PC Based Interactive SPS Conversion Software

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Introduction

Oil & gas exploration is increasingly becoming complicated and different types of seismic surveys are being conducted regularly to support such exploration. Processing of data acquired during seismic surveys, are depending upon the field parameters in many ways. These requirements of processing are fulfilled by storing the parameters in internationally accepted formats. This storing facility not only supports the processing need but also creates the possibility to store them for future requirements. Thus this facility is called Shell Processing Support (SPS) and is very effective to arrange the seismic parameters data into files, formatted in a specific layout called SPS format [Appendix 3,4,5]. These files can be transferred from one computer to another very easily. These seismic parameters include the field geometry, shot / receiver point information, elevation, static corrections etc.. Now a days the processing of the seismic data requires the presence of these files and thus their generation are increasingly becoming more and more important. Here we shall discuss about a PC based package, which takes seismic acquisition parameters in input and generates the SPS formatted files. This package was designed in PC based Microsoft Windows-XP environment so that it can work with data stored in widely used data entry spread sheet MS-EXCEL, which is commonly used to store data in the Geophysical Field Parties of ONGC.

It was observed that the observer reports of the geophysical field parties are stored in MS EXCEL workbook. The main objective of this package is to generate the SPS data interactively as per user requirements using the information stored in MS EXCEL worksheets which are created from observer reports in field itself. This PC based package is developed in-house, it is portable to any PC installation (processor PII and above with minimum 128 RAM & presence of M/S EXCEL s/w.) and may be used for generating the SPS files for currently acquired seismic data. Thus it is easy to consider each and every details of the data acquisition. Since the package has a few inbuilt checks of data in process, the mistakes performed in data entry of the observer reports or the incorrect description of the complicated situations of acquisition may be suitably corrected in the field itself while generating the SPS data. The erroneous entry of coordinates or wrong entries of the recovery shot points are a few examples of such errors. This is an important aspect of this s/w. Thus SPS converted data may be used in the 2D/3D seismic data processing as well as in various other s/w like Geoland etc for better checking of the acquisition parameters for quality control. Presently this s/w has the capability to convert in to SPS format with a few logical as well as visual checks. These checks enable the user to control conversion procedure in a better way.

Software

The package was developed using VC++, VB and PC based Fortran language and uses common utilities of windows O/S. It also has the facility to extract some parameters from SPS data. This conversion program has mainly two modes of processing for converting the data into SPS format.

1. Preprocessing
2. SPS Conversion

Initially the user is required to process the preprocessing mode of execution and thereafter SPS conversion will convert the data.

There are other menus corresponding to different modes of execution of the s/w mostly dedicated to check and correct the errors present in the input data as well as output data.

Preprocessing Mode Of Execution:

This is the initial mode of execution and it interacts with the user to finally generate a control file, which is in turn internally used in SPS conversion. The control file contains the information about various acquisition parameters, the values of which were fetched from the user in this phase of processing. This process starts with a dialog box for accepting the type of the data (2D or 3D) to process. Once the type of data is selected, the next dialog box is displayed to accept the general information which takes the values of the crucial processing parameters from user and stores them in a control file. This general information dialog box determines the presence of various parameters

Fig. 1 : Dialog box for general information

in the EXCEL sheet.[Fig. 1] It requires description of parameters like Swath / Line No,Datum depth in meters, Datum Row No in EXCEL sheet, Data Starting Row No, Geophone Interval, Shooting type etc.. The actual parameter data are stored in specified formats. These formats are of two types :

a). EXCEL sheet format for data recorded with one recording instrument (one tape drive),
b). EXCEL sheet format for data recording with two recording instruments (two tape drives).

The details of these formats are given in Appendix 1 & 2. Since we have two types of formats of input data stored in EXCEL sheet, this program has also two separate versions to read these data. These specific versions are called automatically by the SPS conversion program depending upon the number of recording instruments used in the acquisition. In the initial invocation, the program selects the EXCEL file and then it reads the file. The reading status will be displayed by a scrolling indicator.[Fig. 2A]. Once the reading of the EXCEL file is over, the final reading status will be displayed in the window with the information about No. of rows read. User has to click the done button to finish the reading procedure. [Fig. 2B]. After this, the program also asks the information about the receiver channel assignment. For further processing the complete reading of the EXCEL file is very important.

The data is read and stored in internal temporary data set for SPS conversion. If some problem occurs in reading the file, the EXCEL file should be checked carefully

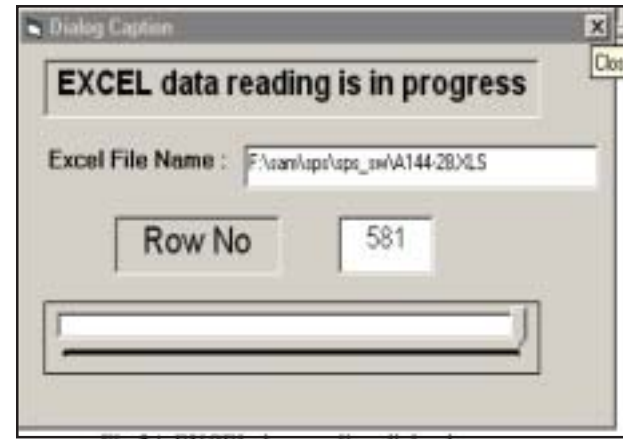


Fig.2a: EXCEL data reading dialog box

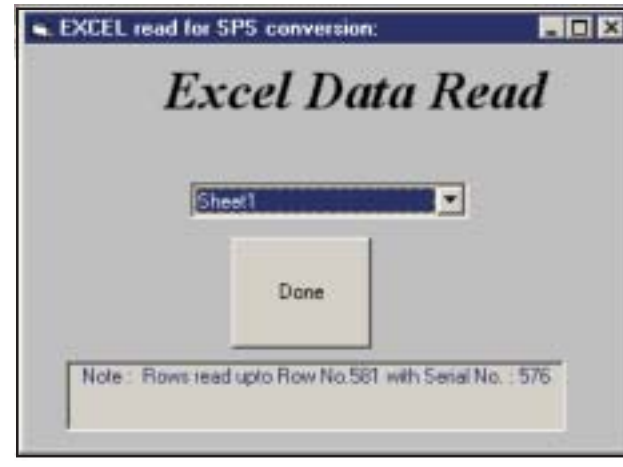


Fig.2b : EXCEL data reading status

and corrected.

Once this is over the creation of the control file is over and the program is ready for SPS conversion . This ends the preprocessing stage. The next step of processing is the actual SPS Conversion.

SPS conversion

This stage of processing converts the information fetched in the preprocessing stage in to SPS formatted data files and some visual and logical checks are provided to check / verify the validity of the converted data.

It requires the control file, which was created in the preprocessing stage. The program writes the output files in the user specified directory.

Three types of output files are generated in the conversion process [Appendix 3,4 & 5]. They are generated differently in different mode of execution:

1). One instrument recording mode will create the files: sps.s1, sps.r, sps.x1.
2). Two instrument recording mode mode will create the files: sps.s1, sps.s2, sps.r, sps.x1, sps.x2 and subsequent processing merges the s- files and x- files in to corresponding one s- file and one x- file.

In case of some error in data, the corresponding error messages are stored in data set which may be viewed by the menu Error Messages .

Add SPS files menu item invokes a program module which combines the source (s1 & s2) and geometry relational (x1 & x2) files generated after SPS conversion process in two instrument mode (two tape drive mode). In fact it combines sps.s1 & sps.s2 files to sps.s1 file and sps.x1 & sps.x2 files to sps.x1 file. These files may be used for further processing.

The sps data may be viewed with the help of the menu item View files. [Fig. 3]

Fig. 3 : View menu for sps data.

Display Lines menu invokes a program module to display the lines on screen either from sps shot data (sps.s1) or receiver data (sps.r). The easting and northing coordinates will be displayed on both the x & y axis of the plot. In the case of shot data display, the shot points are displayed on the plot. The line numbers will be displayed at the edge of each line. The plot may be enlarged by selecting the values of horizontal and vertical multiplier coefficient more than 1. This is a tool for visual check for creation of the sps data. If some error occurs in generating the coordinates, it will be displayed on the plot of the lines. [Fig. 4]

If these coordinates are not available in the sps data, the corresponding line will not be displayed, instead the program will display error.

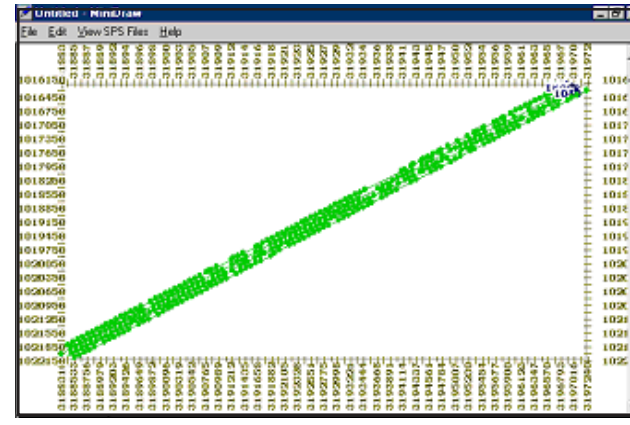


Fig. 4. Display of shot lines from sps.s1 file.

If some problem occurs with the coordinates or they are not available in input data, they may be corrected with the help of the "Coordinate Interpolation" menu of the program.

While generating sps data the module checks the validity of the shot and receiver picket nos. If it detects some error in these nos, it indicates these errors in a file. This file may be viewed by clicking the menu item Error message. It is recommended that this file with errors may be checked after each sps generation process. If the coordinates for some pickets are not provided in the input file, then the "*" will appear in the sps files and this data is not valid. It is observed that the coordinates for the pickets are not supplied in the input data and thus in the output sps data, in the place of coordinates, stars (*) are appearing. In this package there is a possibility to restore the coordinates for every picket if they are available on some pickets (at least on two points of same line and one point in other line). In this case, the user is recommended to process such data with the menu item Coordinate interpolation. The interpolation process requires the grid origin and azimuth angles to perform the interpolation process. These above said two parameters are calculated from the supplied coordinates of at least three points (two points in same line and one point on other line) of the swath (3D data) / line (2Ddata). Once these are determined, then subsequently corresponding bin sizes are also calculated. Now with the help of the control coordinates, their picket numbers and line numbers, the coordinates of other points of same/other lines are determined. After such processing, the coordinates are interpolated and spread over all the pickets. In this interpolation process, the module checks the direction of the frame of reference with the help of azimuth angles and if this frame is tilted with an angle from desired frame of reference, the program indicates that angle of difference to

the user. The user is supposed to correct the coordinates to abolish the difference in angle. Apart from that, the module indicates the coordinates of resulting frame and the grid information to process. In the definition of the grid file, the two sets of azimuth angles and bin sizes are given. One of them will appear as commented information. The module indicates the situation and suggests the user to choose one of these grids as the correct grid of reference.

The output file from this module is generated in the same directory of input file with same name but the extension suffixed with "_modified". If the angle of difference in direction is greater than plus or minus 5 degree then the coordinates of shots or receivers may be rechecked carefully to correct them. Otherwise the resulting frame of reference should be stored in a specific control file and it may be used while processing with the menu Dynamic Frame Interpolation. In this mode of processing the coordinates of shots and receivers are reformed according to the given frame of reference. It is important to mention that in a specified 3D area, each and every swath should be processed with same frame of reference. In that case, while processing with Coordinate interpolation menu, if the resulting frame indicated is different from the desired frame of reference, then the data should be processed with reference to the desired frame of reference by the Dynamic Frame Interpolation menu. This is very important aspect of the sps data processing procedure for 3D data.

It is further observed that if the coordinates supplied by the users are deviated from the correct position by a few meters away erroneously, then this aspect also may be checked by the menu item Detection of errors in meters. This processing will produce the errors in specifying the coordinates of the Shot Points OR Receiver Points in meters. The errors thus specified may be viewed by the menu view the errors in meters and they may be corrected manually in sps files.

In seismic data, it is frequently found that the file numbers are duplicated. In processing these duplicate files create a serious problem and they are to be separated and renumbered before processing. For this purpose, after generation of the sps files the relational file (sps.x1) may be processed with the menu Repeat list of files and selected range of records. This processing will produce not only the list of duplicated files but it generates a list of useful files. This list excludes all NTBC and other nonseismic files present in the data.

To process these sps files in Geovecteur package, there is a need to create the job for processing in a specific format. This package creates this job for processing and regenerates all the sps files. For this processing, the menu Create Job for Geofile is used. The files thus created are ready to process in Geovecteur package.

The package also provides the facilities to extract the values of the elevation, static corrections and coordinate values from SPS data under the menu Data Extraction.

The Help menu provides the detailed online help about the program and its working procedures.

Conclusion

This package provides the user a simple facility to quickly validate and convert the seismic parameters into SPS format. Since this package is designed to work under windows environment of personal computers, it can be easily ported to any remote Geophysical Field Party and thus provides the various tools for validation of the seismic parameters in the field itself.

Acknowledgement

Author expresses his gratitude to Shri G. Sarvesam, G.M.(Geoph.), Head Geophysical Services, A&AA Basin, Jorhat for showing keen interest and the continuous encouragement while developing the s/w. Author is thankful to Dr. D,V,R, Murty, Head RCC, A&AA Basin, Jorhat and Dr. B.R Yadav,DGM (Prog.) for alloting this interesting and challenging project, and providing all the required data and facilities for developing this s/w package. Author is also thankful to S/Shri P.K.Srivastav, C.G.(S), M.K.Mathur, Manager (Prog), Polash Bora, Senior Programmer for providing many technical ideas and materials for this development. He expresses thanks to S/Shri R. Mohan DGM.(Prog.) , Brajesh Das S.G.(S), Prabhash Ghosh, Senior Progammer and the members of the Data Archival System, A&AA Basin, Jorhat for extensively testing the package and for providing the valuable suggestions for improvement of the package.

Views expressed in this paper are that of the author(s) only and may not necessarily be of ONGC.

APPENDIX–1.
EXCEL sheet format for one instrument (tape) drive

The format of the input data file (MS-Excel) of this software must be as described below (for single tape drive case) :

Control rows:

1. **Cell-1 (First row, First column)** should contain the swath number.
2. **Cell-2 (Second row, First column)** should contain the datum.
3. **Cell-3 (Third row, First column)** should contain the Receiver Channel Assignment.
   This has three types of assignments, but one of them widely used and in the program type one is enabled. It has a specific format:
   line No1.(1st ch.-last ch.),line No2.(1st ch.-last ch.),line No3.(1st ch.-last ch.), ...

Example:
104(1-60),105(61-120),106(121-180),107(181-240)

4. The Fourth and Fifth row should contain the header of the data (The first column should not be blank).

Data rows:

Data usually start from the sixth row. The structure of the data must be exactly as described in the table :

Column Number	Field Description
1#	Sl. No.
2#	Line No.
3#	Pkt No.
4	Shot Pt. (Shot Point No. = Line Number*10000 + Pkt No., e.g., 63*10000+15 = 630015)
5	SP Recovery (= Line No*10000 + Pkt No.)
6	Reel No.
7#	File No.
8#	First Channel
9#	Last Channel
10	Northing
11	Easting
12	Elevation. (m)
13	Uphole Time (ms)
14	Shot Hole Depth (m)
15	Dw
16	Vw
17	Vsw
18	Shot Statics
19	Receiver Statics
20	Charge (kg.)
21#	Remarks (must be entered in all the rows, and value should be '0')

Note : # Fields are mandatory.

APPENDIX –2.
EXCEL sheet format for two instruments (tape) drives

The format of the input data file (MS-Excel) of this software must be as described below (for single tape drive) :

Control rows:

1. **Cell-1** (First row, First column) should contain the swath/ line number.
2. **Cell-2** (Second row, First column) should contain the datum.
3. **Cell-3** (Third row, First column) should contain the Receiver Channel Assignment.
   This has three types of assignments, but one of them widely used and in the program type one is enabled. It has a specific format:
   line No1.(1st ch.-last ch.),line No2.(1st ch.-last ch.),line No3.(1st ch.-last ch.), ...
   Example:
   104(1-60),105(61-120),106(121-180),107(181-240)
4. The Fourth and Fifth row should contain the header of the data (The first column should not be blank).

Data rows:

Data usually start from the sixth row. The structure of the data must be exactly as described in the table :-

Column Number	Field Description
1#	Sl. No.
2#	Line No.
3#	Pkt No.
4	Shot Pt. (Shot Point No. = Line Number*10000 + Pkt No., e.g., 63*10000+15 = 630015)
5	SP Recovery (= Line No*10000 + Pkt No.)
6	Reel No. -1
7	Reel No -2
8#	File No. -1
9#	File No -2
10#	First Channel
11#	Last Channel
12	Northing
13	Easting
14	Elevation. (m)
15	Uphole Time (ms)
16	Shot Hole Depth (m)
17	Dw
18	Vw
19	Vsw
20	Shot Statics
21	Receiver Statics
22	Charge (kg.)
23#	Remarks (must be entered in all the rows, and value should be '0')

Note: # Fields are mandatory.

APPENDIX –3.

The **SPS Source file** is as follows:

H26 CREATION TIME OF THIS FILE: 09:59:05 ,Thursday, 26 August 20
H26 FILE CREATED BY USER: PC USER
H26 FILE SPS TYPE " S "
H26 SPS GENERATED AT GSD ERBC JORHAT ONGC
H26
H26

H26 DEFINITION OF FIELD	COLS	FORMAT	UNITS
H26 Record identification	1- 1	A1	#
H26 Line name	2-17	4A4	#
H26 Point number	18-25	2A4	#
H26 Point index	26-26	I1	#
H26 Point code	27-28	A2	# "NOT EXACT"
H26 Static correction	29-32	I4	Msec
H26 Point depth	33-36	F4.1	Metre
H26 Seismic datum	37-40	I4	Metre
H26 Uphole time	41-42	I2	Msec
H26 Water depth	43-46	F4.1	Metre
H26 Map grid easting	47-55	F9.1	#
H26 Map grid northing	56-65	F10.1	#
H26 Surface elevation	66-71	F6.1	Metre
H26 Day of year (julian day)	72-74	I3	# not coded (As Std Convention)
H26 Time (hhmmss)	75-80	3I2	# not coded (As Std Convention)
H26 Recovery shot line number	73-76	I4	
H26 Recovery shot pkt number	77-80	I4	indicates physical position

H26
H26 CONVENTION FOR RECOVERY SHOTS FOR 3D
H26 line & pkt nos of the designated (original) point will be written
H26 easting & northing of the recovered point will be written
H26
H26 Statics correction are to be added with SIGN
H26

```
H26      1         2         3         4         5         6         7         8
H26      5678901234567890123456789012345678901234567890123456789012345678901234567890
S   113   3541E1    012.0     9116      3214601.3 1016292.6 100.0     113 354
S   113   3581E1    -112.0    9116      3214787.0 1016367.2 101.0     113 358
S   113   3621E1    -212.0    9115      3214972.5 1016441.7 101.0     113 362
S   113   3661E1    -212.0    9121      3215158.0 1016516.3 101.0     113 366
S   113   3701E1    -412.0    9122      3215343.5 1016590.9 102.0     113 370
S   113   3741E1    -4 9.0    9113      3215529.3 1016665.5 101.0     113 374
S   113   3781E1    -5 9.0    9122      3215714.8 1016740.0 102.0     113 378
S   113   3821E1    -1 9.0    9115      3215900.3 1016814.6 100.0     113 382
S   113   3861E1    -510.0    9121      3216086.0 1016889.2 103.0     113 386
S   113   3901E1    -410.0    9117      3216271.5 1016963.8 102.0     113 390
S   113   3941E1    -212.0    9120      3216457.0 1017038.3 103.0     113 394
S   113   3981E1    -6 9.0    9114      3216642.5 1017112.9 104.0     113 398
```

APPENDIX –4.

The **SPS Reciever file** is as follows:

```
H26 CREATION TIME OF THIS FILE:     14:18:53 ,Tuesday, 2 August 2005
H26 FILE created by USER: PC USER
H26 FILE SPS TYPE " R "
H26
H26 SPS GENERATED AT GSD ERBC JORHAT ONGC
H26
H26
H26 DEFINITION OF FIELD             COLS        FORMAT      UNITS
H26 Record identification           1- 1        A1          #
H26 Line name                       2-17        4A4         #
H26 Point number                    18-25       2A4         #
H26 Point index                     26-26       I1          #
H26 Point code                      27-28       A2          # "NOT EXACT"
H26 Static correction               29-32       I4          Msec
H26 Point depth                     33-36       F4.1        Metre
H26 Seismic datum                   37-40       I4          Metre
H26 Uphole time                     41-42       I2          Msec
H26 Water depth                     43-46       F4.1        Metre
H26 Map grid easting                47-55       F9.1        #
H26 Map grid northing               56-65       F10.1       #
H26 Surface elevation               66-71       F6.1        Metre
H26 Day of year (julian day)        72-74       I3          # not coded
H26 Time (hhmmss)                   75-80       3I2         # not coded
H26
H26
H26 Statics correction are to be added with SIGN
H26
H26      1         2         3         4         5         6         7         8
H26      5678901234567890123456789012345678901234567890123456789012345678901234567890
R   42    11G4      0         0         3022185.0 781105.8  17.0      42        1
R   42    21G4      0         0         3022221.8 781090.0  17.0      42        2
R   42    31G4      0         0         3022258.5 781074.1  17.0      42        3
```

R	42	41G4	0	0	3022295.0	781058.3	16.0	42	4
R	42	51G4	0	0	3022331.8	781042.4	16.0	42	5
R	42	61G4	0	0	3022368.5	781026.6	15.0	42	6
R	42	71G4	0	0	3022405.3	781010.7	15.0	42	7
R	42	81G4	0	0	3022441.8	780994.9	15.0	42	8
R	42	91G4	0	0	3022478.5	780979.0	15.0	42	9

APPENDIX –5.

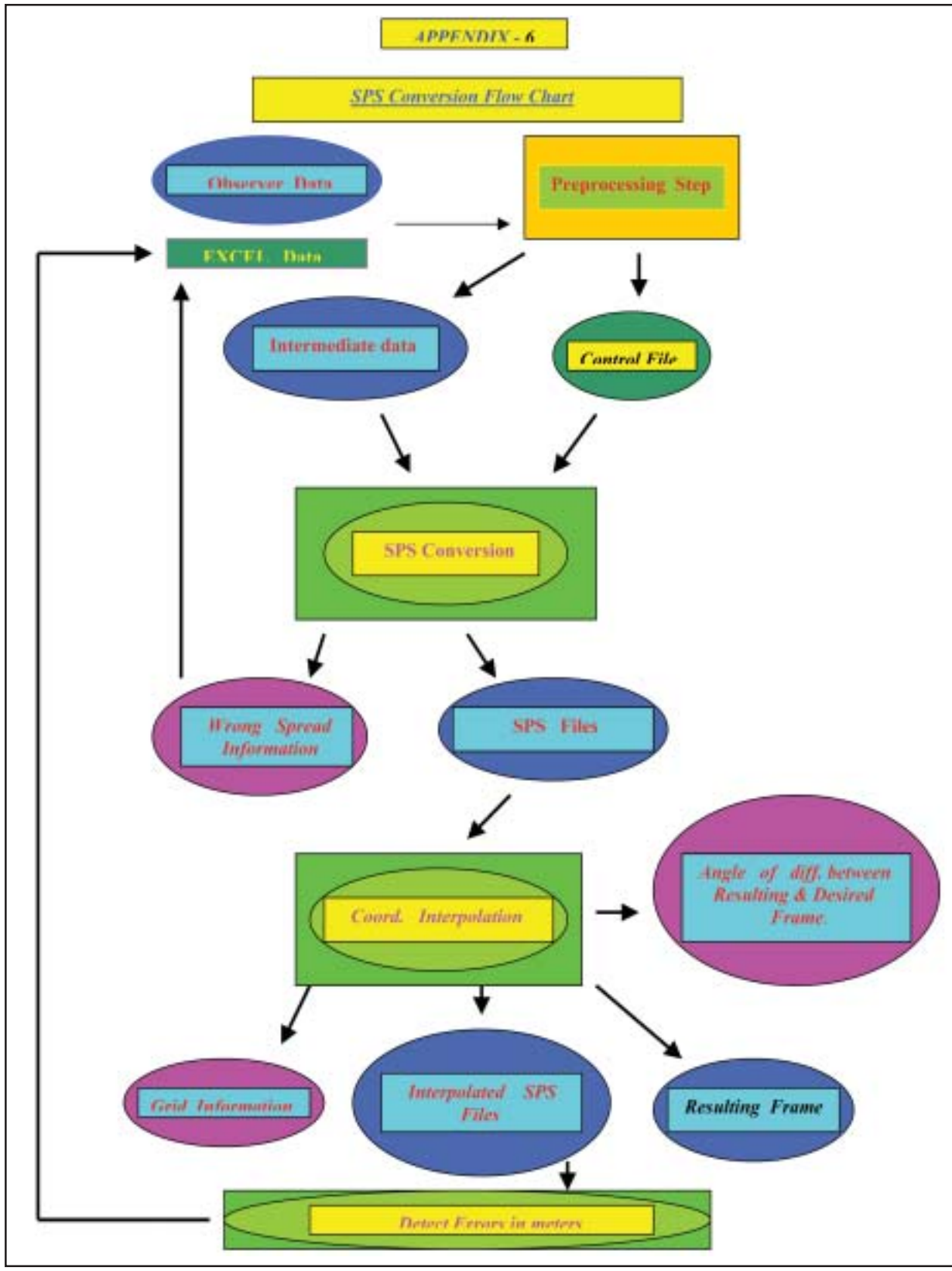
The **SPS Geometry file** is as follows:

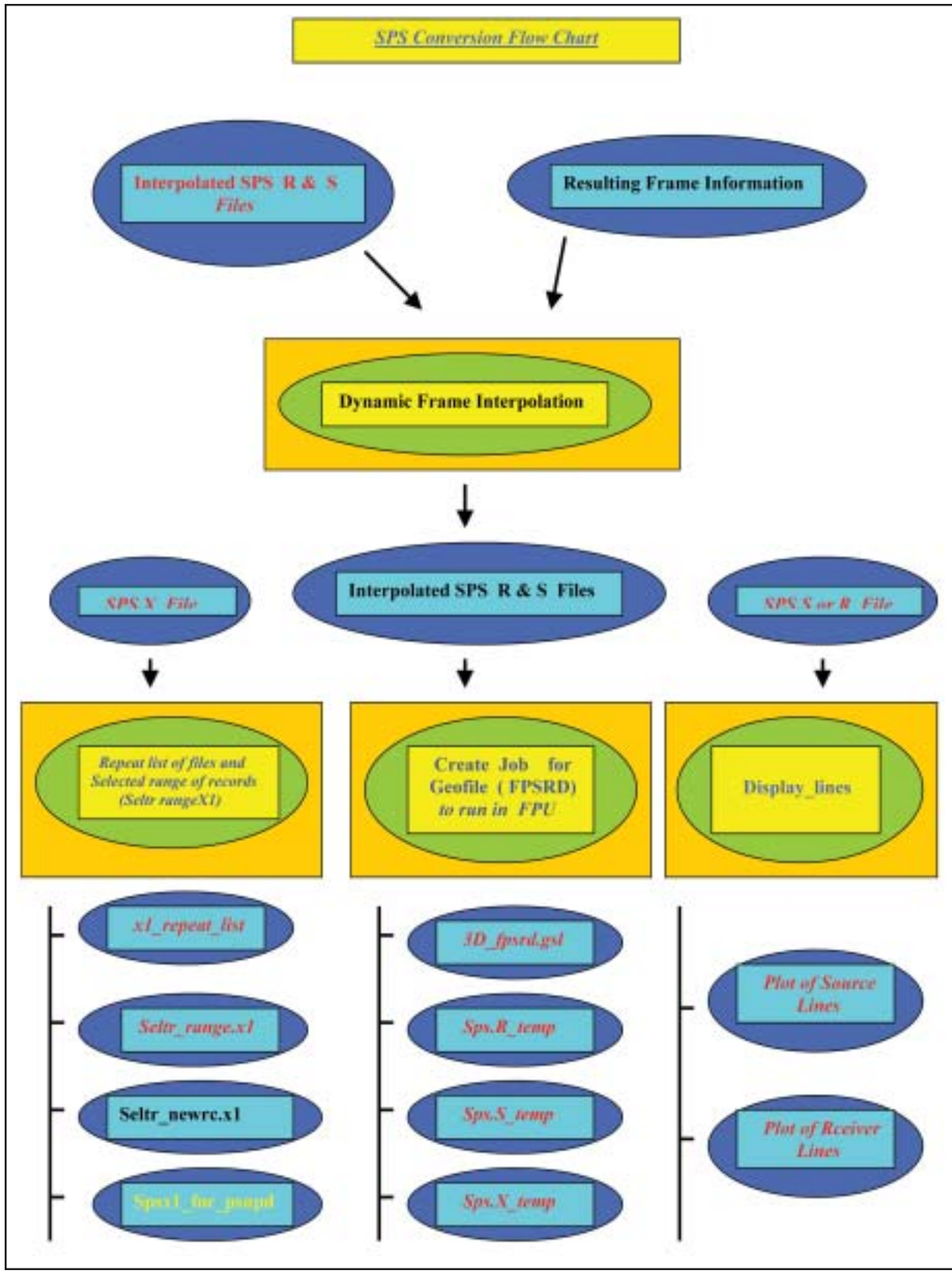
H26 CREATION TIME OF THIS FILE: 09:59:05 ,Thursday, 26 August 2004
H26 FILE CREATED BY USER:sps: at sp1jor_s
H26 FILE SPS TYPE " X "
H26
H26 SPS GENERATED AT GSD ERBC JORHAT ONGC
H26
H26

H26 DEFINITION OF FIELD	COLS	FORMAT	UNITS
H26 Record identification	1- 1	A1	#
H26 Field tape number	2- 7	3A2	#
H26 Field record number	8-11	I4	#
H26 Field record increment	12-12	I1	#
H26 Instrument code	13-13	A1	# "NOT EXACT"
H26 Line name	14-29	4A4	#
H26 Point number	30-37	2A4	#
H26 Point index	38-38	I1	#
H26 From channel	39-42	I4	#
H26 To channel	43-46	I4	#
H26 Channel increment	47-47	I1	#
H26 Line name	48-63	4A4	#
H26 From receiver	64-71	2A4	#
H26 To receiver	72-79	2A4	#
H26 Receiver index	80-80	I1	#

H26

H26	1	2	3	4	5	6	7	8
X	0	98111	113	3541	1	601	117	285	3441
X	0	98111	113	3541	61	1201	118	285	3441
X	0	99911	113	3581	1	601	117	289	3481
X	0	99911	113	3581	61	1201	118	289	3481
X	0	100311	113	3621	1	601	117	293	3521
X	0	100311	113	3621	61	1201	118	293	3521
X	0	101811	113	3661	1	601	117	297	3561
X	0	101811	113	3661	61	1201	118	297	3561
X	0	102311	113	3701	1	601	117	301	3601
X	0	102311	113	3701	61	1201	118	301	3601
X	0	103011	113	3741	1	601	117	305	3641
X	0	103011	113	3741	61	1201	118	305	3641
X	0	105911	113	3781	1	601	117	309	3681
X	0	105911	113	3781	61	1201	118	309	3681
X	0	106211	113	3821	1	601	117	313	3721
X	0	106211	113	3821	61	1201	118	313	3721
X	0	108111	113	3861	1	601	117	317	3761
X	0	108111	113	3861	61	1201	118	317	3761
X	0	108311	113	3901	1	601	117	321	3801
X	0	108311	113	3901	61	1201	118	321	3801
X	0	111811	113	3941	1	601	117	325	3841


APPENDIX - 6
SPS Conversion Flow Chart
Observer Data
Preprocessing Step
EXCEL Data
Intermediate data
Control File
SPS Conversion
Wrong Spread Information
SPS Files
Coord. Interpolation
Angle of diff. between Resulting & Desired Frame.
Geid Information
Interpolated SPS Files
Resulting Frame
Detect Errors in meters


SPS Conversion Flow Chart
Interpolated SPS R & S Files
Resulting Frame Information
Dynamic Frame Interpolation
SPS X File
Interpolated SPS R & S Files
SPS S or R File
Repeat list of files and Selected range of records (Seltr rangeX1)
Create Job for Geofile (FPSRD) to run in FPU
Display_lines
x1_repeat_list
Seltr_range.x1
Seltr_newrc.x1
Spsx1_for_psegd
3D_fpsrd.gsf
Sps.R_temp
Sps.S_temp
Sps.X_temp
Plot of Source Lines
Plot of Receiver Lines