



OEM Plug-in Guidelines

This document is intended to guide an OEM with the task of using AeroSys v3.0 aerotriangulation (AT) software as a plug-in into their propriety softcopy or digital mapping software system. The purpose of AeroSys AT is to serve as an “AT engine” for the vendors mapping software, thus providing a seamless mechanism to generate rigorous least-squares adjusted (bundle method) photo orientations and pass-point ground coordinates for blocks of AT type data. The diagram on the following page illustrates this mechanism.

Once AeroSys has been installed (i.e., C:\AeroSys\ASW30\....), plugging an AT project into AeroSys is a simple three-step process:

- (1) **Write project info to the WinNT/2000/98/95 registry.**
 - Project Data Directory Path
 - Project File Basename
 - Ground Control data file path (*.CTL)

- (2) **Generate the appropriate AeroSys files for your plug-in entry point.**
 - Camera Calibration file (*.CAL)
 - Ground Control file (*.CTL)
 - Refined Photocoordinate file (*.REF)

or

 - Bundle Adjustment Initial Estimates & Observations (*.AER)

- (3) **Launch the appropriate AeroSys program executable.**
 - Configure Auto-Sequence & Aero Ops Parameters

and

 - Prepro.exe (data pre-processing: relorn,stripform,reset,etc.)

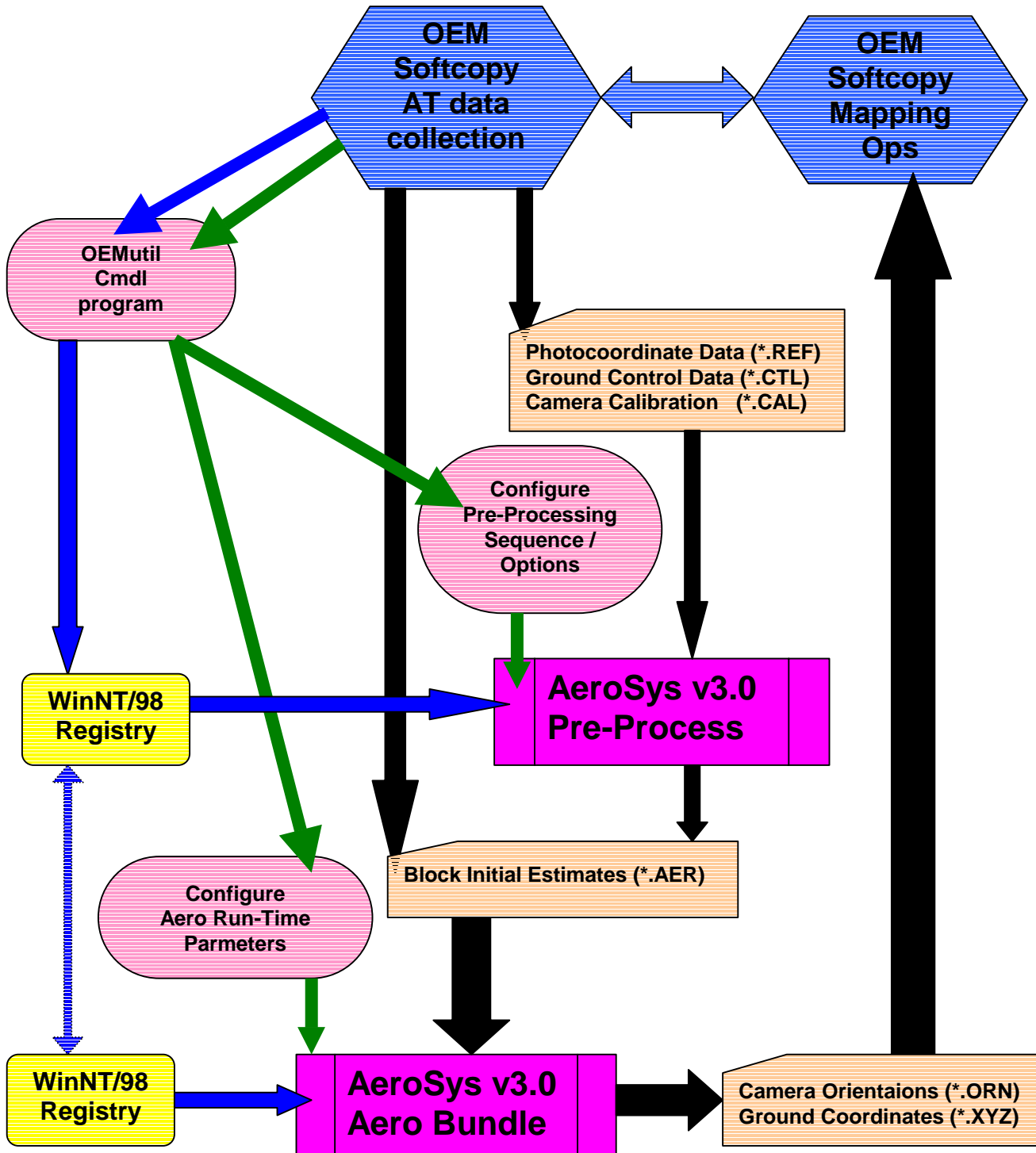
or

 - Aero.exe (least-squares bundle adjustment)

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Dr. Matt Stevens . 1401 Portland Ave . Saint Paul, MN 55104 . 651-645-5320





AeroSys operating options that can be set using OEMUtil.exe:

Flags No.1 through No.3 are used to set general data file & directory info.
Flags No.4 through No.9 are used to set Prepro Options and preferences
Flag No.10 is used to set Aero Bundle Adjustment Options.

OEMutil.exe [Option Flag] [CmdL . . .]

Where:

Cmdl = <tag> [Param1] <Param2> . . . <ParamN>

Flag=1	cmdl= [project_file_basename]	
Flag=2	cmdl= [data_directory_path]	
Flag=3	cmdl= [CTL_data_file_path]	
Flag=4	cmdl= [prepro_sequence_string]	
Flag=5	cmdl= [prepro_option_string]	
Flag=6	cmdl= [Prefix_Chr] [Suffix_Chr] [min_ID_Length]	
Flag=7	cmdl= [Format_X] [Format_Y] [Center_Area_Percent]	
Flag=8	cmdl= [tag] [Max_Vx] [Max_Vy] <[Max_Vz]>	
Flag=9	cmdl= [tag] [SD_x] [SD_y] <[SD_z]> <[SD_opk]>	
Flag=10	cmdl= [tag] {[Param1] . . . <Param(n)>}	
Flag=11	cmdl= [Sxy]	//set default photocoord SD's
Flag=-DUMP	cmdl= <[file_path]>	//Print values to text file
Flag=-FILE	cmdl= [file_path]	//Read File to set Defaults
Flag=-HELP		//Print usage tips



Plug-in Step 1:

At any point in time prior to executing any of the AeroSys exe's, some amount of information needs to be written to the Windows NT/98 registry. How much information you must set will depend upon which AeroSys EXE entry point you intend to launch within your proprietary application.

At a minimum, you must set two pieces of information,

- (1) the project data directory path
e.g., **E:\mapping\myProject**

Note the ending back-slash “ \ “ at the end of the string

- (2) the project file basename (no file extension)
e.g., “**MississippiRiver**” , then AeroSys programs would expect and produce data files named:

E:\mapping\myProject\MississippiRiver.aer
E:\mapping\myProject\MississippiRiver.orn
E:\mapping\myProject\MississippiRiver.xyz
Etc...Etc....

If your data processing (plug-in) entry point is calling the Aero.exe bundle adjustment, then step one is done. Otherwise, if you are calling the Prepro.exe data pre-processing engine, then you must set a third piece of information,

- (3) the full path of the ground control data file
e.g., **E:\mapping\myProjects\GrdControl\MississippiRiv.ctl**

This file is independent of the project basename and data directory path

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AeroSys has provided a command-line utility program for your convenience to set these parameters into the WinNT registry. This utility program is called: OEMutil.exe, and is located in the C:\AeroSys\ASW30\bin program directory. You may wish to re-locate this utility to accommodate your own installation directory structure.

The usage of OEMutil.exe for these three parameters follows:

```
OEMutil.exe <Option Flag:(integer)> <cmdl:(string)>');
```

Where:

Option Flag=1	cmdl= project file basename
Option Flag=2	cmdl= data directory path
Option Flag=3	cmdl= full path to CTL data file

Note: **Try to avoid** path and file names with embedded spaces. Otherwise these strings should be enclosed in a pair of double quotes “_____”.

This sets the project file basename into the reg (*no spaces allowed in basename*)

```
OEMutil.exe 1 MississippiRiver
```

This sets the data directory path into the WinNT registry

```
OEMutil.exe 2 c:\mapping\myProjects\
```

This sets the ground control path into the WinNT registry

```
OEMutil.exe 3 c:\mapping\myProjects\GrdControl\Mississippi.ctl
```



Plug-in Step 2:

The native AeroSys data files that your application will need to generate will depend upon the data processing entry point that you intend on calling from your application. If you plan to directly launch the Aero.exe bundle adjustment program, you must generate the (*.AER) input data file for this program. Following our previous examples, this file could be named,

[E:\mapping\myProject\MississippiRiver.aer](#)

If you plan on launching the AeroSys data pre-processing sequence (**Prepro.exe**), then you must generate three data files, and place them into the designated data directory:

- (1) the (*.CTL) ground control file;
- (2) the (*.REF) refined photocoordinate file; and
- (3) the (*.CAL) camera calibration file.

Note: all AeroSys data files are composed of free-format ASCII text

Sample file formats are shown at the end of this document, and are fully documented in the PDF formatted User Manual (see AeroSys v3.0 CD or visit website)

Web Site: <http://www.bigfoot.com/~AeroSys>

The User Manual can be downloaded from the DOWNLOAD area of the AeroSys web site.



Plug-in Step 3:

So I fibbed a little, Step 3 actually has part two parts:

Part A - Set Program(s) configuration:

- (1) Prepro Auto-execution sequence;
- (2) Prepro Options (optional);
- (3) AeroSys Preferences (optional);

and

Part B - Launch the appropriate EXE, either

(1) Prepro.exe 6 A C

or

(2) Aero.exe C 1



Plug-in Step 3a:

If you are planning to launch the Prepro.exe pre-processing program from your softcopy GUI, then you must configure the auto-sequence parameters. Prepro is a program that will automatically execute a sequence of steps starting with photocoordinate refinement step,, finally to the Aero bundle Adjustment. The pre-processing steps that one can execute are listed below (in order):

<u>Sequence No.</u>	<u>Prepro Step</u>	<u>Calling API</u>
1	Translate	prepro.exe 1 A C
2	Split	prepro.exe 2 A C
3	Build	prepro.exe 3 A C
4	REFINE	prepro.exe 4 A C
5	Combine	prepro.exe 5 A C
6	RELORN	prepro.exe 6 A C
7	STRIPFORM	prepro.exe 7 A C
8	BLOCKFORM	prepro.exe 8 A C
9	ESTIMATE	prepro.exe 9 A C
10	RESECT	prepro.exe 10 A C
11	INTERSECT	prepro.exe 11 A C
12	MERGE	prepro.exe 12 A C
13	IMAGERAYS	prepro.exe 13 A C
14	AERO	prepro.exe 14 A C



The usage of OEMutil.exe for this parameters follows:

```
OEMutil.exe <Option Flag:(integer)> <cmdl:(string)>');
```

Where:

```
Option Flag=4      cmdl= sequence_string
```

The “sequence_string” is a string containing exactly fourteen (14) characters, where each character can only be either a zero (0) or a one (1).

Where:

(zero) 0 = disable sequence step; and

(one) 1 = enable sequence step.

And

The position of each character in the string corresponds to the above listed prepro sequence step, i.e.,

Sequence_string[6] = “**REL**ative **ORie**Ntation” step

NOTE: Steps 1, 2, 3 and 5 (**in red**) should always be disabled.



Normally, one should start the pre-processing sequence with either the **REFINE** or **RELORN** step, depending upon the type of photocoordinate files produced.

If your softcopy or digital mapping system is generating non-refined photocoordinates, i.e., the *.PHC data file, then you need to start prepro at the REFINE step, then set the sequence string as follows:

This sets the prepro sequence_string into the pro node file (/sys/asw.pro)

```
OEMutil.exe 4 00010110111111
```



REFINE step enabled

If your softcopy or digital mapping system is generating refined photocoordinates, i.e., the *.REF data file, then you need to start prepro at the RELORN step, then set the sequence string as follows:

This sets the prepro sequence_string into the pro node file (/sys/asw.pro)

```
OEMutil.exe 4 00000110111111
```



REFINE step disabled



Below is a brief explanation of each of the *major* steps in the prepro sequence:

REFINE (step 4):

Performs the interior photo orientation on image measurements by computing an 2-D AFFINE coordinate transformation based on fiducial measurements and optionally correcting for systematic lens distortion errors.

RELORN (step 6):

Performs the relation orientation for passpoint measurements in a pair of adjacent overlapping vertical photos. The independent model coordinates are computed in model space.

STRIPFORM (step 7):

Performs the formation of a strip of passpoint (and ground control) points in model space by concatenating adjacent independent models using a series of 3-D coordinate transformations.

BLOCKFORM (step 8):

Performs the formation of a block of passpoint (and ground control) points in model space by concatenating adjacent strip models using a series of 3-D coordinate transformations. BlockForm is useful in aerial block configurations that contain flight strips with insufficient ground control points to properly perform a strip polynomial adjustment.

ESTIMATE (step 9):

Performs the model space to object space coordinate calculations by performing either a (1) polynomial strip adjustment, or (2) a rigid-body 2D-3D hybrid coordinate transformation, depending upon the input data source and available object space control density.



(SPACE) RESECT (step 10):

Performs the calculation of each photo's exterior orientation parameters (omega, phi, kappa, XL, YL and ZL).

(SPACE) INTERSECTION (step 11):

Calculates the XYZ object space coordinates for any images points (*imaged in at least two photos*) that were missed or left out during the normal model and strip formation process.

MERGE (step 12):

Merges the input and output data files generated from the previous prepro steps into the initial approximation data file (*.AER) for the Aero.exe bundle adjustment.

IMAGE RAYS (step 13):

Performs a space intersection calculation for each object space point in the (*.AER) data file as a quick check for mis-identified points and blunders.

AERO (step 14):

Prepro automatically calls the Aero.exe bundle adjustment in a separate processing thread.



Prepro Operation Options

Flag=5 cmdl= [Option_String]

Option_String is a literal string containing exactly eleven (11) characters. Each character in the string corresponds to a single option, whose meanings are given below:

<u>Option[i]</u>	<u>Prepro Step</u>	<u>Option</u>	<u>Values</u>
1	Refine	Delete PassPt Prefix	0=disable 1=enable
2	Relorn	Delete PassPt Prefix	0=disable 1=enable
3	Resection	Delete PassPt Prefix	0=disable 1=enable
4	Intersection	Delete PassPt Prefix	0=disable 1=enable
5	Merge	Delete PassPt Prefix	0=disable 1=enable
6	Refine	Lens Distort Corr	0=disable 1=enable
7	Estimate	Auto Degree Select	0=disable 1=enable
8	Estimate	Brief Output	0=disable 1=enable
9	ImageRays	Stop on Gross Error	0=disable 1=enable
10	Estimate	Data File Source	0=strip 1=block
11	Estimate	Adjustment Type	0=polyn 1=rigid

**strip = StripForm,

block = BlockForm

**polyn = polynomial strip adjustment, rigid = rigid body 2D-3D hybrid coordinate transformation

For non-GPS blocks, typically, one would set the following option string for softcopy systems:

OEMutil.exe 5 00000011100

For GPS blocks where BLOCKFORM was enabled, one would set the following option string for softcopy systems:

OEMutil.exe 5 00000001111



Pass Point Identification

Flag=6 cmdl= [Prefix_Chr] [Suffix_Chr] [min_ID_Length]

To set the prefix character to number “\$” (dollar sign) and the suffix character that ID’s a model’s center most passpoint to “2” (two) and specify that a pass point ID has a minimum string length of 6 characters, use

OEMutil.exe 6 \$ 2 6

Image Frame Format

Flag=7 cmdl= [Format_X] [Format_Y] [Center_Area_Percent]

To setup for a normal 9” x 9” aerial camera and also specify that a model’s center most passpoint will lie within an (integral) square area centered in a photograph that is the size of 25% of the format’s largest dimension, use

OEMutil.exe 7 228.6 228.8 25

Integer Value



Max Residuals

Flag=8 cmdl= [tag] [MaxVx] [MaxVy] <[MaxVz]>

The Max Residuals threshold values are used to screen the results of each Prepro step in order to report unusually large observation residuals to the Error Log file (BaseName.ERR) which is located in the user designated data directory. Examples to set typical values for each Prepro step are listed below:

OEMutil.exe	8	REFINE	0.010	0.010	NULL
OEMutil.exe	8	RELORN	0.003	0.003	NULL
OEMutil.exe	8	STRIPFM	0.030	0.030	0.030
OEMutil.exe	8	BLOCKFM	0.050	0.050	0.050
OEMutil.exe	8	ESTIMPOLY	1.000	1.000	1.000
OEMutil.exe	8	ESTIM2D3D	3.000	3.000	3.000
OEMutil.exe	8	RESECT	1.000	1.000	NULL
OEMutil.exe	8	INTERSECT	0.050	0.050	NULL
OEMutil.exe	8	IMAGERAYS	0.100	0.100	NULL



Default Standard Deviations

Flag=9 cmd1= [tag] [SDx] [SDy] <[SDz]> <[SDopk]>

The default standard deviations are those that are applied to the basic observation types. In a typical non-GPS block, passpoints and camera station observations are normally allowed to “float”, where the photocoordinate observations are usually set to 3 to 5 microns.

Examples to set typical values for each observation type are listed below:

OEMutil.exe	9	CAMSTA	10000	10000	10000	6000
OEMutil.exe	9	PASSPT	10000	10000	10000	NULL
OEMutil.exe	9	PHTCRD	0.003	0.003	NULL	NULL

PHTCRD units are millimeters.

CAMSTA units are the same as the ground control,
Except that SDopk are arc_minutes

PASSPT units are the same as the ground control.



Aero Bundle Adjustment Configuration Options

Flag=10 cmdl= [tag] {[Param1] . . . <Param(n)>}

TAG PARAMETERS

TERMIN	[Max_Iter] [CAM_opk] [CAM_xyz] [PNT_xyz] [Sigma_O]
STATS	[Blunder_Level] [Signif_Level] [Lower_Limit] [Upper_Limit]
DOF	[Defin] [CAM_min] [CAM_xyz] [GRD_xyz]
WORK	[Work_Dir_Path]
GENERAL	[Option_String]
ATMOSPH	[E D] [Option_String] [Air_Temp] [Air_Pres]
EARTHCURV	[E D] [Earth_Radius] [Option_String] [HT]
TRACE	[Option_String]

Sample Calls to OEMutil.exe

OEMutil.exe	10	TERMINATE	10	0.0001	0.0001	0.0001	0.0001
OEMutil.exe	10	STATS	3.29	1.96	0.9000	1.1000	
OEMutil.exe	10	DOF	0	60	1.0	0.5	
OEMutil.exe	10	WORK	c:\temp				
OEMutil.exe	10	GENERAL	111100100				
OEMutil.exe	10	ATMOSPH	0	00000	68.0	29.9	
OEMutil.exe	10	EARTHCURV	1	6378000	00	100.0	
OEMutil.exe	10	TRACE	00000				



Termination Criteria

TERMIN [Max_Iter] [CAM_opk] [CAM_xyz] [PNT_xyz] [Sigma_O]

Set parameters to control bundle adjustment termination:

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[Max_Iter]	Maximum number of iterations	10
[CAM_opk]	Camera Orientation Correction Threshold	0.0001
[CAM_xyz]	Camera Position Correction Threshold	0.0001
[PNT_xyz]	Object Point Correction Threshold	0.0001
[Sigma_O]	Sigma_O Correction Threshold	0.0001

Statistical Parameters

STATS [Blunder_Level] [Signif_Level] [Lower_Limit] [Upper_Limit]

Set parameters to control bundle adjustment statistical comparisons:

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[Blunder_Level]	Blunder Detection Threshold Level	3.29
[Signif_Level]	Parameter Significance Threshold	1.96
[Lower_Limit]	Chi-square Interval Lower Limit	0.9000
[Upper_Limit]	Chi-square Interval Upper Limit	1.1000



Degrees of Freedom

DOF [Defin] [CAM_min] [CAM_xyz] [PTN_xyz]

Set parameters to control bundle adjustment statistical comparisons:

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[Defin]	Definition Type: Enhance or Standard	Enhanced=0
[CAM_min]	Observation Weight Threshold**	60.0
[CAM_xyz]	Observation Weight Threshold**	1.0
[PTN_xyz]	Observation Weight Threshold**	0.5

** Adds one degree of freedom for every observation weighted with a Standard Deviation less than the specified threshold.

Work Directory Path

WORK [work_dir]

Set parameters to point to spare (temporary) work space:

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[work_dir]	Work (temp) directory path	C:\Temp

**This parameter is not critical since one generally lets the WinNT virtual memory management system control memory resources for any process.



General Options

GENERAL [Option_String]

Set parameters to configure general operating behavior

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[Option_String]	Nine character string	111100100

The Option_String contains exactly nine characters, each character can be either a zero (0) or a one (1), to indicate whether the corresponding option is enabled=1 , or disabled=0

POS Option Group Option Description

1	Text Output	Brief Aero.LOG file
2	Text Output	Update *.AER input file
3	Text Output	Generate Output even though solution diverges
4	Basic Operation	Compute Extended adjustment statistics
5	Basic Operation	override photocoordinate Sxy's by Sigma_O
6	Basic Operation	Apply lens distortion corrections to raw PhtCoords
7	Basic Operation	Enable Surveying Observations
8	Basic Operation	Enable Self-Cal
9	Special Operation	Input data file is simulated w/o random error



Atmospheric Corrections

ATMOSPH [E|D] [Option_String] [Air_Temp] [Air_Pres]

Set parameters to configure corrections based on atmospheric refraction

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[E D]	disabled / enabled [0 1]	0 = disabled
[Option_String]	five character literal string	00000
[Air_Temp]	Air Temperature	68.0 (F)
[Air_Pres]	Air Pressure	29.9 (inches Hg)

The Option_String contains exactly nine characters, each character can be either a zero (0) or a one (1), to indicate whether the corresponding option is enabled=1 , or disabled=0

<u>POS</u>	<u>Option Group</u>	<u>Option Description</u>	
1	Elevation Units	0=Feet	1=Meters
2	Temperature Units	0=Fahrenheit	1=Celsius
3	Pressure Units	0=Inches Hg	1=Millibars Hg
2	Air Temp	0=at Ground	1= at Camera Sta
3	Air Pressure	0=at Ground	1=at Camera Sta



Earth Curvature Corrections

EARTHCURV [E|D] [Earth_Radius] [FT|M] [Auto|User] [H]

Set parameters to configure corrections based on earth curvature

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[E D]	disabled / enabled [0 1]	1 = enabled
[Earth_Radius]	earth's radius	6378000 (meters)
[Option_String]	2 character string	00
[H]	User Specified, Avg Grd Elev	100.0

<u>POS</u>	<u>Option</u>	<u>Description</u>	<u>Defaults</u>
1	[FEET or METERS]	Ground Control Units	0=feet
2	[Auto or User Spec]	Average Ground Elevation	0=Auto

Tracing Options

TRACE [Option_String]

Set parameters to configure program debugging break points

<u>PARAM</u>	<u>Description</u>	<u>Defaults</u>
[Option_String]	Five character string	00000

The Option_String contains exactly nine characters, each character can be either a zero (0) or a one (1), to indicate whether the corresponding option is enabled=1 , or disabled=0

<u>POS</u>	<u>Option</u>	<u>Description</u>
1		Show breakpoint dialog after Data Input Steps
2		Show breakpoint dialog after Least Square Solution
3		Show breakpoint dialog after Statistical Inverse Computation
4		Show breakpoint dialog after Extended Statistics
5		Show breakpoint dialog after Data Output Steps



Plug-in Step 3b:

To launch program Prepro (starting at the RELORN step), which also subsequently automatically launches the Aero Bundle Adjustment, execute the following command line within your program:

```
prepro.exe 6 A C
```

To launch program Aero, execute the following command line within your program:

```
aero.exe C 1
```

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BaseName.AER

The data format of Basename.AER consists of six blocks of data.
These data blocks are listed below:

Block No.	Description	See Details
1	Header/Project Information	See Aero Data Block No.1
2	Interior Orientation	See Aero Data Block No.2
3	Exterior Orientation	See Aero Data Block No.3
4	Object Space Coordinates	See Aero Data Block No.4
5	Image Coordinates	See Aero Data Block No.5
6	Survey Observations	See Aero Data Block No.6

NOTE:

All input is free format, i.e. variables are delimited by blank spaces. This file is automatically generated by Program MERGE for data for a strip or block of photos that have been processed by the "Front-End" aerial data reduction programs listed in the AERIAL MENU.

A sample "Basename.AER" data file is shown below. This data set uses 3 photos each from a separate camera, 9 object space points (3 control points, 1 check point & 5 passpoints), 1 distance observation and refined image coordinates.

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AER

Sample Input File for Program AERO

```
3 3
0 28.619 -0.458 0.025 1.5E-04 -2.4E-07 1.5E-10 0 0 0 0
0 28.573 0.146 -0.010 1.2E-04 -9.2E-08 -1.1E-10 0 0 0 0
0 24.064 0.128 0.049 2.1E-04 -2.5E-07 -3.3E-10 0 0 0 0
1 112 21 33 -10 14 54 -78 42 57 6000 6000 6000
1 199.8650 158.3790 6.7113 1000 1000 1000
2 121 21 30 -39 36 55 -68 40 55 6000 6000 6000
2 175.9437 178.9040 3.2790 1000 1000 1000
3 124 23 42 -21 42 55 -71 52 24 0.0001 0.0001 0.0001
3 196.9983 182.8812 6.0132 0.0001 0.0001 0.0001
100.0 100.0 100.0
51 191.991 191.634 41.140 3 100.0 100.0 0.1
52 192.991 192.634 42.140 3 0.1 0.1 100.0
53 193.991 193.634 43.140 3 0.1 0.1 0.1
54 194.991 194.634 44.140 2 0.1 0.1 0.1
61 199.991 199.634 41.140 1
67 199.762 199.629 9.882 1
901 200.510 200.842 40.946 1
902 198.507 212.861 12.362 1
903 210.391 201.765 13.052 1
-99
1 1 0.005 0.005 0.0 1.0 1.0 1 0
61 -9.983 -3.215 1
67 8.174 -6.974 1
901 -9.374 -3.043 1
902 7.276 -7.515 1
903 7.183 0.428 1
-99
2 2 0.005 0.005 0.0 1.0 1.0 1 0
61 -14.226 1.824 1
67 2.673 2.141 1
901 -13.479 1.496 1
902 5.490 -5.268 1
903 5.066 6.154 1
-99
3 3 0.005 0.005 0.0 1.0 1.0 1 0
61 -16.042 -2.292 1
67 7.496 -7.801 1
901 -14.939 -2.309 1
902 -10.547 -4.821 1
903 -7.774 -6.067 1
-99
1 0 61 67 31.177 0.053
-99
```

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Aero Data Block No.1

Header/Project Information

Line 1:	AER	(string)
Line 2:	Title/Project	(string)
Line 3:	NumCam, NumPht	(2 integers)

NOTES:

1. Line 1 is a three-character string, capital letters "AER".
2. Line 2 is a string (**max length of 80 char**) to describe the input data by project name, etc.
3. **NumCam** = Number of cameras used in the block of photos
4. **NumPht** = Number of photos in the block.



Aero Data Block No.2

Camera Calibration Data

A minimum of one data line per camera that is used in the photo block
Must appear in AERO DATA BLOCK NO.2.

Line 1:	NumFids,CFL,Xo,Yo,K0,K1,K2,K3,P1,P2,P3	(1 integer, 10 reals)
Line (1 + NumFids):	FidID, Xf, Yf, Sx, Sy	(1 integer, 4 reals)

Notes:

- NumFids** = Number of fiducial marks used to transform the image coordinates. Program AERO can transform unrefined photo coordinates into the fiducial system if this option is enable in the CONFIG Menu

The value of NumFids can range within the interval **[0...9]**.
- IF NumFids is greater than zero**, Then one additional line for each fiducial used in the camera must be provided immediately afterwards, ordered sequentially according to FidID.

The value of FidID can range within the interval **[1...9]**.
- FidID** = ID number of the fiducial mark.
Xf, Yf = Calibrated fiducial coordinates.
Sx, Sy = Standard deviations of calibrated fiducials.
- CFL** = Calibrated focal length.
- Xo, Yo** = Principal point coordinates.
- K0,K1,K2,K3** = Coefficients of radial lens distortion (dR).

where $dR = K0*r^1 + K1*r^3 + K2*r^5 + K3*r^7$
- P1,P2,P3** = Coefficients of tangential distortion.
- P1,P2,P3 should be set to 0, unless precise values are known.**
- Data lines must be listed by camera order**, that is camera no.1 line(s) are listed first, camera no.2 line(s) appear second, etc.

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Aero Data Block No.3

Camera Position and Orientation

Two data lines are required for each photograph in the aerial block.

<i>Line 1: PhtNum, Omega, Phi, Kappa, Sw, Sp, Sk</i>	(10 intergers, 3 reals)
<i>Line 2: PhtNum, XL, YL, ZL, Sx, Sy, Sz</i>	(1 integer, 6 reals)

Notes:

1. **PhtNum** = Photo ID number (*integer*) assigned to the photograph.
2. **Omega, Phi, Kappa** = Orientation of the camera at the time of exposure. Each of these three rotations is each expressed as a group of 3 integers (degrees, minutes, and seconds).

If a rotational value is negative, then only the first non-zero integer of the three (deg, min, sec) needs to be prefaced with a negative sign
(ie. **-110 13 42, or 0 -7 18, or 0 0 -51**).
3. **Sw, Sp, Sk** = Standard deviations of the camera rotations expressed in arc minutes.
4. **XL, YL, ZL** = Ground coordinates of the camera exposure station.
5. **Sx, Sy, Sz** = Standard deviations of camera exposure station.

!! IMPORTANT !! **The order of the photo unknowns in the numerical solution of the bundle adjustment corresponds to the same order listed in the data block.**



Aero Data Block No.4

Object Space Coordinates

Line 1 :	SDx, SDy, SDz	(real)
Line (2 + ...) :	PtID, X, Y, Z, PtType, Sx, Sy, Sz	(string, 3 reals, Int, 3 reals)
Line (2 + NumPts) :	-99 to indicate no more XYZ points	(integer)

Notes:

1. **SDx, SDy, SDz** = Default standard deviations assigned to the object space coordinates of points which are not designated as control.
2. **PtID** = Point ID number. This Id label **cannot exceed 16 characters**.
3. **X, Y, Z** = Object space coordinates.
4. **PtType** = Point Type, value ranging between **[1 .. 3]**.

<u>POINT TYPES</u>	<u>PassPoint</u>	<u>CheckPoint</u>	<u>ControlPoint</u>
Non-Feature	1	2	3

5. **Sx, Sy, Sz** = Standard deviations of control point coordinates.
If PtType is a pass point or check point, then Sx, Sy, Sz need not be specified and are automatically assigned the defaults as ... SDx, SDy, SDz.
6. Points connected by survey observations **must be placed first in the list** of XYZ points.
7. **NumPts** = Total number of object space points.
9. The data block must end with a negative number, i.e. the first non-blank character must be a '-' (minus sign).



Aero Data Block No.5

Photo coordinates

This data block is broken into an equal number of sub-blocks as the number of photos. The data format of a sub-block is shown below.

Line 1:	PhtNum, CamNum, Sx, Sy, Beta, ScaleX, ScaleY, PosNeg, Trans	(2 int, 5 reals, 2 int)
Line (2 +...):	PtID, X, Y, Flag	(string, 2 reals, integer)
Line (2 + NumPts):	-99 to indicate no more points	(integer)

Notes:

1. **PhtNum** = Photo ID number (*integer*) assigned to the photograph.
 2. **CamNum** = ID number (*integer*) of the camera. [1 ... NumCam]
 3. **Sx, Sy** = Default standard deviations of the photo coordinates.
 4. **Beta** = Affinity Term, angle of non-orthogonality between the xy axis of the measuring device. **!! Beta should be set to zero seconds unless a precise value is known!!**
 5. **ScaleX, ScaleY** = Scale factors in x and y axis. **!! Scale factors should be set to 1.0 unless precise values are known!!**
 6. **PosNeg** =
1 for slide (positive) film
2 for negative film
 7. **Trans** =
0 : no transformation
1 : conformal
2 : affine
3 : projective
- IF TRANS does not equal zero** (Trans \neq 0), then the next **NumFids** data lines (*PtID, x, y*) after Line No.1 must correspond to the measured fiducial marks for the photograph.
8. **PtID** = Point ID number. This ID label cannot exceed 16 characters.
 9. **X, Y** = Photo coordinate measurements.
!! These must be uncorrected (for lens distortions) if the SELF-CAL option is used in the bundle adjustment!!
 10. **Flag** = 0: Do not use photocoordinate in the adjustment
1: Use photocoordinate in the adjustment
 11. The data sub-block for each photo must end with a negative number, i.e. the first non-blank character must be a '-' (minus sign).
-



Aero Data Block No.6

Survey Observations

Line (1 + ...)	Type, StaAT, StaFROM, StaTO, Observ, StdDev	(integer, 3 PointIDs, 2 reals)
Line (1 + NumObsv):	-99 to indicate no more observations	(integer)

Notes:

1. **Type** = Kind of surveying observation:

- 1 = Slope Distance
- 2 = Height Difference
- 3 = Horizontal Angle

2. **StaAT, StaFROM, StaTO** = Point ID number.

This ID number cannot exceed 16 characters.

For surveying observation types 1 or 2, StaAT = 0 (zero).

3. **Observ** = Observed measurement.

If Type 1 or 2, Then Observ = a single real number.

If Type 3, Then Observ = three integers (Deg Min Sec).

If the angle observation is negative in value, only the first non-zero integer needs to be prefaced with a "-" (minus) sign. (eg. -115 7 24, or 0 -48 11, or 0 0 -51)

4. **StdDev** = Standard deviation of the surveying observation.

If Type 1 or 2, Then StdDev = a single real number.

If Type 3, Then StdDev is reported in units of arc seconds.

5. **NumObsrv** = Total number of surveying observations.

6. The data block must end with a negative number,
i.e. the first non-blank character must be a '-' (minus sign).

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BaseName.CAL

Line 1:	CAL	(string)
Line 2:	Title/Project ID	(string)
Line 3:	NumFids, FL, Xo, Yo, K0, K1, K2, K3 P1, P2,P3	(1 int, 10 reals)
Line (4 + ...NumFids):	FidID, Xf, Yf, Sx, Sy	(1 int, 4 reals)

Notes:

1. Line 1 is a three-character string, capital letters "CAL".
2. Line 2 is a string to describe the input data by camera name,etc.
(maximum length equals 80 characters)
3. **NumFids** = Number of fiducial marks used to transform the image coordinates. The value of NumFids can be an integer ranging between the values of 0 and 9.
4. **IF NumFids > 0**, Then one additional line for each fiducial used in that camera must be provided immediately afterwards. These lines are ordered by the value of FidID. The value of FidID can range within the interval **[1..9]**.
5. **Xf, Yf** = Calibrated Fiducial Coordinates
Sx, Sy = Standard Deviations of Calibrated Fiducials
6. **FL** = Calibrated Focal Length
7. **Xo, Yo** = Principal Point Offset Coordinates
8. **K0,K1,K2,K3** = Coefficients of Radial Lens Distortion
9. **P1,P2,P3** = Coefficients of Tangential Distortion.
These values should be set to zero unless precise values are known.
10. **Line No.3 to No.(3 + NumFids) are repeated for each camera used in the block of photos. These data lines must be listed by camera order, i.e. camera No.1 is listed first, camera No.2 second, etc.**
11. For implementation with a softcopy system, usually this file can be "dummy-ed out" provided that the photocoordinates do not need to be refined by Prepro. The only relevant parameter is the calibrated focal length "FL", all other parameters can be set to zero; e.g., (a 3 line file)

CAL

"Sample 3 line data file for refined softcopy photocoordinates"

0 152.44 00 0000 000

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BaseName.CTL

Line 1:	CTL	(string)
Line 2:	Title/Project ID	(string)
Line (3 + ...ctNumPts):	PtID, X, Y, Z, Sxy, Sz	(string, 5 reals)
Line (4 + ..ctNumPts):	-99 to indicate no more control points	(integer)
Line (5 + ...ckNumPts):	PtID, X, Y, Z, Sxy, Sz	(string, 5 reals)
Last Line:	-99	(integer)

Notes:

1. Line 1 is a three-character string, capital letters "CTL".
2. Line 2 is a string to describe the input data by project name, etc.
(maximum length equals 80 characters)
1. **ctNumPts** = Number of control points listed in the file.
ckNumPts = Number of check points listed in the file.
4. **PtID** = Point ID number.
This ID number cannot exceed 16 characters in length.
5. **X, Y, Z** = Ground control coordinates.
6. **Sxy** = Standard deviation of the control point in X and Y.
7. **Sz** = Standard deviation of the control point in Z.
8. **For horizontal control points:** Set **Z = Sz = 0 (zero)**.
9. **For vertical control points:** Set **X = Y = Sxy = 0 (zero)**.
10. The data file must end with a negative number,
i.e. the first non-blank character must be a '-' (minus sign).
11. The operator must create this file.

!! WARNING !! If you are creating this file from the data listing of a control survey make sure that you enter your data:

as [PtID, EASTING, NORTHING, Z] RIGHT!

and NOT [PtID, NORTHING, EASTING, Z]. WRONG!



This file contains the object space or ground control point values for the project area. AeroSys has several format conversion utilities that can assist the user in creating this data file without the need to manually edit. An example data file is shown on the next page.

Starting with the third line in the text file, each data line contains six white space delimited (free format) tokens,

PtID Xg Yg Zg Sxy Sz

Where:

PtID = point ID number (an alpha-numerical string, max 16 chars)

Xg = X ground coordinate (surveyors easting)

Yg = Y ground coordinate (surveyors northing)

Zg = Z ground coordinate (surveyors elevation)

Sxy = Standard deviation of horizontal component of ground control
i.e., its horizontal estimated accuracy.

Sz = Standard deviation of vertical component of ground control
i.e., its vertical estimated accuracy.

Point Types

A ground control point can be either a horizontal only, vertical only, or 3D point type. A 3D point type contains non-zero values for both Sxy and Sz.

A horizontal point type has $Sz = Zg = 0$ (zero).

A vertical point type has $Sxy = Xg = Yg = 0$ (zero).

IMPORTANT

The values assigned to Sxy and Sz should be derived from the surveyor's horizontal and/or vertical adjusted network data. In general, this will mean that the values of Sxy and Sz will vary slightly from point to point. An error ellipse diagram usually shows a graphical representation of this variation. **If your ground control is generated by GPS data collection techniques, be sure to ask for the NETWORK SOLUTION which is usually available as a post-processing option**

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A sample ground control file is shown below. This file contains both ground control and checkpoints. **Check points are listed after the first "-99" and terminated by a second "-99"**. During the solution of the bundle adjustment, checkpoints are treated as passpoints, but their final adjusted values are compared to their original values to calculate a RMS difference.

CTL					
Pine Bend: Martinez					
21041	0.0	0.0	877.20	0.000	0.013
21042	0.0	0.0	885.70	0.000	0.017
21043	0.0	0.0	855.30	0.000	0.009
11041	4727.14	13923.29	0.0	0.019	0.000
11042	6412.48	10132.98	0.0	0.012	0.000
10101	8698.26	14006.85	863.98	0.010	0.017
10102	11140.07	14006.84	897.86	0.013	0.015
10103	8436.41	13554.32	878.98	0.014	0.019
10104	10440.33	11809.56	898.51	0.011	0.020
10105	7581.32	10031.12	860.70	0.010	0.014
-99					
10106	11189.77	10033.01	984.63	0.010	0.018
-99					

CHECK POINT(S)

Horizontal Sxy

Vertical Sz

Note: The mathematics of a bundle adjustment assumes that ground control coordinates reside in (or have been transformed into) a local vertical coordinate system. If your softcopy system does this, then you need to **disable the Earth Curvature Correction** in the Aero.exe bundle adjustment. If not, which in this case you do not perform any special coordinate transformation and use the surveyor's data directly (i.e., Easting, Northing, Elevation as X,Y,Z), then you must **enable the Earth Curvature Correction**.

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BaseName.REF

Line 1:	REF	(string)
Line 2:	Title/Project ID	(string)
Line 3:	NumStrips, Focal, Strip Data (1)	(integer, real)
	. . .	
	Strip Data (NumStrips)	

Notes:

1. Line 1 is a three-character string, capital letters "REF".
2. Line 2 is a string to describe the input data by project name, etc.
(maximum length equals 80 characters)
3. **NumStrips** = Number of photo strips.
4. **Focal** = Calibrated focal length (mm) of the aerial camera.
5. **Strip Data (1) ... (NumStrips)** have the following data format:

Line 1:	StripNo, NumPhts	(integers)
	Photo Data (1)	
	. . .	
	Photo Data (NumPhts)	

6. **StripNo** = Id number for the photo strip.
7. **NumPhts** = Number of photos contained in the photo strip.
8. **Photo Data (1) ... (NumPhts)** have the following data format:

Line 1:	PhotoNum	(integer)
Line (2 +):	PtID, X, Y, Flag	(string, 2 reals, integer)
	. . .	
Line (2 + NumPts):	-99 to indicate no more points	(integer)

9. **PhotoNum** = Photo ID number.
10. **NumPts** = Number of image point measured in the photo.
11. **PtID** = Point ID number.
This ID number cannot exceed 16 characters in length.

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12. X, Y = refined photo coordinate observations.
Flag = a tag to indicate to Program Aero to use the observation. Always set to '1'
13. The data block for each photo must end with a negative number, i.e. the first non-blank character must be a '-' (minus sign).
14. **The order of photos listed in the strip must correspond to the exposure sequence in the direction of the strip flight line.**
15. There is no limit to the number of photos that can be concatenated together to form a photo strip.
16. The order of strips within the data file must correspond to the same sequence that forms the photo block, i.e. physically adjoining photo strips must be listed in sequential order. **Additional cross-strips should be placed at the end of the data file after the primary photo strips.**
17. There is no limit to the number of strips that can be concatenated together to form the data file.
18. All variables are delimited by blank spaces.
19. This file is automatically generated by the REFINE pre-processing step in AeroSys.
20. This file contains **REFINED** photocoordinates

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REF

DMI: KC135

3 152.929

1 6

106

301	111.89400	-88.01500	1
304	-9.27400	-18.46400	1
305	-10.56800	64.44400	1
502	103.05500	91.25100	1
1050	92.40600	2.49000	1
1051	94.29800	-87.39100	1
1052	91.83300	91.88600	1
1053	46.49900	1.30100	1
1060	-9.79400	6.61600	1
1061	-3.55300	-91.58700	1
1062	2.94300	99.91200	1

-99

105

301	19.26300	-90.07700	1
304	-99.02400	-22.06700	1
305	-100.10100	60.33200	1
501	105.67100	100.95000	1
502	11.42700	87.97100	1
1040	94.54700	9.15200	1
1041	96.03500	-76.68100	1
1042	92.80200	98.15200	1
1043	47.15300	6.02300	1
1050	0.53600	-0.55600	1
1051	2.08300	-89.57200	1
1052	0.20200	88.50400	1
1053	-44.42800	-2.06800	1
1060	-99.43300	2.81000	1
1061	-93.53000	-94.32600	1
1062	-86.76100	95.83600	1

-99

104

301	-74.63800	-94.67600	1
303	58.02200	-17.82900	1
501	12.99000	94.36600	1
502	-79.15000	82.49100	1
1030	84.09400	4.92100	1
1031	88.63000	-82.13500	1
1032	87.10600	98.16900	1
1033	32.38700	5.91700	1
1040	1.07600	3.63200	1
1041	1.37100	-81.70700	1
1042	0.42300	91.73100	1
1043	-45.46100	0.88600	1
1050	-91.48000	-5.30600	1
1051	-91.49600	-94.08700	1
1052	-90.28200	83.11500	1

-99

103

302	73.73800	-77.69800	1
303	-27.21300	-21.45600	1
306	67.08900	-57.73700	1
307	-7.66100	80.43100	1
501	-71.28500	89.84700	1
702	48.08800	21.70400	1
1020	90.53100	0.99600	1
1021	93.50800	-67.88400	1
1022	86.57200	95.32800	1
1023	37.25400	-4.27100	1
1030	-1.58300	1.21100	1
1031	2.16500	-85.42400	1
1032	1.77600	94.02500	1
1033	-52.51600	2.08700	1
1040	-83.31800	-0.24900	1
1041	-83.52200	-84.93500	1

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1042 -83.60700 87.16500 1
 307307 38.94500 84.49800 1

-99
 102

302 -18.46200 -80.15500 1
 306 -24.74900 -60.36200 1
 307 -97.79200 77.41300 1
 308 30.13400 78.54600 1
 317 107.25900 84.46600 1
 701 49.57700 -63.91500 1
 702 -42.79800 18.64100 1
 1010 101.40500 -2.68300 1
 1011 88.17300 -92.21900 1
 1012 86.15400 99.40500 1
 1013 45.65200 0.69100 1
 1020 -1.14600 -2.01100 1
 1021 0.82300 -70.38200 1
 1022 -3.96000 91.95700 1
 1023 -53.73800 -7.22700 1
 1030 -92.21400 -1.75600 1
 1031 -89.35300 -88.04000 1
 1032 -88.41600 90.97800 1
 307307 -51.59600 81.31000 1

-99
 101

308 -57.75100 75.55900 1
 317 16.73800 81.06800 1
 701 -39.69200 -66.57900 1
 1010 11.45700 -5.55800 1
 1011 -1.81100 -94.75600 1
 1012 -2.88000 96.04900 1
 1013 -44.03000 -2.14300 1
 1020 -89.24400 -4.74900 1
 1021 -88.23500 -73.10500 1
 1022 -91.01300 89.10200 1

-99
 2 5
 205

316 20.29300 104.62700 1
 502 21.61000 -51.93100 1
 703 21.87600 35.29100 1
 2040 96.88700 1.83100 1
 2041 93.15900 -87.59900 1
 2042 92.77600 101.06500 1
 2043 43.79600 -0.45200 1
 2050 0.12100 -10.74500 1
 2051 -0.12900 -92.27600 1
 2052 -4.41200 92.69300 1
 2054 3.62200 21.49200 1

-99
 204

307 85.23000 -56.42900 1
 312 63.56200 101.90600 1
 313 92.93100 35.39000 1
 316 -75.79400 99.10500 1
 501 21.20700 -46.39500 1
 502 -72.07600 -57.20100 1
 703 -73.01500 29.90700 1
 2030 88.39100 0.10500 1
 2031 88.65800 -93.86500 1
 2032 87.22900 95.98800 1
 2033 40.07400 10.49200 1
 2040 1.72000 -2.29200 1
 2041 -0.21100 -91.51900 1
 2042 -2.71800 96.67900 1
 2043 -50.74500 -5.42600 1
 2050 -94.24100 -16.43900 1
 2051 -93.20200 -97.89200 1
 2052 -100.22800 86.81900 1
 2054 -91.07500 15.82800 1

-99

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203

307	-4.23900	-60.69300	1
312	-26.57000	97.53000	1
313	3.22600	31.07800	1
501	-68.39600	-50.91400	1
504	61.95500	63.57600	1
505	25.62300	71.90800	1
2020	91.92100	4.48200	1
2021	88.22200	-92.44800	1
2022	87.33400	89.30300	1
2023	54.72600	4.32200	1
2024	89.77700	-60.87700	1
2030	-0.81500	-4.22000	1
2031	-0.62500	-97.97600	1
2032	-2.61100	91.78900	1
2033	-48.64900	5.95400	1
2040	-88.30800	-7.07300	1
2041	-89.37300	-95.83800	1
2042	-92.13700	91.83300	1
307307	41.99100	-56.88300	1

-99
202

307	-97.55500	-66.06700	1
308	29.65900	-64.36700	1
313	-90.62500	25.72600	1
314	20.54800	97.76200	1
317	104.73300	-61.30900	1
503	51.96900	67.66600	1
504	-31.61200	58.54600	1
505	-68.51700	66.65400	1
2010	92.13300	-10.06900	1
2011	99.65300	-93.87300	1
2012	93.96100	102.49400	1
2013	41.95400	-11.35200	1
2020	-1.03000	-0.29900	1
2021	-3.89600	-97.13300	1
2022	-7.00800	84.33500	1
2023	-38.81600	-0.71300	1
2024	-3.25600	-65.62500	1
2030	-94.04300	-9.56200	1
2031	-93.66100	-103.31600	1
2032	-96.77000	86.39400	1
307307	-51.25900	-61.95600	1

-99
201

308	-63.02800	-68.19900	1
314	-71.39600	93.56500	1
317	9.95600	-65.90400	1
503	-40.59000	63.20300	1
2010	-1.08400	-14.73700	1
2011	5.02300	-98.18500	1
2012	2.81300	97.84700	1
2013	-49.89100	-15.54400	1
2020	-92.65600	-4.18900	1
2021	-95.83100	-100.37500	1
2022	-99.02800	80.31100	1
2024	-95.70400	-69.15400	1

-99
3 5
305

315	43.81000	0.33400	1
316	41.70300	-32.11800	1
3040	92.65000	3.30900	1
3041	93.20500	-88.45300	1
3042	93.13000	105.30800	1
3050	3.10800	-6.65700	1
3051	-1.02600	-74.87000	1
3052	2.85300	88.20200	1

-99
304

310	75.11300	101.11800	1
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312	95.24500	-38.60600	1
315	-48.87300	-8.36000	1
316	-50.85400	-40.82900	1
3030	99.62200	9.08700	1
3031	96.63900	-76.63600	1
3032	97.21800	107.60800	1
3033	38.53300	-2.79200	1
3040	0.49200	-5.25500	1
3041	1.43000	-97.20200	1
3042	0.84500	96.59600	1
3050	-89.76000	-15.43700	1
3051	-93.15300	-83.68000	1
3052	-89.86800	79.25200	1

-99
303

309	42.06400	-3.20900	1
310	-23.18200	91.44100	1
311	50.89100	96.65300	1
312	-1.75800	-48.16500	1
504	90.44400	-82.60000	1
505	52.74000	-74.80400	1
3020	91.01900	8.12200	1
3022	89.36400	100.91700	1
3023	39.24000	22.27200	1
3030	2.33200	-0.33800	1
3031	0.26800	-86.20300	1
3032	-0.92300	98.31300	1
3033	-58.12100	-12.89100	1
3040	-96.89600	-15.89100	1
3041	-94.79300	-107.54300	1
3042	-97.52200	85.71300	1
3099	71.42400	-28.64500	1
309309	78.42100	-26.64500	1

-99
302

309	-50.98900	-16.64900	1
311	-40.87300	82.14000	1
312	-95.30000	-61.69100	1
314	52.97100	-56.53700	1
503	86.33400	-89.41100	1
504	-2.27000	-96.75000	1
505	-40.82000	-88.74400	1
3010	104.13400	1.57800	1
3012	96.49800	96.05100	1
3013	53.70800	9.10400	1
3020	-2.06100	-5.31800	1
3022	-3.05600	86.48500	1
3023	-53.56000	8.73000	1
3030	-90.52100	-13.79800	1
3031	-93.43800	-100.09200	1
3032	-92.47400	83.41500	1
3099	-21.66200	-42.13900	1
309309	-14.60600	-40.13200	1

-99
301

314	-45.12700	-66.29600	1
503	-12.50300	-98.75700	1
504	-99.29700	-106.51100	1
3010	6.67500	-7.91900	1
3012	-1.23300	86.65100	1
3013	-43.70200	-0.80100	1
3020	-99.49600	-15.65500	1
3022	-99.88500	76.34000	1
309309	-111.82100	-50.41500	1

-99



BaseName.PHC

Line 1:	PHC	(string)
Line 2:	Title/Project ID	(string)
Line 3:	NumStrips, Focal, NumFid	(integer,real,integer)
	Strip Data (1)	
	. . .	
	Strip Data (NumStrips)	

Notes:

- Line 1 is a three-character string, capital letters "PHC".
- Line 2 is a string to describe the input data by project name, etc.
(maximum length equals 80 characters)
- NumStrips** = Number of photo strips.
- Focal** = Calibrated focal length (mm) of the aerial camera.
- NumFid** = Number of camera fiducials measured per photo.
- Strip Data (1) ... (NumStrips)** have the following data format:

Line 1:	StripNo, NumPhts	(integers)
	Photo Data (1)	
	. . .	
	Photo Data (NumPhts)	

- StripNo** = Id number for the photo strip.
- NumPhts** = Number of photos contained in the photo strip.
- Photo Data (1) ... (NumPhts)** have the following data format:

Line 1:	PhotoNum, Focal, Misc	(integer, disregarded)
Line (2 + ...):	FidNum, X, Y	(integer, 2 reals)
Line (2 + NumFid + ...):	PtID, X, Y	(string, 2 reals)
Line (2 + NumFid + NumPhts):	-99 to indicate no more points	(integer)

- PhotoNum** = Photo ID number.
- All variables on Line 1 to the right of PhotoNum are disregarded.

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12. The next **NumFid** lines after Line No.1 of a photo data block must contain the measured fiducial coordinates, if NumFid is greater than zero.
13. **FidNum** = Fiducial ID number.
14. **X, Y** = Unrefined photo coordinate measurements.
15. **NumPts** = Number of image point measured in the photo.
16. **PtID** = Point ID number.
This ID number cannot exceed 16 characters in length.
17. The data block for each photo must end with a negative number, i.e. the first non-blank character must be a '-' (minus sign).
18. **The order of photos listed in the strip data must correspond to the exposure sequence in the direction of the strip flight line.**
19. There is no limit to the number of photos that can be concatenated together to form a photo strip.
20. The order of strips listed in the data file must correspond to the same sequence that forms the photo block, i.e. physically adjoining photo strips must be listed in sequential order. **Additional cross-strips should be placed at the end of the data file after the primary photo strips.**
21. There is no limit to the number of strips that can be concatenated together to form the data file.
22. All variables are delimited by blank spaces.
23. This file is automatically generated by BUILD pre-processing step in AeroSys
24. This file contains **UN-REFINED** photocoordinates..

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PHC

991023 ESE/Warrensburg (5299W98)

2 153.747 4

1 14

1014	153.747	0		
	1	101.80200	100.66800	
	2	-108.66600	-112.92300	
	3	103.20400	-111.24700	
	4	-110.10500	98.98700	
	901131	-94.57000	78.12800	
	901132	-89.74500	-4.15800	
	901133	-89.03600	-88.46200	
	119	-109.95000	71.78900	
	901141	-4.33400	82.75900	
	901142	-3.23400	-1.68700	
	901143	-1.61800	-80.00100	
	124	-36.35400	-93.46100	
	2063	-42.27200	78.81600	

-99

1013 153.747 0

	1	104.59000	106.46700	
	2	-105.17400	-107.69600	
	3	106.69600	-105.44700	
	4	-107.31000	104.20700	
	901121	-92.17500	86.57900	
	901122	-85.33400	-2.09600	
	901123	-91.30000	-86.79000	
	901131	-3.42600	82.60400	
	901132	1.19600	0.18900	
	901133	1.48800	-84.16400	
	123	-48.74200	1.44400	
	119	-18.63000	76.40400	
	2053	-38.86500	78.94200	
	901131	-3.42600	82.60400	
	901132	1.19600	0.18900	
	901133	1.48800	-84.16400	
	119	-18.63000	76.40400	
	901141	85.66500	86.40900	
	901142	86.34600	1.90100	
	901143	87.58600	-76.44400	
	124	53.59000	-89.61300	
	2063	48.09300	82.82000	

-99

1012 153.747 0

	1	104.20300	107.46000	
	2	-105.58300	-106.84100	
	3	106.29800	-104.45500	
	4	-107.73200	105.08700	
	901111	-85.05000	93.95300	
	901112	-90.43000	-2.11500	
	901113	-87.94200	-66.67700	
	901121	-3.70400	87.17500	
	901122	3.02200	-1.62300	
	901123	-3.13700	-86.22200	
	2043	-42.05200	70.62600	
	901121	-3.70400	87.17500	
	901122	3.02200	-1.62300	
	901123	-3.13700	-86.22200	
	901131	85.01000	82.33000	
	901132	89.28600	-0.07100	
	901133	89.03700	-84.25600	
	123	39.41300	1.60300	
	119	70.02600	76.27100	
	2053	50.21800	79.01000	

-99

1011 153.747 0

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	1	104.94300	105.72200
	2	-104.77100	-108.50200
	3	107.10800	-106.19700
	4	-106.96300	103.41000
	901101	-88.86800	86.06400
	901102	-94.74100	-4.53900
	901103	-99.82900	-86.18500
	901111	4.07700	91.82300
	901112	0.41300	-4.02000
	901113	4.14100	-68.42700
	113	-63.94300	4.15100
	114	-64.67800	82.04000
	2033	-44.99000	78.62000
	901111	4.07700	91.82300
	901112	0.41300	-4.02000
	901113	4.14100	-68.42700
	901121	84.33900	85.80000
	901122	92.56300	-2.71600
	901123	87.73400	-87.21000
	2043	47.37700	68.95500

-99
1010 153.747 0

	1	102.49700	106.90900
	2	-107.11300	-107.53800
	3	104.76200	-105.00100
	4	-109.42300	104.36400
	901091	-94.96500	72.02800
	901092	-92.61300	-3.21700
	901093	-91.99900	-77.25100
	901101	0.00000	89.70300
	901102	-5.60800	-0.93900
	901103	-11.76700	-82.37400
	2023	-45.39600	87.43500
	116	-28.69400	-73.72100
	901101	0.00000	89.70300
	901102	-5.60800	-0.93900
	901103	-11.76700	-82.37400
	901111	91.93700	94.89800
	901112	88.15700	-1.14700
	901113	91.94100	-65.56200
	113	24.72600	7.51800
	114	24.21800	85.51500
	2033	43.44300	81.96600

-99
1009 153.747 0

	1	105.47400	105.56600
	2	-106.00600	-106.90700
	3	105.88400	-106.36900
	4	-106.45100	105.01800
	901081	-86.49500	57.34600
	900112	-98.40200	-5.89800
	901083	-84.39300	-96.51700
	901091	-1.43100	70.42300
	901092	1.56700	-4.23000
	901093	0.57100	-78.78500
	106	-60.87800	83.40200
	2013	-42.35600	66.90900
	901091	-1.43100	70.42300
	901092	1.56700	-4.23000
	901093	0.57100	-78.78500
	901101	94.27600	86.69600
	901102	89.09600	-3.21500
	901103	81.85400	-85.38800
	2023	48.60800	84.98800
	116	64.50700	-76.28300

-99
1008 153.747 0

	1	101.94300	103.99600
	2	-108.09800	-110.04600
	3	103.78900	-107.93800
	4	-109.97600	101.87900

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901071	-94.91500	61.40300
901072	-99.81900	3.81200
901073	-93.26400	-73.62900
901081	-0.00300	64.82200
900112	-12.12200	0.68500
901083	-0.03300	-88.11900
901081	-0.00300	64.82200
900112	-12.12200	0.68500
901083	-0.03300	-88.11900
901091	87.00600	76.18700
901092	88.62700	-0.08000
901093	84.10000	-73.06600
106	26.70300	91.36200
2013	45.57900	73.60300

-99		
1007	153.747	0
	1	104.93600 106.74400
	2	-106.34200 -105.92000
	3	105.54300 -105.17500
	4	-106.97000 105.99800
	901061	-92.13500 101.38400
	900111	-99.76900 10.87200
	901063	-93.62100 -62.08700
	901071	-2.80400 68.09100
	901072	-7.94100 9.90600
	901073	-0.71300 -67.52900
	901071	-2.80400 68.09100
	901072	-7.94100 9.90600
	901073	-0.71300 -67.52900
	901081	91.48100 73.21900
	900112	80.28600 8.52800
	901083	91.96100 -79.88700

-99		
1006	153.747	0
	1	102.86100 111.46100
	2	-106.21300 -103.47000
	3	105.64500 -100.41600
	4	-109.02100 108.43400
	901051	-95.68900 92.53900
	901052	-94.41900 4.73200
	901053	-94.63300 -79.28600
	901061	-1.53100 96.45100
	900111	-10.15700 7.89900
	901063	-4.37400 -65.92900
	105	-41.72800 -76.15200
	104	-17.69700 80.98100
	901061	-1.53100 96.45100
	900111	-10.15700 7.89900
	901063	-4.37400 -65.92900
	901071	85.50100 65.96100
	901072	80.95800 8.69200
	901073	89.90800 -69.62700

-99		
1005	153.747	0
	1	104.58500 104.79400
	2	-103.79000 -110.75200
	3	108.09400 -107.11500
	4	-107.31400 101.16300
	901041	-94.39600 70.27400
	901042	-88.75400 -5.74900
	901043	-89.40200 -87.71800
	901051	-1.89500 82.89500
	901052	-0.63500 -4.21500
	901053	-0.34100 -88.69500
	103	-50.37500 -6.49100
	901051	-1.89500 82.89500
	901052	-0.63500 -4.21500
	901053	-0.34100 -88.69500
	901061	90.93500 87.24800
	900111	82.68500 -0.60600
	901063	89.25000 -74.71200

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105 51.92700 -85.25700
104 75.08700 71.91300

-99
1004 153.747 0
1 103.72600 105.92700
2 -104.58900 -109.79100
3 107.28100 -105.97700
4 -108.16900 102.11000
901031 -97.27700 65.09200
901032 -91.29100 -2.53800
901033 -92.31300 -101.17800
110 -101.17600 -1.63500
901041 -1.95500 74.87100
901042 3.18200 -1.50300
901043 1.88800 -82.93600
901041 -1.95500 74.87100
901042 3.18200 -1.50300
901043 1.88800 -82.93600
901051 90.65200 86.89900
901052 90.59700 -0.82100
901053 90.15000 -84.88900
103 41.80200 -2.61400

-99
1003 153.747 0
1 104.35300 106.05400
2 -105.48700 -108.06300
3 106.41200 -105.88000
4 -107.56300 103.85900
901021 -93.28600 90.18100
900102 -90.47700 13.61200
901023 -90.19200 -73.96400
901031 -1.21100 81.58700
901032 1.35600 11.50800
901033 -2.21500 -83.45400
110 -8.28700 12.76300
109 -11.74400 75.24400
901031 -1.21100 81.58700
901032 1.35600 11.50800
901033 -2.21500 -83.45400
110 -8.28700 12.76300
901041 97.05900 88.57000
901042 96.20900 9.22200
901043 88.69600 -69.68200

-99
1002 153.747 0
1 103.58600 106.49500
2 -107.17100 -106.85000
3 104.74500 -105.42800
4 -108.34700 105.13000
901011 -88.26700 98.39300
901012 -96.15800 12.91200
901013 -94.60800 -70.28600
901021 -1.77800 87.59600
900102 0.02400 11.62900
901023 -0.94900 -76.46000
100 -61.95000 102.39700
101 -54.39600 -63.12600
901021 -1.77800 87.59600
900102 0.02400 11.62900
901023 -0.94900 -76.46000
901031 90.13200 81.12100
901032 90.86200 11.48600
901033 87.02800 -84.23100
110 81.40900 12.53200
109 79.73800 74.61900

-99
1001 153.747 0
1 107.12300 111.18700
2 -105.45000 -100.27700
3 106.46800 -100.77300
4 -104.82000 111.69100

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901011	9.91600	91.70300
901012	0.57100	8.18300
901013	0.03000	-75.92400
901021	94.60200	81.43400
900102	95.96200	7.08400
901023	94.32900	-82.09800
100	35.84100	95.57200
101	40.88200	-68.51100

-99

2 6

2006	153.747	0		
	1	106.21000	104.40100	
	2	-107.63500	-105.82600	
	3	104.26300	-107.51200	
	4	-105.71000	106.09700	
	902051	-96.73000	72.50700	
	902052	-89.80500	-8.70300	
	902053	-90.48800	-69.83800	
	902061	-5.44000	75.60400	
	902062	0.10800	-3.60700	
	902063	-0.75300	-66.12700	
	1131	-53.84600	-66.16300	
	119	-69.71300	-72.42300	
	120	-76.93000	4.98100	
	121	-80.37200	50.72800	
	118	-9.47800	97.60500	

-99

2005

153.747	0			
	1	104.74900	104.07700	
	2	-107.19700	-107.96600	
	3	104.71300	-107.86300	
	4	-107.18100	103.95900	
	902041	-93.00800	75.91100	
	902042	-86.94600	9.86100	
	902043	-92.35300	-76.69900	
	902051	-8.57300	73.76100	
	902052	-0.00800	-8.20400	
	902053	0.49100	-68.19400	
	1121	-53.36700	-58.66800	
	902051	-8.57300	73.76100	
	902052	-0.00800	-8.20400	
	902053	0.49100	-68.19400	
	902061	82.76100	78.12200	
	902062	87.89100	-1.77500	
	902063	87.02700	-63.09200	
	1131	35.82200	-64.01000	
	119	20.54300	-70.33600	
	120	12.00100	5.63000	
	121	8.57800	51.68900	
	118	78.33700	100.78000	

-99

2004

153.747	0			
	1	106.57300	106.21300	
	2	-105.94300	-105.35700	
	3	105.94900	-105.71100	
	4	-105.36000	106.56300	
	902031	-88.68700	57.61100	
	902032	-91.29400	11.49800	
	902033	-95.10600	-80.64600	
	115	-109.53500	8.11100	
	902041	0.98800	63.02400	
	902042	7.24000	-0.91100	
	902043	1.16700	-90.13700	
	1111	-43.35500	-65.49500	
	117	-25.06500	5.66200	
	902041	0.98800	63.02400	
	902042	7.24000	-0.91100	
	902043	1.16700	-90.13700	
	902051	82.73300	61.62300	
	902052	93.46000	-18.15600	
	902053	95.91800	-80.02200	

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1121 40.03000 -70.57700

-99

2003 153.747 0
1 106.39800 101.84400
2 -108.09800 -107.62000
3 103.80500 -110.07700
4 -105.52800 104.29900
902021 -94.62700 65.64200
902022 -92.61500 -9.47600
902023 -93.32600 -81.16000
902031 0.86400 50.15200
902032 -0.22100 3.77600
902033 -2.28200 -87.53100
114 -22.22200 -84.60800
1101 -47.00700 -80.03300
115 -19.11200 0.56000
902031 0.86400 50.15200
902032 -0.22100 3.77600
902033 -2.28200 -87.53100
115 -19.11200 0.56000
902041 90.57900 55.29300
902042 97.91800 -9.21000
902043 92.28200 -97.68800
1111 47.83000 -73.01300
117 65.45500 -2.42100

-99

2002 153.747 0
1 103.77200 101.69200
2 -108.28700 -110.34500
3 103.61000 -110.24800
4 -108.16600 101.58500
902011 -95.00700 82.86800
902012 -91.55600 0.37300
902013 -91.29000 -83.38400
902021 -7.04300 80.51900
902022 -2.53400 2.11600
902023 -2.60500 -66.16100
1091 -51.16300 -79.02200
106 -110.39900 -67.19200
107 -67.58000 -4.29800
108 -68.67200 85.93200
902021 -7.04300 80.51900
902022 -2.53400 2.11600
902023 -2.60500 -66.16100
902031 92.34100 63.58000
902032 89.74100 15.23200
902033 83.92700 -72.18000
114 65.55300 -69.48800
1101 42.03600 -65.25000
115 69.83700 12.04300

-99

2001 153.747 0
1 105.26400 114.63900
2 -100.87200 -103.07300
3 110.97800 -97.22000
4 -106.61000 108.79400
902011 -0.27300 90.38500
902012 2.92500 8.15800
902013 2.53900 -75.44800
902021 87.08700 90.17500
902022 92.09200 12.52500
902023 90.98800 -55.23100
1091 42.04000 -69.69200
106 -16.61100 -59.94200
107 26.33000 4.21400
108 25.75500 94.08000

-99