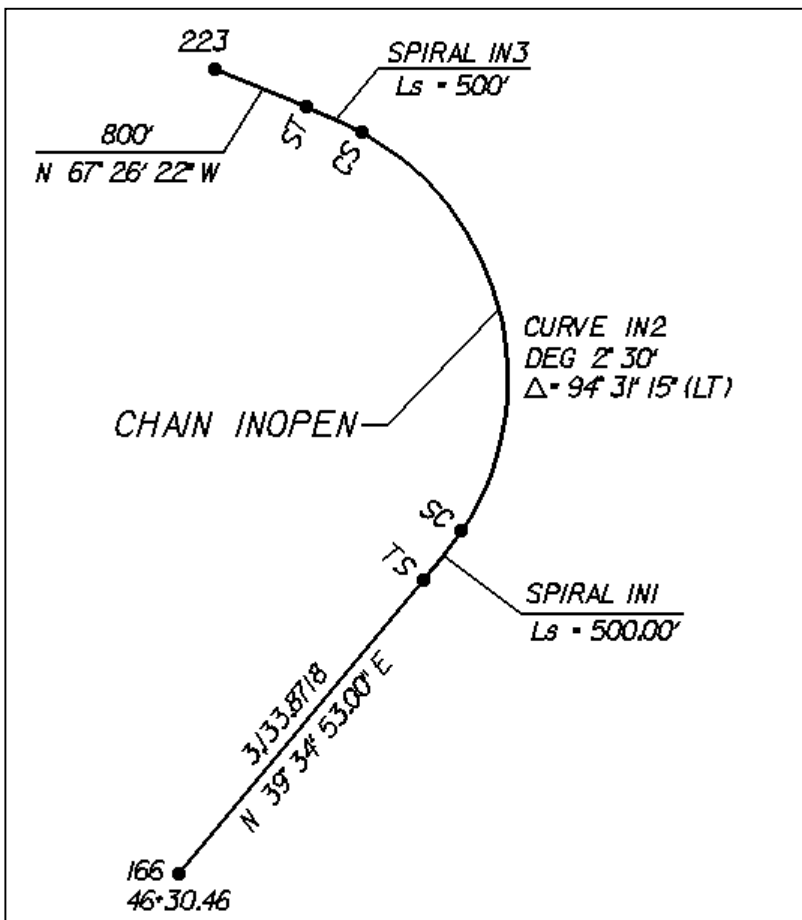
THE DELTA IS 94 31 15 LT

THE ENDING SPIRAL S13 LENGTH IS 500

THE ENDING POINT 200 IS 800 FROM THE END OF THE SPIRAL (ST) AT

N 67 26 22 W

EXERCISE 2 same as exercise 1 without using spiral types, assume 10000,10000 on point 166



The reference is made to the GEOPAK manual, Part II Coordinate Geometry, Chain Commands, Section 9 and to GEOPAK online Help.

COORDINATE GEOMETRY CONCEPTS

INCOMPLETE ALIGNMENT

An incomplete alignment is a chain or alignment with missing elements. The incomplete alignment set of commands permits a chain or alignment to be defined with certain unknowns.

The Incomplete Alignment commands solve the unknown parts of the given alignment, define and store each curve and POT, and generate and store the new chain name. The initial points must be known or redefined by its new coordinates.

One or two unknown distances

One or two unknown directions

One, two, or three unknown angles

One or two unknown radii

(One unknown distance, one unknown direction, one unknown angle or radius)

The program *solves* for the unknowns, to a maximum of three unknowns, *defines* the incomplete (unknown) elements and stores the chain.

NOTE: THREE UNKNOWN DISTANCES IS NOT SUPPORTED

Command Incomplete Alignment structure

ALI name INC	opening command to activate the incomplete alignment
Initial POT command	only required for the initial point
Intermediate POT command	required for each POT (other than initial point)
CURve command	required for each curve
SPIral command	required for each spiral
Ending POT	represents the terminal point of incomplete alignment
END ALIgment command	closing command to start calculation of the missing element(s) and generate new chain

INCOMPLETE ALIGNMENT COMMAND. The Alignment Name Incomplete command is the first statement and activates the incomplete alignment group of commands.

ALIgment name INComplete
ALI L1REV OPEN

COORDINATE GEOMETRY CONCEPTS

INITIAL POINT (POT) COMMAND FOR INCOMPLETE

ALIGNMENT. The initial point command represents the starting point of the new alignment or chain name. There is an optional station command, which if not used will start at 0+00.00

FORMAT A:

POT pa TD direction (STATION station) where pa is a previously stored point
POT 10 TD N 16 52 32 E STA 24+25.36

FORMAT B:

POT n N northing E easting TD distance (STATION station)
POT 100 N 76531.66 E 2094824.90 TD N 16 52 32 E STA 12+00.04

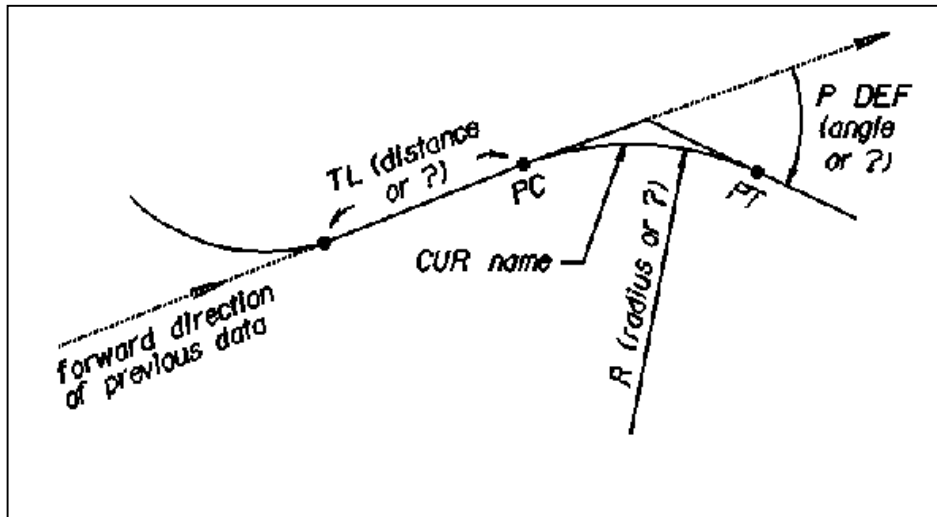
POT n X easting Y northing TD distance (STATION station)
POT 100 X 2094824.66 Y 76531.66 TD N 16 52 32 E STA 12+00.04

CURVE COMMAND FOR INCOMPLETE ALIGNMENT. The curve command creates a new curve name defined by a minimum of three data types: TL (back tangent length), R radius of curvature and (P/M) DEFlection angle (plus or minus the external angle of deflection). The given data and is linked to the previous element in the chain. There are four FORMATS for curve data.

FORMAT A: The back tangent distance (TL), a radius of curve (R) and the (P / M) deflection angle (P DEF angle), defines the curve name.
(The direction of the TL is defined by the forward direction of the previous data.)

CURve name TL distance R radius (P / M) DEFLECTION angle
CUR C1 TL 350 R 1909.8593 P DEF 20 05 08.2
CUR C1 TL 0 R 1909.8593 P DEF 20 05 08.2

Note: TL can be zero if the PC is at the initial point.

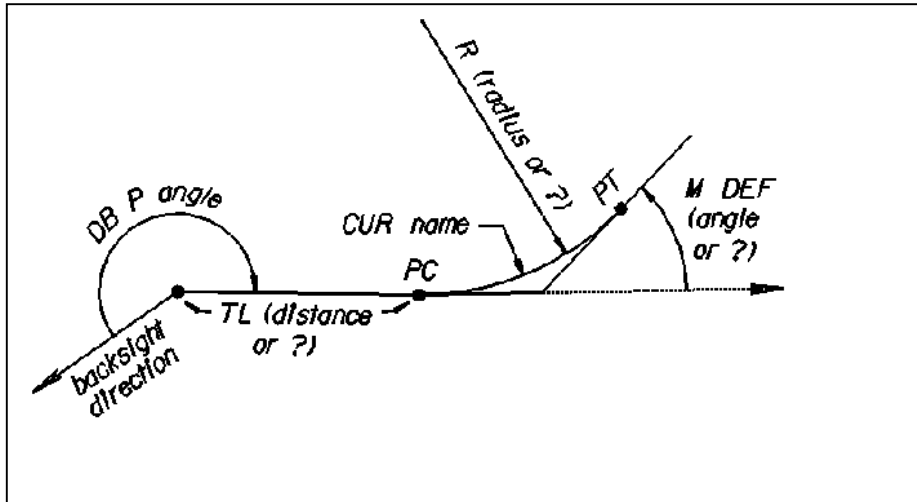


COORDINATE GEOMETRY CONCEPTS

FORMAT B: The curve name is defined by the “*backsight direction*” of the TL to the previous element plus or minus clockwise angle (*DB P angle). The ahead tangent direction is defined by radius of curvature (R), plus or minus deflection angle (*M DEF angle). *See drawing

CURve name DB (P/M) angle TL distance RADIUS radius
(P/M) DEFlection angle

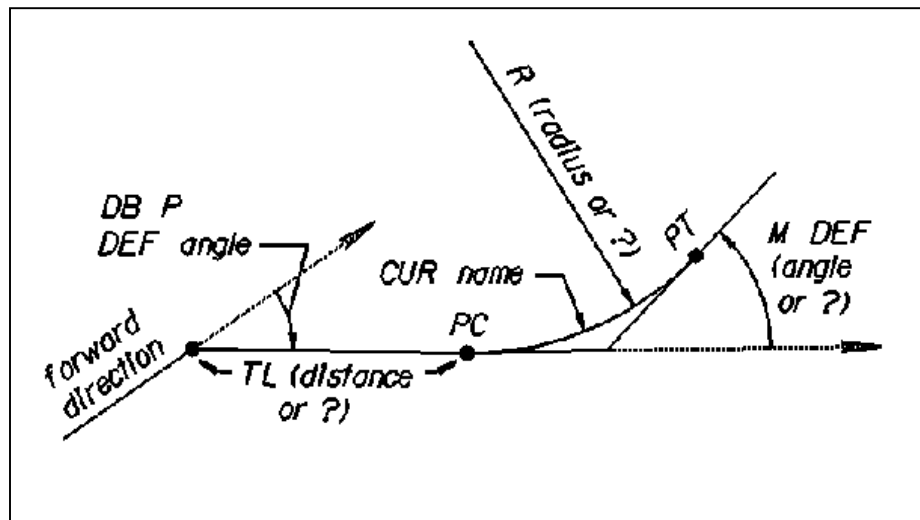
CUR C1 DB P 210 00 00 TL 350.00 R 1909.8593 M DEF 20 05 08.2



FORMAT C: The curve name is defined by the “*forward direction* of the TL distance” from the previous element, plus or minus deflection angle (DB P angle*). The tangent ahead of the TL is defined by radius of curvature and plus or minus deflection angle (M DEF angle*). *See drawing

CURve name DB (P/M) DEFlection angle TL distance Radius radius (P/M)
DEFlection angle

CUR C13 DB P DEF 37 25 30 TL 157.35 R 1525 M DEF 52 35 28

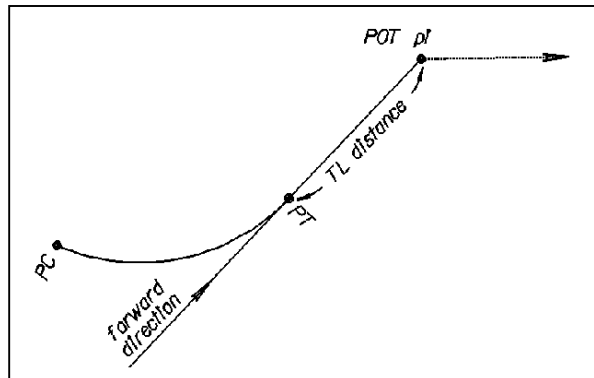


COORDINATE GEOMETRY CONCEPTS

INTERMEDIATE POT COMMAND FOR INCOMPLETE ALIGNMENT. The POT command represents an intermediate point *pi* on the incomplete alignment. It is calculated by its distance (TL distance) and forward direction from the previous element.

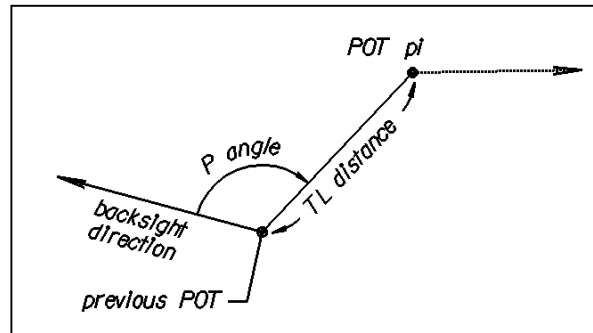
FORMAT A: the *pi* is calculated by its “TL distance”, measured from the previous *PT*, and the direction given from the previous element.

POT pi TL distance
POT 40 TL 340.22



FORMAT B: The *pi* is calculated by its “TL distance”, measured from the previous POT while the direction is defined by way of the backsight direction plus or minus clockwise angle.

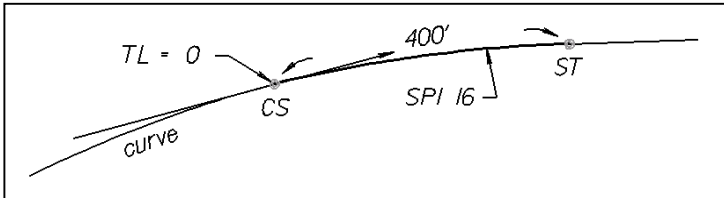
POT pi (P / M) (DEF) angle TL distance
POT 40 P DEF 67 34 25 TL 178.48
POT 40 67 34 25 TL 178.48 ←————— This is iffy, use with caution



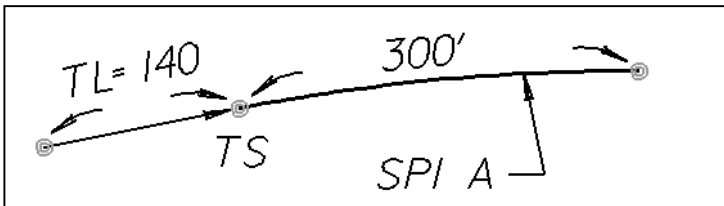
COORDINATE GEOMETRY CONCEPTS

SPIRAL COMMANDS FOR INCOMPLETE ALIGNMENT. The Spiral commands create a new spiral name defined by a minimum of two data types: TL (back tangent length) and LS (length of Spiral. The new spiral is linked to the previous element in the chain to set its position in the alignment.

SPIral name TL distance LS length
SPI S16 TL 0 LS 300



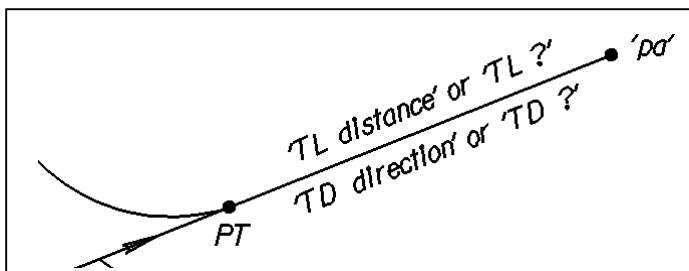
SPI A TL 140 LS 300



ENDING POT COMMAND FOR INCOMPLETE ALIGNMENT. The Ending POT command represents the terminal point of the incomplete alignment and must be a point already stored *pa* or redefined by its coordinates N northing E easting.

FORMAT A: The point *pa* is already stored, TL distance measured from the previous PT and the TD direction is the forward direction from the previous element.

POT pa (P/M (DEF) angle) TL distance TD direction
POT 53 TL 435.28 TD ?
POT 53 TL ? TD PI SPI S16 ST SPI S16

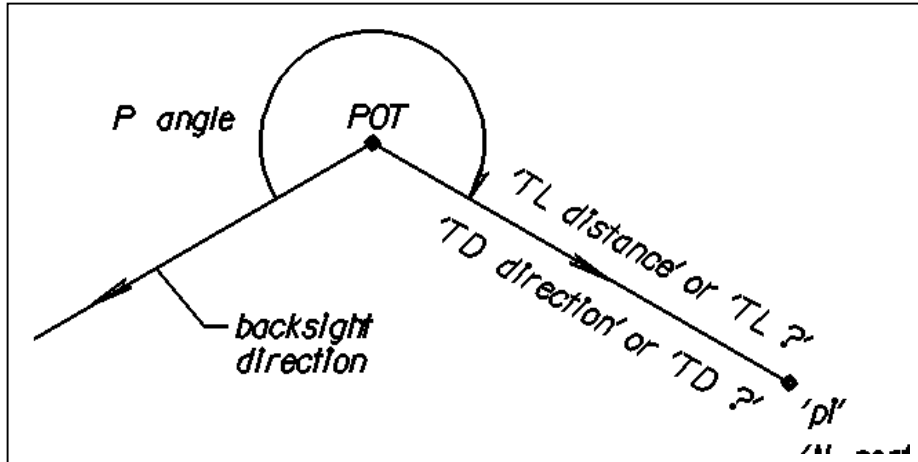


the direction is defined as the PI of a spiral to the ST of the spiral (also curve PI to curve PT)

COORDINATE GEOMETRY CONCEPTS

FORMAT B: The ending point is redefined by its coordinates N northing E easting, TL distance measured from the previous POT, and TD direction is defined by the backsight direction to a previous element plus or minus clockwise angle (*P angle).

POT pi N northing E easting (P/M (DEF) angle) TL distance TD direction
POT 56 N 967352.1710 E 2399059.2480 TL ? TD ?



END INCOMPLETE ALIGNMENT COMMAND AND DESCRIBE CHAIN. The End Alignment command initiates the calculation process of the new chain name computes unknowns, stores curves, POT's and chain, then deactivates the incomplete alignment definition. Format C describes the chain name as stored.

FORMAT A:
END ALIGNment

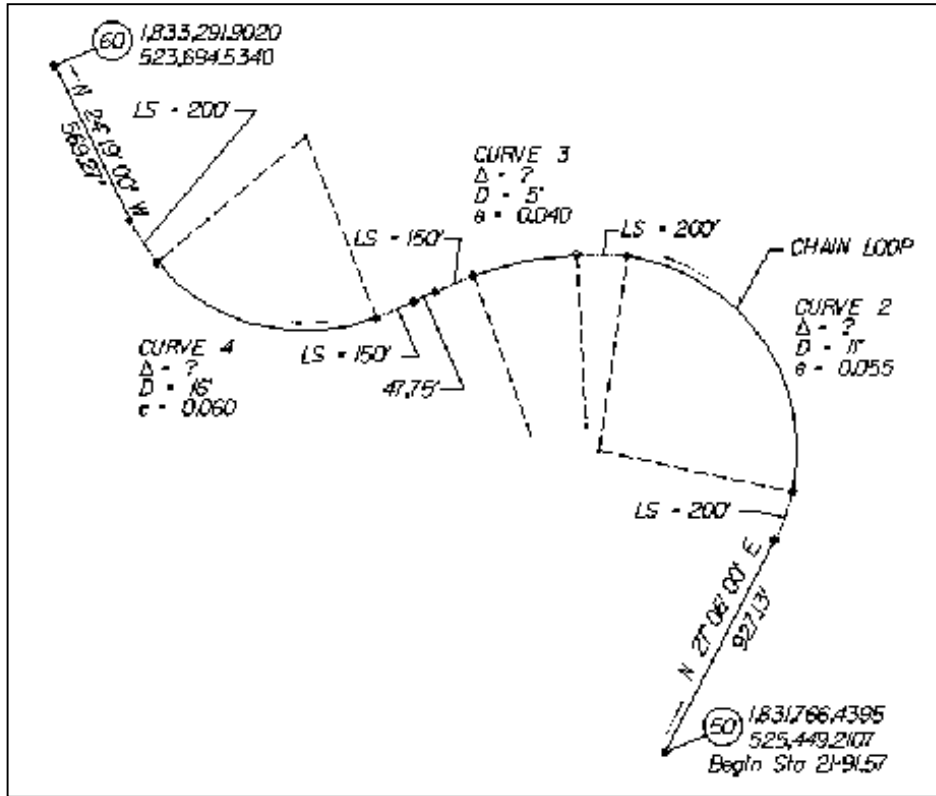
FORMAT B:
END ALIGNment name

FORMAT C:
END ALIGNment name DEScribe

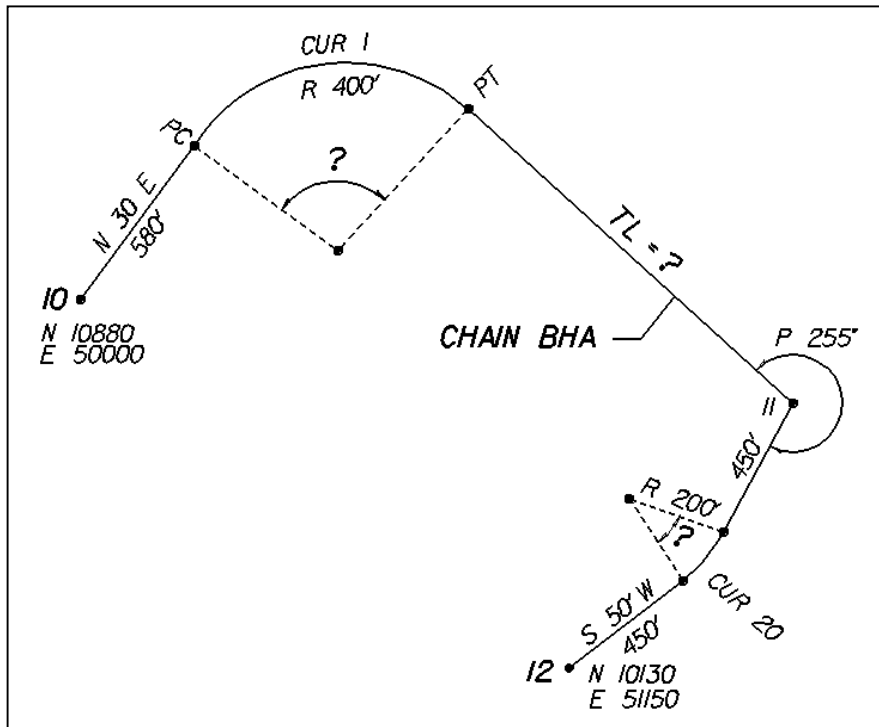
COORDINATE GEOMETRY CONCEPTS

WRITE COMMAND LINES FOR THE INCOMPLETE ALIGNMENTS FOR THE EXAMPLES SHOWN

EXAMPLE 3



EXAMPLE 4



COORDINATE GEOMETRY CONCEPTS

INVERSE ALIGNMENT

The Inverse Alignment command creates and stores a new chain name where the coordinates of POT's and PI's are known, and one given element of a circular curve may be inserted between to tangents. The direction of these tangents may be adjusted to an even value of minutes or seconds.

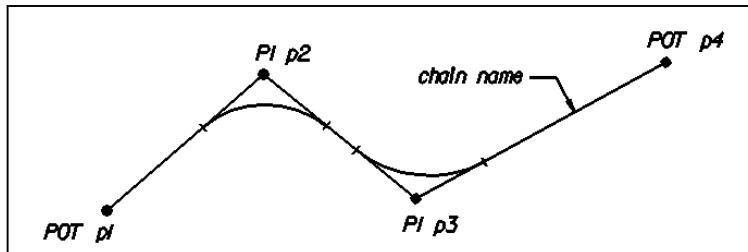
INVERSE ALIGNMENT STRUCTURE

ALI name INV	opening command to activate the inverse alignment
POT command	required for each POT
CURve command	required for each curve
END ALIGNment command	closing command to initiate the calculation process and generate the new chain "name by orderly linking the given elements

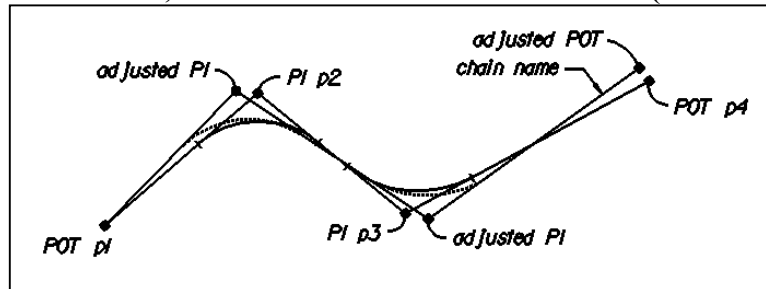
ALI name INV for INVERSE ALIGNMENT. The ALI name INV command activates the inverse alignment group of commands and is the first statement required to generate the new 'chain name'. (ROU value SEC) or (ROU value MIN) defines the rounding to be applied to the directions of the given tangent between POT's or PI's.

FORMAT A: POT's and curve PI's remain unchanged during the calculation

ALIGNment name INVerse



FORMAT B or C: The directions of the tangents are adjusted to the nearest even value of minutes or seconds, and POT's and PI's are redefined (first POT, p1 is unchanged).



FORMAT B OR C

ALIGNment name INVerse round value SECond

ALIGNment name INVerse round value MINutes

COORDINATE GEOMETRY CONCEPTS

POT COMMAND FOR INVERSE ALIGNMENT. The POT commands define the starting and ending point of the new alignment or chain name, as well as any intermediate intersection point without a circular curve.

FORMAT A: PI's $p1$, $p2$, and $p3$ defined by point already stored

POT pa (**FIX**) (**STATION station**)

POT 10 STA 10+00.00

this is the default command

FORMAT B: POT pi is redefined with it coordinates N northing E easting.
Coordinated may be adjusted when the ROUND option is present.

POT pi N northing E easting (**FIX**) (**STATION station**)

POT 20 N 967352.1710 E 2399059.2480

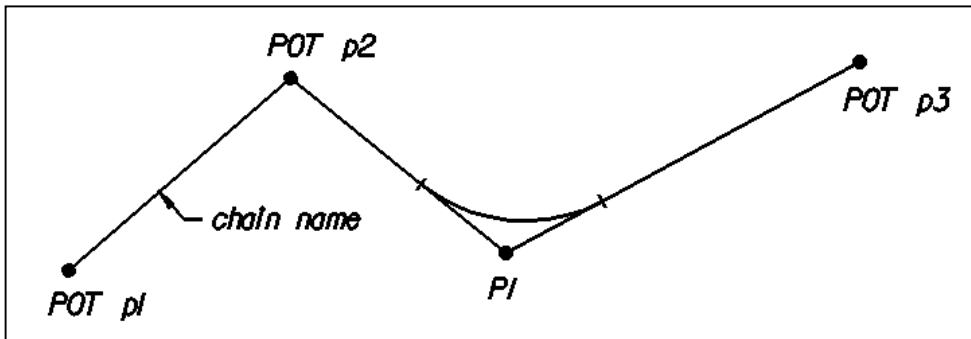
this is the default command

Optional 'FIX'

FORMAT A: POT's $p1$, $p2$, and $p3$ are defined by points already stored. *The coordinates are fixed when the ROUND option is present.*

POT pa (**FIX**)

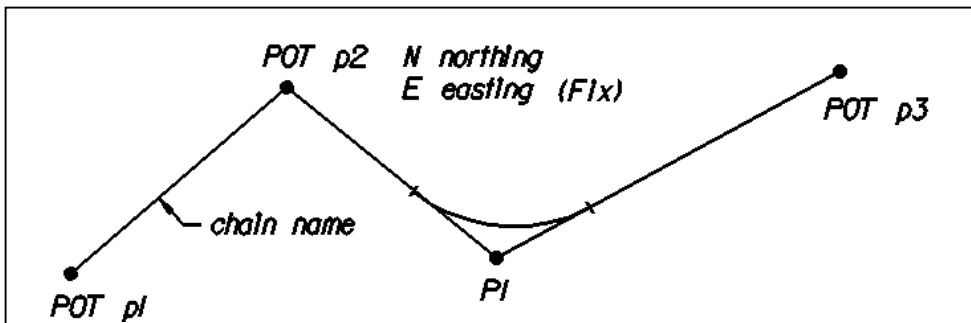
POT 10 FIX STA 10+00.00



FORMAT B: POT pi is redefined with it coordinates N northing E easting.
Coordinated are fixed when the ROUND option is present.

POT pi N northing E easting (**FIX**) (**STATION station**)

POT 20 N 967352.1710 E 2399059.2480 FIX

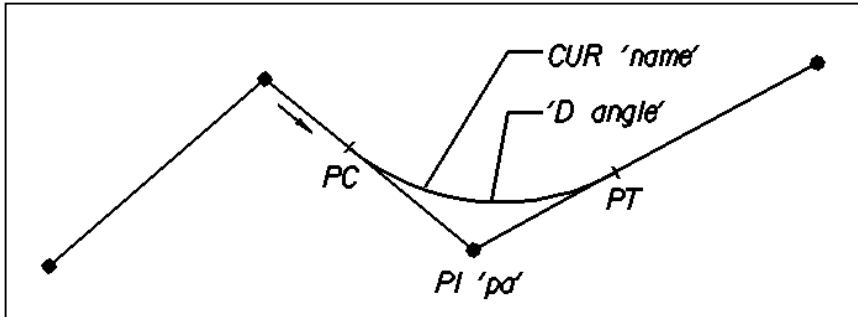


COORDINATE GEOMETRY CONCEPTS

CURVE NAME COMMAND FOR INVERSE ALIGNMENT The Curve Name command defines a new curve 'name' at *PI pa* by inserting an arc between the two tangents with a radius given or derived from *angle Degree* or *distance Length*.

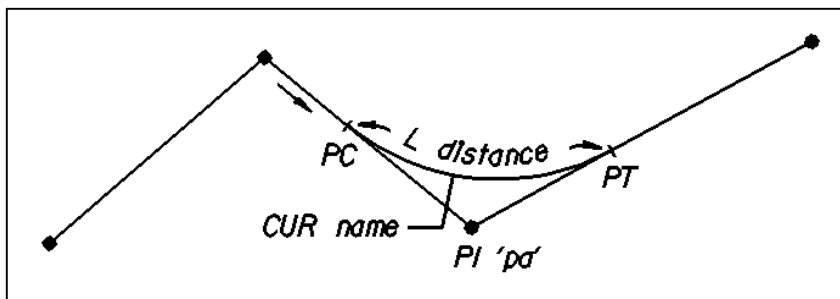
FORMAT A: The curve Name is defined with the degree of curvature *D angle* inserted between the two tangents at previous stored *PI pa*.

CURve name PI pa (FIX) Degree angle
CUR C12 PI 20 D 2 30



FORMAT B: The curve name is defined with the arc *L distance* inserted between the two tangents at previously stored *PI pa*. *XY coordinates can also be utilized if the GEOPAK user preferences are set to XY*. This PI may be adjusted when the **ROUND** option is used and **FIX** is not used.

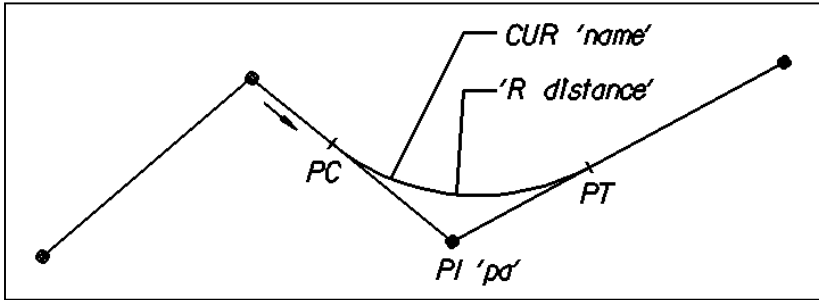
CURve name PI pa (FIX) Length distance
CUR C12 PI 29 L 275.68



COORDINATE GEOMETRY CONCEPTS

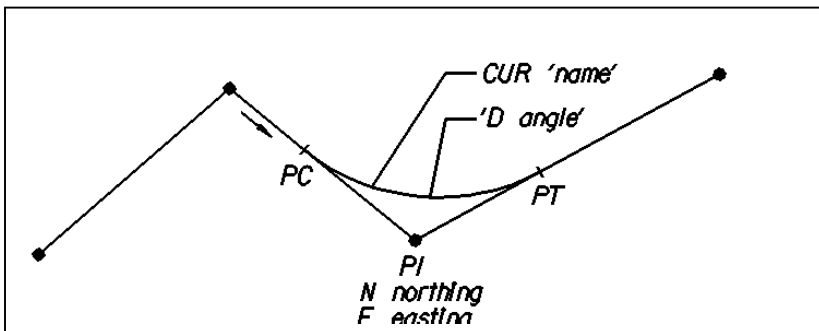
FORMAT C: The curve name is defined with the radius of curvature R distance inserted between the two tangents at previously stored PI pa. This PI may be adjusted when the ROUND option is present and FIX is not given.

<u>CURve name</u>	<u>PI pa</u>	<u>(FIX)</u>	<u>Radius distance</u>
CUR C12	PI 29		R 400



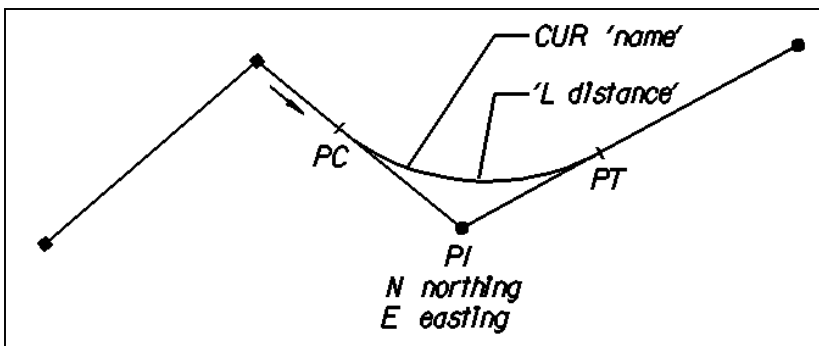
FORMAT D: The curve name is defined with the degree of curvature D angle inserted between the two tangents at PI redefined with its new coordinates N northing, E easting. This PI may be adjusted when the ROUND option is present and FIX is not given.

<u>CURve name</u>	<u>PI N northing E easting</u>	<u>(FIX)</u>	<u>Degree angle</u>
CUR C12	PI N 5010208 E 11000100		D 34 43 00



FORMAT E: The curve name is defined with the length of the arc L distance inserted between the two tangents at PI redefined with its new coordinates N northing E easting. This PI may be adjusted when the ROUND option is present and FIX is not given.

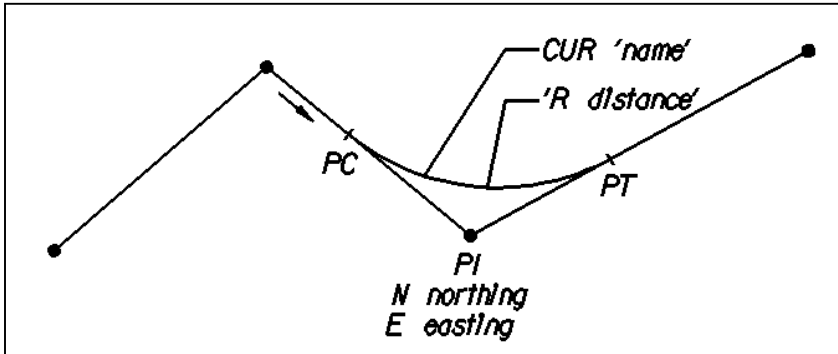
<u>CURve name</u>	<u>PI N northing E easting</u>	<u>(FIX)</u>	<u>Length distance</u>
CUR C12	PI N 5010208 E 11000100		L 275.68



COORDINATE GEOMETRY CONCEPTS

FORMAT F: The curve name is defined with the radius of curvature R distance inserted between the two tangents at PI redefined with its new coordinates N northing e easting. This PI may be adjusted when the ROUND option is present and FIX is not given.

CURve name PI N northing E easting (FIX) Radius distance
 CUR C12 PI N 5010208 E 11000100 R 400



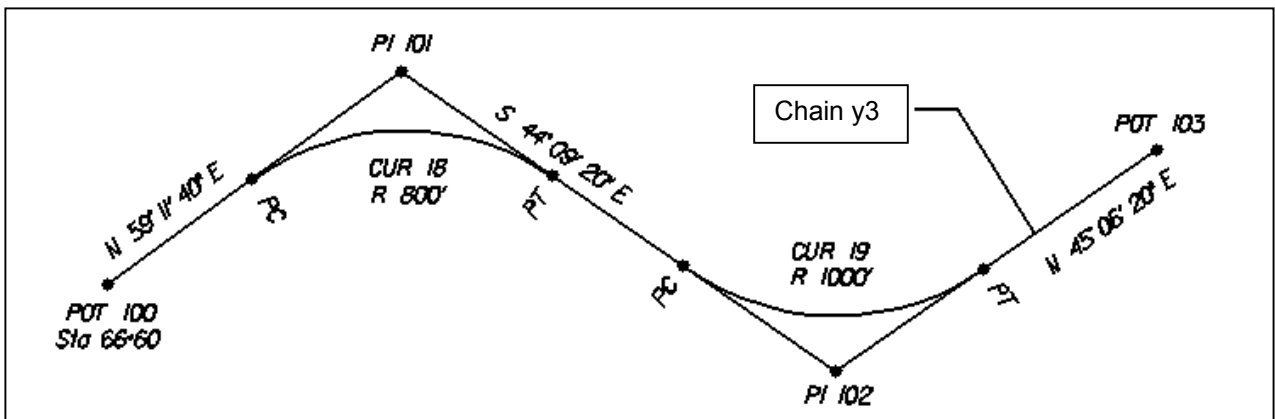
END ALIGNMENT COMMAND FOR ALIGNMENT. The END ALI command initiates the calculation process of the new chain name with or without rounding, stored curves, POT's and chain and deactivates the inverse alignment definition. Format C also describes the chain name as stored.

FORMAT A: END ALIgnment

FORMAT B: END ALIgnment name

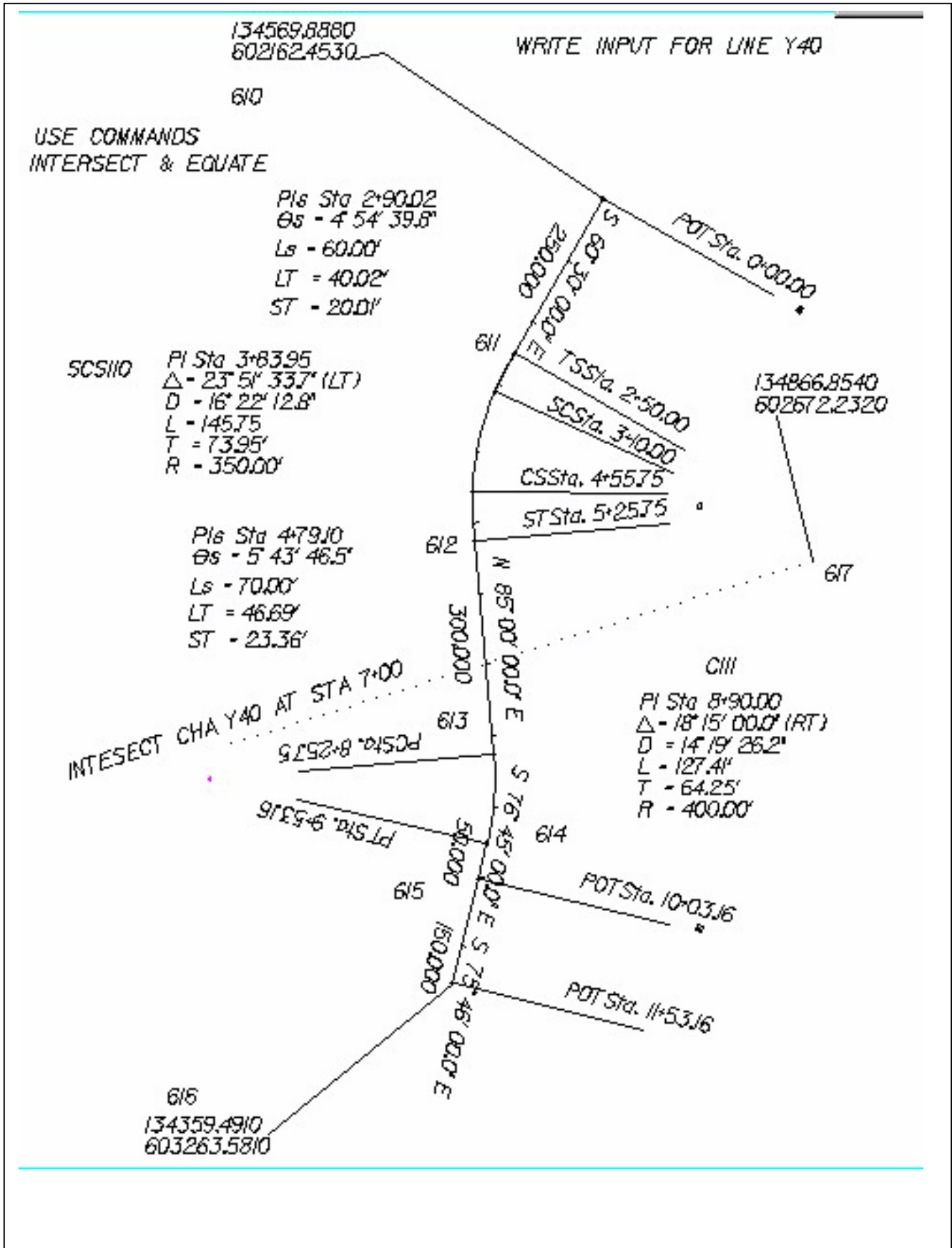
FORMAT C: END ALIgnment name DEscribe

EXERCISE 5: WRITE ALIGNMENT FOR THIS CHAIN Y3



NOTE : 100 TO 101 IS 1789; 101 TO 102 IS 1923; AND 102 TO 103 IS 2100

COORDINATE GEOMETRY CONCEPTS



COORDINATE GEOMETRY CONCEPTS

COGO Intrinsic Precision

There is a very small section of the GEOPAK manual, which is often overlooked. Yet prudent usage of the features documented there add significantly to the power and flexibility of GEOPAK COGO. Although they are covered in the Beginning GEOPAK Course, they are covered here in more detail. Since the concepts here are somewhat complex, they must be practiced in order to be learned well enough to use them regularly.

The word “slot” used in the following context refers to pieces of the COGO command. For example a locate command

LOCATE n (TRAVERSE) pa (DISTANCE) distance direction (OFFSET offset)

The words and letters in lower case represent user-supplied values. n and pa are points, the distance , direction, and offset are real numbers. As you will see shortly, you can fill in these values by referring to other points. So when you use an integer number to refer to pa, the integer goes in that “slot”.

Referring to Bearings or Distance from Previously Stored Points

If two or more points are already stored in the .gpk file, you may name a bearing or distance by referring to these pre-existing points. For example, you know that point 2 lies N 32 57 18.32 E from point 1 at a distance of 273.110. If you want to locate point 3 from point 2 at that same bearing. You could enter

LOC 3 2 100.00 N 32 57 18.32 e

It would be simpler, though, to enter the bearing by referring to the existing point:

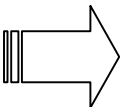
LOC 3 2 100.00 1 to 2

In this example, the text “1 to 2” is interpreted by GEOPAK as the bearing from 1 to 2 because it is the bearing “slot”.

If you put the “1 to 2” statement in the distance “slot” of the command, it will be interpreted as a distance.

LOC 4 3 1 to 2 s 80 w

“1 to 2” in this line would be interpreted as a distance of 273.110



LOC 4 3 1 to 2 1 to 2

“1 to 2” in this line would be interpreted as a distance in that “slot” and bearing in that “slot”

COORDINATE GEOMETRY CONCEPTS

Arithmetic in Bearings and Distances

You can put arithmetic in the bearing and the distance “slot”. Although you can multiply and divide, the most useful forms for us are the P for plus and M for minus. Since GEOPAK is free form notation, you can use arithmetic to modify regular bearing notations such as

N 17 56 01.12 w m 90

This equals

S 72 03 58.88 w

Or you can combine the point to point method with arithmetic. If for example, the bearing from point 11 to 43 equals N 45 E then

11 to 43 p 10 is interpreted by GEOPAK as N 55 E.

Naming Points for Curves and Spirals

GEOPAK curve elements and GEOPAK spiral elements each has “intrinsic value points”, which are stored in the .gpk file each time one of these elements is stored. For example, every curve has a PI. By virtue of the fact that the PI has a northing and easting, it is a point. (*The same is true for the point of curve PC, the point of tangent PT, every point on the curve POC, the center of the curve or radius point CC.*) This means you can use a PI (or any other intrinsic point) in the same way as you use other points. The great advantage of this is that these points automatically change when the element they define change. This can be a time saver if you are in the process of developing an alignment.

At the time of this writing of this course outline, intrinsic point reference is not in the GEOPAK manual. Here is a list of intrinsic points and syntax for curves.

<u>Intrinsic Point</u>	<u>Syntax</u>
Curve PI	PI <i>name</i>
Curve PC	PC <i>name</i>
Curve PT	PT <i>name</i>
Curve Center	CC <i>name</i>
Spiral TS	TS <i>name</i>
Spiral SC	SC <i>name</i>
Spiral CS	CS <i>name</i>
Spiral ST	ST <i>name</i>
Spiral PI	PIS <i>name</i>

COORDINATE GEOMETRY CONCEPTS

The items in the syntax column are what go into the point “slot” in any GEOPAK command. For example, one could say

LOC 12 from 5 DIS 53.001 s 17 26 w

Where 5 is in the pa “slot”. If the need were there, you could then write

LOC 12 PT YC2 53.001 s 17 26 w

in which (PT y2C2) is now in the pa “slot”.



The statement, locate point 12 at a distance of 53.001 units, from PT of curve Y2C2 at a bearing of S 17 26 W. if the location of curve Y2C2 changes at a later time for some reason, point 12 does not automatically follow it. The command must be re-read. However, after the re-reading takes place the relationship is restored.

Putting It All Together

Taken separately, the two topics of “arithmetic in Bearings and Distances” and “Naming Points from Curves and Spirals” are rather limited. However, when the two are used in conjunction with each other, their power and utility become evident.

Here is how it works. Point to point syntax used in a Bearing (or Distance) “slot” as {pa to pb}. As we learned, intrinsic can be put into point “slots”. So to refer to the “direction ahead” bearing on a pre-existing curve (named LC3), you can say “PI LC3 TO PT LC3”. To refer to the long chord distance of curve RBC1, enter “PC RBC1 TO PT RBC1” in a command’s distance “slot”.

Below is a list of curve and spiral components and the syntax to use at the COGO command line.

<u>Command</u>	<u>Syntax</u>
Curve back tangent	PC <i>name</i> TO PI <i>name</i>
Curve Ahead Tangent	PI <i>name</i> TO PT <i>name</i>
Line from PC to Curve Center	CC <i>name</i> TO CC <i>name</i>
Line from Curve Center to PC	CC <i>name</i> TO PC <i>name</i>
Type I Spiral Long Tangent	TS <i>name</i> TO PIS <i>name</i>
Type I Spiral Short Tangent	PIS <i>name</i> TO SC <i>name</i>
Type II Spiral Short Tangent	CS <i>name</i> TO PIS <i>name</i>
Type II Spiral Long Tangent	PIS <i>name</i> TO ST <i>name</i>

A simple example – one form of the curve command is as follows

STO CUR name PC pa DB direction R radius P/M DEF delta

COORDINATE GEOMETRY CONCEPTS

Let us say you are building an alignment and you already have curve RCC1 stored. You now want to store RCC2 with a PRC from RCC1. From other design decisions, $R = 150$ and $\Delta = 11$ degrees and 30 minutes right. In order to utilize the COGO Intrinsic Precision techniques here you could store RCC2 with the statement.

**STO CUR RCC2 PC PT RCC1 DB PI RCC1 TO PT RCC1 R 150
DEF 11 30**

Compare this statement with the general form found on page 14 of the curve information. We used Option 1 for the back tangent reference.

An example of intrinsic values to store a curve with only five known points: The PC, PI, PT, a point on the curve, and the radius point.

Stored point 1 is the PC
Stored point 2 is the PI
Stored point 3 is the PT
Stored point 4 is point on the curve
Stored point 5 is the radius point

[1]STOre CURve name [2]Back Tangent reference [3]Element
[4A or 4B]Ahead Tangent Reference [5]STATION Station label station

STO CUR CC3 PC 1 DB 1 TO 2 RAD 1 TO 5 DA 2 TO 3 STA 4+00

THE BACK TANGENT IS DEFINE PC 1 DB PC TO PI "1 TO 2"
RADIUS IS FROM PC TO THE CENTER OF THE CURVE (CC) "1 TO 5"
AND THE AHEAD TANGENT REFERENCE (DA) IS PI TO PT "2 TO 3"
OR DA IS POINT AHEAD "PA 3"