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FLAW (ESIE) SOFTWARE DESIGN DESCRIPTION**Appendix D: File Structure of C-Scan File**

Unlike other files used by FLAW, the C-Scan file contains dummy space holders / gaps between useful data. The offset column describes the start position of the data (if it is known). The structure of a General Helical data file is presented in the following table:

Offset	Length	Type	Description
0	61	Data Header	CDataHeader class
70	728	Extended Data Header	CDataExtendedHeader class
800	156	Ultrasonic Hardware info	CUltrasonicHardware for ANDE only
1024	*	Raw Data	Raw data for different axial positions
N/A	*	File Footer	File footer (Not exists for CIGAR version earlier than 5.0)

The Data Header type is:

Length	Type	Description
1	Byte	Generating Station 1 = Pickering A 2 = Pickering B 3 = Bruce A 4 = Bruce B 5 = Darlington A 6 = Darlington B 7 = Point Lepreau 8 = Gentilly 9 = Wolsung 10 = Cordoba 11 = Cernavoda
1	Byte	Unit number. Possible values are: 1, 2, 3, 4, 5, 6, 7, or 8
1	Byte	Year. In two digit format such as 99, 02
1	Byte	Month. Possible values are from 1 to 12
1	Byte	Day. Possible values are from 1 to 31
1	Byte	Channel number. Possible values are from 1 to 24
1	Byte	Channel letter. Possible values are from A to Z
1	Byte	Channel end. 1 = Inlet 2 = Outlet
1	Byte	Reactor face. 1 = East 2 = West 3 = North 4 = South
10	String	Inspection head ID. Format is TMxx/Cyyy e.g. TM41/C062
22	String	Operator name
10	String	Date e.g. 03-Nov-99
10	String	Time e.g. 15:30:22

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The Extended Data Header type is:

Length	Type	Description
2	WORD	Scan type. 514 = General Helical C-Scan 517 = Circumferential B-Scan 522 = GH Cal Step 1 523 = GH Cal Step 2 524 = B-Scan Cal
4	Position	CPos. Scan start position
4	Position	CPos. Scan end position
1	Byte	First channel
1	Byte	Last Channel
2	Version	CVersion. Software version
2	WORD	Axial Increment in resolution units
4	Float	True axial start position in mm (Used in new file format)
4	Float	True axial end position in mm (Used in new file format)
1	Byte	Axial pitch in units of 0.1 mm
1	Byte	Unused
4 x 2	Short	4 power check in dB
7 x 2	Short	7 Chanel gain in dB
60	String	Operator comment
10	Byte	Unused
16 x 21	String	16 Channel labels
16 x 2	Channel Threshold	16 CThreshold. Channel thresholds (Used in Legacy file format only)
8 x 4	64 bit Integer	8 B-Scan channel offsets. Stored in an array of integer with 16 elements
25 x 2	Short	Gate delays stored in an 2D array [5][5] of short
25 x 2	Short	Gate Ranges stored in an 2D array [5][5] of short
5 x 2	Short	Receiver frequencies stored in an array of short with 5 elements
4	Float	Axial encoder resolution in mm/bit
4	Float	Axial increment resolution in mm/bit
4	Float	Scan sensitivity relative to notch in dB
8	64 bit integer	File footer offset
4 x 12	String	4 channel labels for ANDE system
1	Byte	File flip indicator

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The Position type is:

Length	Type	Description
2	WORD	Axial position in encoder counts (Used in legacy file format only)
2	short	Rotary position in encoder counts

The Version type is:

Length	Type	Description
1	Byte	Major version number
1	Byte	Minor version number. E.g. Version 5.0 Major = 5, Minor = 0

The Channel Threshold type is:

Length	Type	Description
1	Byte	Threshold value
1	Byte	Polarity. 0 = ABOVE, else = BELOW

The Ultrasonic Hardware Info data in C-Scan file only exists for ANDE data file. The type is:

Length	Type	Description
12 x 7	UTX	12 sets of data for CUTX class
12 x 1	Byte	12 digitization rates
12 x 1	Byte	12 digitizer attenuation
12 x 2	WORD	12 gate start
12 x 2	WORD	12 gate width

The UTX type is:

Length	Type	Description
1	Byte	Gain
1	Byte	Pulse voltage
1	Byte	Pulse width
2	WORD	Low filter
2	WORD	High filter

The Raw Data type contains the axial position and axial data at the axial position.

For data file from CIGAR version earlier than 5.0 or ANDE version 1.0 or earlier, the axial position is a 2 byte short. For everything else, the axial position is a 4 byte float.

Each axial data contains channels of data slice. The number of channels is stored in the Data Extended Header type, Last Channel field. A typical ANDE GH data file has 20 channels and the GH data file for CIGAR or CANDE has only 16 channels. A channel has 3600 data points, which represents a data point for every 0.1 degree

The number of Raw Data records dependent on the number of data collected. It is stored in a GH data file is calculated based on the size of the data file. The space between the Raw Data offset 1024 to the offset position for File Footer is for Raw Data records. With the known number of channels, and the correct byte size of the axial position, the number Raw Data records can be calculated by dividing the space for Raw Data records with the size of each Raw Data record.

The Raw Data type is:

Length	Type	Description
2 or 4	Short or float	Axial position for the data slice. Old file format uses 2 bytes short. New file format uses 4 bytes float
N x 3600	Byte	N channels of data slice. Each channel of data slice has 3600 (byte) values

The offset for the File Footer is stored as a member of the Data Extended Header. The File Footer is used as a place to store the Software Gains, changes to the recorded instrument parameters, or analyst comment.

The footer entries have variable lengths so the file footer structure lists the number of entries first and then the entries headers, which are both constant size, follow by the variable length entry data.

The header contains the offset location of the entry data and the entry type. There are 3 types:

- Type 0 – Track change records. Recording changes made to hardware during scan
- Type 1 – Software gains
- Type 2 – Analyst comments

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The File Footer type is:

Length	Type	Description
4	Integer	Item count. N Footer Entries
N x *	Footer Entry Header	N headers of Footer Entry
N x *	Footer Entry Data	N data of Footer Entry

The Footer Entry Header type is:

Length	Type	Description
8	64 bit Integer	Offset position for the Footer Entry Data
2	WORD	Footer entry type. 0 = Track change record 1 = Software gains 2 = Analyst comments

The Footer Entry Data type 0 (Track change records) is:

Length	Type	Description
4	Integer	Number of change parameters N
N x 68	Change Track Record	Change track records. CChangeTrackRecord classes

The Change Track Record type is:

Length	Type	Description
4	Float	Axial position
24	String	Date and time
20	String	Parameter name
10	String	Parameter value before the change
10	String	Parameter value after the change

The Footer Entry Data type 1 (Software gains) is:

Length	Type	Description
20 x 4	Software Gain	20 CSoftwareGain for each channel. only 16 used for CANDE and CIGAR

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The Software Gain type is:

Length	Type	Description
4	Float	Software gain

The Footer Entry Data type 2 (Analyst comments) is:

Length	Type	Description
4	Integer	Length of the analyst comment string
N	String	The analyst comment string

Appendix E: File Structure of B-Scan File

Unlike other files used by FLAW, the B-Scan file contains dummy space holders / gaps between useful data. The offset column describes the start position of the data (If it is known). The structure of a B-Scan data file is presented in the following table:

Offset	Length	Type	Description
0	61	Data Header	CDataHeader class
70	728	Extended Data Header	CDataExtendedHeader class
800 or 850	156 or *	Ultrasonic Hardware Info or BScan Hardware Info	CUltrasonicHardware for ANDE only or CBScanHardware for CIGAR or CANDE
1024	*	Raw Data	Raw data for different channels
N/A	*	File Footer	Optional file footer (Does not exist for CIGAR version earlier than 5.0)

The Data Header type is same as C-Scan data file Data Header type in Appendix D:

The Extended Data Header type is same as C-Scan data file Extended Data Header type in Appendix D:

The Ultrasonic Hardware Info type is same as C-Scan Ultrasonic Hardware Info type in Appendix D:

The BScan Header Info type has 2 different formats: one for version earlier than 5.0, and one for version 5.0 or later.

The BScan Header Info type for version earlier than 5.0 is:

Length	Type	Description
4	Float	Digitization Rate in MHz for 4 channels
21	Byte	Unused
4 x 18	Old UT Info	4 sets of old UT info

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The Old UT Info type is:

Length	Type	Description
2	Byte	Unused
4	Float	TOF gate start in us
4	Float	TOF gate width in us
2	WORD	Receiver gain in dB
2	Short	Receiver frequency
4	Byte	Unused

The BScan Header Info type for version 5.0 or later is:

Length	Type	Description
4 x 4	Float	4 Sampling rate for 4 channels
4 x 12	New UT Info	4 sets of new UT info

The New UT Info type is:

Length	Type	Description
4	Float	TOF gate start in us
4	Float	TOF gate width in us
2	WORD	Receiver gain in dB
2	Short	Receiver frequency

The Raw Data contains up to 4 sets of B-Scan Channel Data. The number of B-Scan Channel Data sets is stored in the Data Extended Header type, Last Channel field.

Each B-Scan Channel Data contains the data dimension and the AxialData. The Axial Data is broken down into Data Frames.

Each Data Frame represents the B-Scan data for a signal axial position. The Data Frame contains the data start position (POSL) and a 2-D array of different rotary positions and their A-Scan data.

The size of a Data Frame is 6 (For POSL) + (number of rotary points x number of wave points).

The size of a B-Scan Channel Data is 6 + (size of Data Frame x number of axial points).

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B-Scan Channel Data type is:

Length	Type	Description
*	B-Scan Channel Data	Up to 4 sets of B-Scan channel data

The B-Scan Channel Data type:

Length	Type	Description
6	Dimensions	The dimension of the channel data. cbDIMENSIONS
*	Data Frame	A list of data frames

The Dimensions type is:

Length	Type	Description
2	Short	Numbers of wave points
2	Short	Numbers of rotary points
2	Short	Numbers of axial points

The Data Frame type is:

Length	Type	Description
6	Position	Start position of the data frame. POSL
*	Axial Data	A list of A-Scan data for different rotary positions. The dimensions of the data is described in Dimensions

The File Footer type is same as C-Scan File Footer type in Appendix D: