ICES Fisheries Technology Committee
ICES CM 2004/B:04

Report of the Planning Group on the HAC Data Exchange Format (PGHAC)

17 April 2004
Gdynia, Poland

https://doi.org/10.17895/ices.pub.9628

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46 · DK-1553 Copenhagen V · Denmark
Telephone + 45 33 38 67 00 · Telefax +45 33 93 42 15
www.ices.dk · info@ices.dk

Contents

Summary

The Planning Group on the HAC Data Exchange Format (PGHAC) met in Gdynia, Poland, on 17 April 2003 to address the following Terms of Reference:

a) Co-ordinate the development of the HAC standard data exchange format;
b) Provide information on the changes in the format and its evolution;
c) Share information between manufacturers and users on the way acoustic data are processed and stored;
d) co-ordinate production of a new collated HAC specification manual;
e) review modifications to HAC compatible software to allow full data exchange.

The PG discussed the following main issues. These are presented with a short description of the conclusions.

- Final acceptance of independent platform attitude tuples 42 and 10142. These tuples are to allow information on sounders mounted on towed bodies or nets. They were reviewed in 2003 and have been accepted into the format in 2004
- Final versions of EK60 Tuples. These have been discussed by the PG in 2002 and 2003, and modifications proposed. The final drafts were presented, and minor changes proposed. The tuples will be accepted following circulation to the members.
- Range calculation algorithm for EK500 in tuple 10090 – SIMRAD has now made this available and it will be incorporated in the standard document under preparation.
- Review work on multi-beam tuples 220 and 2200. New drafts of these were examined and suggestions made for improvement. The finalized versions will be considered by correspondence by the group for inclusion in 2005.
- Clarification of variable length tuples. There has been some confusion about the use of variable length tuples and comment fields. ALL comment fields are now fixed and all new tuples can be variable in length.
- Seabed classification tuples. The existing tuple set was reviewed and it was agreed that this was sufficient for seabed discrimination purposes. Additionally, it was agreed that the classification data was too highly processed to be appropriate for tuple definition, which is primarily for raw data.
- New HAC standard document. The PG agreed that it was very desirable to collate all changes and additions made to the HAC standard since publication of the original specification. A draft of this was presented, and amendments suggested. It is proposed to publish this as an ICES Coop Research Report, and also via the web if possible.
- Review modifications to HAC compatible software to allow full data exchange. Progress has been good on the work ensuring the use of HAC as a data exchange format within the EU SIMFAMI project.
- Descriptions of angle data in HAC. Some problems were identified with the descriptions for angle data in a number of tuples. It was proposed that these should be redrafted and clarified for inclusion in the new standard document. This has been carried out.
- The future of PGHAC. The group felt that most of the compatibility issues leading to the formation of PGHAC had been resolved. The results of this would be encompassed in the new standard document. However, there were clear new developments that would benefit from existing or new HAC standards, especially those involving multi-beam sounders. Therefore, it was agreed that the group should continue, but that the group’s work could be conducted by e-mail. The current Chair also offered his resignation, and the members of the Planning Group proposed Laurent Berger of IFREMER as the new Chair.

1 Opening of the meeting

The meeting was chaired by D. Reid, (UK, Scotland) who also acted as Rapporteur. A full list of participants is attached as Annex 1.

2 Background

The Terms of Reference for the PGHAC as agreed at the FAST meeting (Bergen. Norway, June 2003) and approved at the ICES Annual Conference, Tallinn, Estonia, September 2003 were:

a) coordinate the development of the HAC standard data exchange format;
b) provide information on the changes in the format and its evolution;
c) share information between manufacturers and users on the way acoustic data are processed and stored
d) co-ordinate production of a new collated HAC specification manual
e) review modifications to HAC compatible software to allow full data exchange

PGHAC will make its report available to WGFAST and will report by 15 May 2004 for the attention of the Fisheries Technology Committee.

3 Introduction

In 1999, the Working Group on Fisheries Acoustics Technology (WGFAST) (meeting in St. John's, Newfoundland) adopted the ***HAC*** standard data format for raw and edited hydroacoustic data (Simard *et al.* 1997; 1999) as the common format for exchanging fisheries acoustics data and for comparing processing algorithms within the ICES community (ICES CM 1999/B:2: Section 10.3, p. 12). A group of experts including FAST members and representatives of hardware and software manufacturers was assigned the responsibility of coordinating the development of the format. This included the examination of proposals to introduce new information in the ***HAC*** environment and the definition of a generic set of tuples for echosounders that were not covered by the already defined tuples[*] of this upgradable format. At the WGFAST in Haarlem, Netherlands, it was agreed that this was a major issue of importance to all members of the fisheries acoustic community and that a more permanent group should be set up. This was proposed at the ASC in Bruges, Belgium (September 2000) and was formally incorporated as an ICES Planning Group (PGHAC, ICES Annual Report for 2000. Part 3. p. 256).

4 Subjects addressed

The PG discussed the following main issues:

[*] Tuple: a labeled group of bytes encapsulating special type of information in the ***HAC*** format, which forms the basic structure of this format and that gives the format its upgradability and versatility property. Tuples belongs to tuple families or classes that groups the information by themes. Unique numbers, varying from 0 to 65535, identify each tuple. The ***HAC*** co-ordinating committee has to allocate these numbers to prevent any "collision" in the tuple usage by various groups around the world and to agree on the definition of the various fields of information they contain.

- Final acceptance of independent platform attitude tuples 42 and 10142
- Final versions of EK60 Tuples. Circulated by SIMRAD
- Range calculation algorithm for EK500 in tuple 10090 – SIMRAD have made available
- Review work on multi-beam tuples 220 and 2200
- Revisit the question of variable length tuples – deferred from 2003
- Seabed classification tuples – QT evaluation of existing sets and proposals.
- New HAC standard document
- Review modifications to HAC compatible software to allow full data exchange
- Descriptions of angle data in HAC
- The future of PGHAC

The new tuples and changes to existing tuples are detailed in the annex and are only described briefly here. For more detail please see Annex 2

4.1 Final acceptance of independent platform attitude tuples (42 and 10142)

These new tuples were proposed and written by IFREMER to allow the recording of the attitude and relative position of an independent platform e.g., a towed body or sounder mounted on a fishing net. The tuples describe the set up for such a platform and its attitude recording systems (tuple 42) and a ping style tuple for recording continuous data (tuple 10142). Following edits proposed in 2003 the tuples were accepted. The tuple descriptions were provided in Tables 2 and 3 in Annex 2 of the 2003 report.

4.2 New Tuples (210 and 2100) for use with the SIMRAD EK60 Echosounder

Detailed proposals for new sounder and channel tuples for the EK60 were presented at the 2003 meeting. Final revisions based on the comments of the PG were presented at this meeting. All proposed revisions had been carried out by SIMRAD. Apart from a few minor details the PG had only one major request for further changes. This was in the field order adopted by SIMRAD for the sounder and channel tuples which was different from that adopted for the EK500 tuples. While this was not felt to affect the usability of the tuples, it was likely to lead to confusion. As it was relatively simple to adopt the same field order, this was requested and will be carried out prior to final publication in the new standard document (see Section 4.7 below). The final versions of the tuples will be circulated and are subject to the standard two month approval.

4.3 Range calculation algorithm for EK500 in tuple 10090

At the 2003 meeting the following text was included in the final report.

"The SIMRAD acquisition software produces the DEPTH of a detected single target, whereas in most cases the users would prefer the RANGE to that target. It appears that the SIMRAD software calculates the depth from the range and angle, so this value is a calculated rather than "raw" value. PGHAC would like manufacturers to provide the range to the target in any future applications. In addition, it was agreed that SIMRAD would make the algorithm for calculating depth from range available to the general user. This would allow the back calculation for range. When this is made available it will be included in the format text as a footnote."

SIMRAD has now kindly provided the algorithms. These will be included in the new HAC format document under preparation

For EK500 target depth appears to be the only target range corrected for transducer offset and **heave** information. The EK 60 algorithm is more complex and will be included in the documentation of the appropriate tuple.

4.4 Progress on the development of multi-beam tuples 220 and 2200

IFREMER presented the new tuples for use with multi-beam echosounders. These were adapted from the current EK60 tuples with additional fields introduced where required. The echosounder tuple will include fields for frequency, angles and beam formation Some fields have been moved from the channel tuples to the sounder tuples e.g., fields dealing with transmitted power, pulse shape or transducer geometry.

The channel tuple designs will be based on one channel per beam, with the number of channels given at offset 6 in the echosounder tuple. The channel tuples will contain additional data on beam type e.g., single or split, single reference or split reference, as well as data on the transmission weighting for the beams

A new tuple – 2210, was defined to hold the weighting array and will refer to the channel tuple.

Detailed descriptions of these three tuples are included with this report - see Annex 2.

Finalised versions of these tuples will be agreed by correspondence by the members of PGHAC with SIMRAD and IFREMER. These will be included in the 2005 report of the PG.

4.5 Variable length tuples

In previous reports problems were identified with the use of variable length tuples combined with variable length comment fields. To clarify this, the Planning Group has now decided that for all tuples, the comment fields will be of a fixed dimension as specified in the standard document. Variable length tuples are now allowed for any new tuple and should specify the actual length in the appropriate field. However, given the possibility of older, fixed length tuples and newer, variable length ones, **developers should always check tuple size when coding.**

4.6 Seabed classification tuples

The following is reprinted from the 2003 report;

"Following the 2002 meeting an approach was made by Quester-Tangent of Canada about the potential for the use of the HAC format to store sea bed classification data (ASC). This issue has become more topical with the formation of the Acoustic Seabed Classification Study Group within FAST. It was agreed that to a great extent the data specifications and quality required by HAC was also required for input to ASC post processing. To that extent, the existing HAC format would be appropriate. The output data is relatively straightforward and is also highly processed, as in such a form it is no longer easily transferable to another analysis system, the need for a HAC tuple description was unclear. It was agreed that Quester Tangent would study the existing format, and determine if all the requisite data fields were available. If not they will propose modifications which can be examined by the PG at its 2004 meeting."

After investigation by Quester Tangent it was agreed that output ASC data was too highly processed to be suitable for HAC inclusion. In most cases it would not be available at a ping level, and combined some or many raw variables derived from the seabed echo. The principle behind the development and use of the HAC format (Simard *et al.* 1997 and 1999) is to archive sufficiently raw data to allow reconstruction of the echogram in detail. QTC agreed that current data fields at sounder, channel and ping level provided adequate data quality for this type of ASC post processing. No further action required

4.7 New HAC standard document

At the 2003 PGHAC meeting the need to assemble all recent modifications and additions from PGHAC reports and to assemble a single definitive document was recognized. Over the previous 5 years, a number of new tuples had been added to the overall list as well as to the lists of tuples for HAC compatibility and compliance. In addition many tuples had been changed and updated, sometimes more than once. This created a difficult situation for anyone wishing to develop HAC compatible or compliant software. It was agreed that Ian McQuinn of DFO Canada would undertake this task with collaboration from the rest of PGHAC.

A draft document was presented to the group and the basic details agreed. Some modifications were still required, but progress was recognized as being good. Following discussion Ian McQuinn agreed to complete the document and circulate to PGHAC for approval.

This document describes:

- the need for a common data exchange format;
- the structure of a HAC file;
- the syntax rules;
- the definition of the basic tuples, the minimum tuples and the optional tuples;
- a complete description of the basic tuples;
- the definition of a HAC compatible software.

As this document will be definitive and useful for many developers and acoustic researchers, the PG felt that it would be useful to publish it as an ICES CRR. The PG also agreed that it was important that it should also be available as a downloadable PDF document on the ICES and other appropriate web sites. PGHAC have requested support from WGFAST, FTC and the Publications Committee for this course.

4.8 Review modifications to HAC compatible software to allow full data exchange

A table of current known HAC compatible software is presented in a table in chapter 8 of this report.

The group also reviewed ongoing work under the EU Project SIMFAMI aimed at using HAC format files for data exchange between different software. To date the project has been able to exchange data successfully between SIMRAD BI500, Movies plus and Echoview. As the use of the HAC format for data exchange was the initial purpose of setting up PGHAC, the group were delighted that this was now possible.

4.9 Descriptions of angle data in HAC

During the review process for the development of the new standard document, it was noted that many of the descriptions of the angle variables were ambiguous and inconsistent. Jon Preston of QTC, Canada agreed to examine these and redraft with a more consistent and understandable layout. The results of this exercise are presented in Annex 3.

4.10 The future of the PGHAC

As a part of this meeting, the PGHAC reviewed progress of the group to date and the choices for the future of the group. The bulk of the problems identified with the existing format have been resolved over the last four years. The production of a new standard document describing the HAC data format and rules was considered as an appropriate conclusion to this process. However, the field of fisheries acoustics (both in hardware and software) is in constant development, and it is anticipated that standard HAC data formats will be required in this context. The most important development will be the extension of the use of multi-beam echo sounders, and HAC tuples are under development for this. Other uses include sound speed and possibly inclusion of acoustic trawl geometry instruments.

Therefore, the group felt that there was a continued need for the existence of PGHAC to:

- continue to coordinate the development of the HAC standard data exchange format;
- respond to the developments in echosounders and in processing software and to encourage the use of HAC as a standard data format;
- provide tuple formats to handle multi-beam echosounders (e.g., SIMRAD MBES).

The group proposed that for the meantime it should continue to work by correspondence (email) only, and to meet as required in the future, when new issues arise and for the introduction of new tuples into the format.

5 Tuple allocation rules

The following is reprinted from the last report and is included here for the guidance of users and developers.

The rules for allocating tuple numbers and accepting new tuple definitions: the basic tuples and the optional tuples of the common data format.

*To ease the use of the **HAC** format by various software developers requiring the addition of new tuples, and to facilitate the work of the coordinating Committee, the tuple classes were divided in two groups. A first group is the basic tuples classes for which any tuple addition will require a thorough examination and a unanimous agreement by the coordinating committee. Tuple numbers will be allocated temporarily to the applicants during their definition and debugging period for a maximum of 14 months, after which they will be retired if the committee has not accepted their description. (See below; the Committee will meet annually to resolve outstanding issues). A second group is the optional tuple classes that concern auxiliary information or secondary level of data analysis. For these classes, the committee will allocate tuple numbers at the request of the users, on presentation of a short justification and objectives of the tuple by the applicant. In addition there is a need to define the minimum tuples required to define the minimum needs of a **HAC** compliant file.*

The Basic tuple classes are: Position tuples, Platform attitude tuples, Echosounder tuples, Channel tuples, Ping tuples, Threshold tuples, Environmental tuples for sound speed profiles, End of file tuples and the HAC signature tuple.

The Optional tuple classes are: Mission and project tuples, Navigation tuples, Event marker tuples, Edition tuples, Classification tuples, Environmental tuples except sound speed profiles, Private tuples, and Index tuples.

The minimum tuples in a HAC file are: Position tuples, an Echosounder tuple, a Channel tuple, Ping tuples, a Threshold tuple, an End of file tuple and the **HAC** signature tuple.

New or recently added tuple numbers

The following is presented as a summary of changes made at this meeting of PGHAC and includes a list of the tuples added since the initial definition of the ***HAC*** version 1.0. The preparation of the new standard HAC document (see Section 4.7) will include a substantial number of small changes to a range of tuples. In most cases these will be to remove errors and inconsistencies. These are not documented here and developers and users are advised to obtain this document on publication.

5.1 List of added tuples since HAC version 1.0

The following tuple numbers have been added to the list of defined tuples or in use:

39, 41, **42**, 210, 300, 301, 901, 1001, 2001, 2002, 2100, 3000, 3001, 4000, 5000, 5001, 9001, 10011, 10039, 10090, 10119, 10140**, 10142,** 12000, 12005, 12010, 12050, 12051, 12052, 12053, 12100, 13000, 13500, 14000, 65397, 65406. **Numbers in bold represent those tuples added at the 2003 meeting.**

5.2 Temporary tuples assigned for development at 2003 meeting – progress:

- 4010 Complex data parameter sub-channel tuple – still under development
- 10002 Complex data ping data – still under development

5.3 Tuples modified at the 2004 meeting

No modifications were made at this meeting, but users are advised to consult the standard document when it becomes available.

5.4 New tuples included at the 2004 meeting

11000 Environmental tuple for sound speed profiles – outline design by DFO (temporary – for development by IFREMER)

5.5 HAC compliance and HAC compatibility

A data file is defined as ***HAC*** compliant if it conforms to the ***HAC*** syntax rules, contains the minimum required ***HAC*** tuples described above using the exact tuple format described (Simard *et al.* 1997 or subsequent updates).

A software application tool is defined as ***HAC*** compatible if it can read and/or write, and use a minimum number of commonly used basic tuples, in the little endian format used by PC platforms.

In the 2003 PGHAC report the list of tuples required for HAC compatibility was defined as:

20	Geographic and time reference tuple
100	BioSonics Echosounder Tuple
200	SIMRAD EK500 Echosounder Tuple
901	Generic Echosounder Tuple – replaced previous version tuple 900
1000	BioSonics Channel Tuple
2000	SIMRAD EK500 Channel Tuple – original
2001	SIMRAD EK500 Channel Tuple – revised: 1) add Surface Blanking range 2) Save 2 dec. for angle offsets and 3dB beamwidth
2002	SIMRAD EK500 Channel Tuple patch tuple - Addition of both Sv and TS transducer gains
9001	Generic Channel Tuple– replaced previous version tuple 9000
10000	Standard Ping U32 – Time series of data samples Uncompressed 32-bit sample format range
10001	Ping U-32-16-angles Time series of split-beam off-axis angle sample data. Uncompressed 32-bit sample format range
10010	Ping C32 - Time series of samples. Compressed 32-bit sample format range
10011	Ping C-32-16-angles Time series of compressed split-beam off-axis angle sample data. Compressed 32-bit sample format range
10030	Ping U-16 - Time series of data samples. Uncompressed 16-bit sample format range
10031	Ping U-16-angles Time series of split-beam off-axis angle sample data. Uncompressed 16-bit sample format
10040	Ping C-16. Time series of samples. Compressed 16-bit sample format range:
10100	General threshold - Constant and time-varied threshold
65534	End of file
65535	HAC signature

Tuples 10030 and 10031 were added to the standard in 2003.

Two further tuples were added to the standard at this meeting of PGHAC 2003:	
42	Towed body position sub channel tuple
10142	Ping style tuple for towed body position data

The following table represents the ability of some of the currently available data acquisition software to read and write the above list of tuples and therefore their HAC compatibility

	Data Acquisition/Processing Software			
Tuple number	CH1(ver. 3.5)	CH2(ver 2.9)	Echoview (ver 3.1)	Movies+ (ver. 4.2)
20	W	R	RW	RW
100	W	R	R*	
200	W	R	R	RW
901	N/A	R*W*	RW	RW
1000	W	R	R*	
2000	W	R	R	R
2001	W	R	R*	RW
2002	W	R		RW
9001	N/A	R*W*	RW	RW
10000	W	R	RW	R
10001	W	R	RW	
10010	W	RW		R
10011	W	RW	RW	
10030				R
10031				
10040	W	R		RW
10100	WW	R	W*	RW
65534	W	R	RW	RW
65535		R	RW	RW

* Represents implementation planned for 2002/2003 – **Bold** represents new to standard

6 Recommendations

It was agreed that the group should continue to work by correspondence under the new Chairmanship of L. Berger, IFREMER, France. Proposed Terms of Reference are:

The **Planning Group on the HAC Data Exchange Format** [PGHAC] (Chair: L. Berger, France) will continue to work by correspondence in 2005 to:

a) coordinate the further development of the HAC standard data exchange format;
b) provide information on the changes in the format and its evolution;
c) share information between manufacturers and users on the way acoustic data are processed and stored;
d) Review the new collated HAC specification manual;
e) Review the development of tuples for multi-beam echosounders.

PGHAC will make its report available to WGFAST and will report by 15 June 2005 for the attention of the Fisheries Technology Committee.

7 References

Reid, D.G. (Ed.) (2001). Echo Trace Classification. ICES Cooperative Research Report. No. 238. ICES Copenhagen. 107pp

Simard, Y., McQuinn, I., Diner, N., and Marchalot, C. 1999. The world according to ***HAC***: summary of this hydroacoustic standard data format and examples of its application under diverse configurations with various echosounders and data acquisition software. ICES-Fisheries Acoustics Sciences and Technology meeting, St. John's, Newfoundland, Canada, 20-22 April 1999, Working paper. 14 pp.

Simard, Y., I. McQuinn, M. Montminy, C. Lang, D. Miller, C. Stevens, D. Wiggins and C. Marchalot. 1997. Description of the ***HAC*** standard format for raw and edited hydroacoustic data, version 1.0. Can. Tech. Rep. Fish. Aquat. Sci. 2174: vii + 65 pp.

8 Annexes

Annex 1 – List of Participants

Name	Organisation	Phone	Fax	E-mail
Erik Stenersen	Simrad AS, Norway	+47 33034462	+47 33034000	Erik.stenersen@simrad.com
Laurent Berger	IFREMER, Brest, France	+33 298 224986	+33 298224650	Laurent.berger@ifremer.fr
Noel Diner	IFREMER, Brest, France	+33 298224177	+33 298224650	Noel.diner@iferemer.fr
Ian McQuinn	DFO, IML, Canada	+1 418 775 0627	+1 418 775 0740	Mcquinni@dfo-mpo.gc.ca
Dave Reid	FRS, Aberdeen, UK	+44 01224 295 363	+44 1224 295511	Reiddg@marlab.ac.uk
John Preston	Quester Tangent, Canada	+1 250 6566677	+1 250 6554696	jpreston@questertangent.com

Annex 2 – Modifications to Existing Tuples and Proposed New Tuples

The following tables have been adopted as a standard component of this report and are designed outline any changes to existing tuples and define new provisional tuples. Where a tuple has been modified by the PG the changes are in **bold** and only those fields which have been changed are included, all other fields remain as previously described. The new tuples are provisional and will be reviewed by PGHAC in 2005 for acceptance into the standard. Software developers are reminded that these should not be shipped in any new software prior to this approval. The specification of the attribute field to include patch tuples is given in Table 9.

All users and developers are reminded that a new HAC standard document collating ALL changes since the original version 1.0.

Table 1. Definitions.

Data Type	**Size**	**Range**
DOUBLE	64 bit	Floating point
FLOAT	32 bit	Floating point
LONG	32 bit	Integer -2147483647 to 2147483647
ULONG	32 bit	Integer 0 to 4294967295
SHORT	16 bit	Integer -32767 to 32767
USHORT	16 bit	Integer 0 to 65535
CHAR	7 bit	Microsoft ASCII table for PC

Integer values are used to represent the encoded units presented in the tables.

Table 2. EK60 Echo sounder tuple 210– a new tuple for adoption in 2004.

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit range
0	Tuple size	4	ULONG	Tuple data size: 58 bytes	Byte	58
4	Tuple type	2	USHORT	Tuple type code: **210.** Tuple type code for the Simrad EK 60	Unitless	210
6	Number of SW channels	2	USHORT	Number of software channels associated with this sounder	Unitless	[1 to 65535]
8	Echo sounder document identifier	4	ULONG	Unique identification number for the echosounder document (i.e. the group of channels).	Unitless	[0 to 4294967295]
12	Sound speed	2	USHORT	Mean speed of sound. 0.0 = Profile used, 6553.5 = Not available	0.1 m/s	[1400.0 to 1700.0 m/s]
14	Ping mode	2	USHORT	1 = normal, 2 = external, 65535 = not available	unitless	[0 to 65535]
16	Ping interval	2	USHORT	0.0 = not known or variable	0.01 s	[0.00 to 655.35 s]
18	Space	2	USHORT		unitless	
20	Remarks	40	CHAR	SW version (example: “1.2.34.5678”)	ASCII	40 characters
60	Tuple attribute	4	LONG	Attribute of the tuple	Unitless	[-2147483648 to 2147483647]
64	Backlink	4	ULONG	Tuple size: 68 bytes	Byte	68

Field ping mode and ping interval have been reordered according to sounder tuple EK500 (2001)

.

Table 3. EK60 Echo channel tuple 2100 – new tuple for adoption in 2004.

Offset (byte)	**Field**	**Length (bytes)**	**Format**	**Content**	**Encoded units**	**Limit range**
0	Tuple size	4	ULONG	Tuple data size: 258 bytes	Byte	258
4	Tuple type	2	USHORT	Tuple type code: **2100.** Tuple type code for the Simrad EK 60	Unitless	2100
6	Software channel identifier	2	USHORT	Unique identifier for this software data channel	Unitless	[0 to 65535]
8	Echosounder document identifier	4	ULONG	Identification number for the parent echosounder document	Unitless	[0 to 4294967295]
12	Frequency channel name	48	CHAR	Example: "GPT 38 kHz 0090720171d3 1 ES38B"	ASCII	50 characters
60	Transceiver software version	30	CHAR	Example: "020221"	ASCII	30 characters
90	Transducer name	30	CHAR	Example: "ES38B"	ASCII	30 characters
120	Time sample interval	4	ULONG	Time between each sample	us	[1 to 65536 us]
124	Data type	2	USHORT	Type of data sampled: 0 = Electrical phase angles [Units: 180/128 degree] 1 = Electrical power [Units: dB re 1W] 2 = Sv [Volume backscattering strength in dB] 3 = TS [point target strength in dB] 4 = Complex voltage [Complex voltage from quadrants in split beam. Units: V]	Unitless	[0 to 65535]
126	Transducer beam type	2	USHORT	0=single, 1=split	Unitless	[0 to 65535]
128	Acoustic frequency	4	ULONG	Acoustic frequency	Hz	[1000 to 1000000 Hz]
132	Transducer installation depth	4	ULONG	Installation depth of transducer relative the sea surface 42949672.94 = dynamic platform 42949672.95 = not available	0.0001 m	[0.0000 to 10000.0000 m]
136	Start sample	4	ULONG	Number of samples offset from transducer face. 0=no offset	Unitless	[0 to 4294967295]
140	Platform identifier	2	USHORT	Unique identifier of the installation platform of the transducer 65535 = unavailable	Unitless	[0 – 65535]
142	Transducer shape	2	USHORT	0= other 1= oval (which includes circular transducer) 2= rectangular 3= cross array 4= ring … 65535= not available	Unitless	[0 – 65535] Presently: [0 – 4]

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit range
144	Transducer face alongship angle offset	4	LONG	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane of the attitude sensor co-ordinate system. Positive angles indicate the forward side is above the horizontal.	0.0001 deg	[-180.0000 to +180.0000 deg]
148	Transducer face athwartship angle offset	4	LONG	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane of the attitude sensor co-ordinate system. Positive angles indicate the starboard side is above the horizontal.	0.0001 deg	[-180.0000 to +180.0000 deg]
152	Transducer rotation angle	4	LONG	Mechanical angle of rotation of alongship axis of transducer relative to alongship axis of attitude sensor co-ordinate system. Positive angles are clockwise rotation (to starboard).	0.0001 deg	[-180.0000 to +180.0000 deg]
156	Transducer main beam axis alongship angle offset	4	LONG	Mechanical offset angle of the main axis of the acoustic beam in the alongship plane relative to the perpendicular to the transducer face. Zero (0) is perpendicular to the transducer face. Positive angles indicate the down-propagating sonar beam is oriented forward.	0.0001 deg	[-180.0000 to +180.0000 deg]
160	Transducer main beam axis athwartship angle offset	4	LONG	Mechanical offset angle of the main axis of the acoustic beam in the athwartship plane relative to the perpendicular to the transducer face. Zero (0) is perpendicular to the transducer face. Positive angles indicate the down-propagating sonar beam is oriented to starboard.	0.0001 deg	[-180.0000 to +180.0000 deg]
164	Absorption coefficient	4	ULONG	Absorption of sound in the propagation medium	0.0001 dB/km	[0.0000 to 300.0000 dB/km]
168	Pulse duration	4	ULONG	Duration of transmitted pulse	us	[0 to 65536 us]
172	Bandwidth	4	ULONG	Transceiver bandwidth	Hz	[100 to 100000 Hz]
176	Transmission power	4	ULONG	Transmit power referred to the transducer terminals	W	[0 to 10000 W]
180	Transducer alongship angle sensitivity	4	ULONG	Electrical phase angle in degrees for one mechanical angle in the alongship (fore-aft) direction.	0.0001 El./mec. deg	[0.0000 to 100.0000]
184	Transducer athwartship angle sensitivity	4	ULONG	Electrical phase angle in degrees for one mechanical angle in the athwartship (fore-aft) direction.	0.0001 El./mec. deg	[0.0000 to 100.0000]
188	Transducer alongship 3 dB beam width	4	ULONG	Half power (3dB) beam width of the transducer in the alongship direction.	0.0001 deg	[1.0000 to 99.9999 deg]
192	Transducer athwartship 3 dB beam width	4	ULONG	Half power (3dB) beam width of the transducer in the athwartship direction.	0.0001 deg	[1.0000 to 99.9999 deg]
196	Transducer equivalent two-way beam angle	4	LONG	Equivalent two way beam opening solid angle. MacLennan and Simmonds, “Fisheries Acoustics”1992, Section 2.3.	0.0001 dB	[-100.0000 to 0.0000 dB]
200	Transducer gain	4	ULONG	Transducer gain used in power budget calculations for calculation of TS.	0.0001 dB	[0.0000 to 99.9999 dB]
204	Transducer sA correction	4	LONG	Correction to transducer gain to obtain transducer gain used in power budget calculations for calculation of Sv (and sA). Transducer Sv gain = Transducer gain + Transducer sA correction.	0.0001 dB	[-10.0000 to +10.0000 dB]

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit range
208	Bottom detection minimum depth	4	ULONG	Minimum depth required for bottom detection.	0.0001 m	[0.0000 to 15000.0000 m]
212	Bottom detection maximum depth	4	ULONG	Maximum depth required for bottom detection.	0.0001 m	[0.0000 to 15000.0000 m]
216	Bottom detection minimum level	4	LONG	Bottom detection minimum level used in the bottom detector function. Ref. EK60 manual	0.0001 dB	[-80.0000 to 0.0000 dB]
220	Remarks	40	CHAR	Character string used for any comments to this channel.	ASCII	40 characters
260	Tuple attribute	4	LONG	Attribute of the tuple	Unitless	[-2147483648 to 2147483647]

Field transducer name has been displaced
Field time sample interval has been displaced according to channel tuple EK500 (2001)
Field transmission mode has been suppressed; this information is stored in the ping
Field transducer beam type has been displaced
Fields transducer depth and start sample have been displaced according to channel tuple EK500 (2001)
Fields platform identifier and transducer shape have been added since they have been omitted in the current version
Field transducer rotation angle has been displaced according to channel tuple EK500 (2001)
Fields pulse duration and bandwidth have been displaced according to channel tuple EK500 (2001)

Table 4. Multi-beam echo sounder - Echo sounder tuple 220– a new tuple for adoption in 2005.

Offset (byte)	**Field**	**Length (bytes)**	**Format**	**Content**	**Encoded units**	**Limit Range**
0	Tuple size	4	ULONG	Tuple data size: 58 bytes	Byte	174
4	Tuple type	2	USHORT	Tuple type code: **220.** Tuple type code for the Simrad MBES	Unitless	220
6	Number of SW channels	2	USHORT	Number of software channels associated with this sounder	Unitless	[1 to 65535]
8	Echo sounder document identifier	4	ULONG	Unique identification number for the echosounder document (i.e. the group of channels).	Unitless	[0 to 4294967295]
12	Transducer name	50	CHAR	Example:	ASCII	50 characters
62	Transceiver software version	30	CHAR	Example: "020221"	ASCII	30 characters
92	Sound speed	2	USHORT	Mean speed of sound. 0.0 = Profile used, 6553.5 = Not available	0.1 m/s	[1400.0 to 1700.0 m/s]
94	Trigger mode	2	USHORT	1 = normal, 2 = external, 65535 = not available	Unitless	[0 to 65535]
96	Ping interval	2	USHORT	0.0 = not known or variable	0.01 s	[0.00 to 655.35 s]
98	Pulse form	2	USHORT	1 = CW, 2 = FM, 65535 = not available	Unitless	[0 to 65535]
100	Pulse duration	4	ULONG	Duration of transmitted pulse	us	[0 to 65536 us]
104	Time sample interval	4	ULONG	Time between each sample	us	[1 to 65536 us]
108	Frequency beam spacing	2	USHORT	1 = Linear, 2 = Optimised, 65535 = not available	Unitless	[0 to 65535]
110	Frequency space shape	2	USHORT	1 = V, 2 = Inverse V, 3 = I, 65535 = not available	Unitless	[0 to 65535]
112	Transmission power	4	ULONG	Transmit power referred to the transducer terminals	W	[0 to 10000 W]
116	Transducer installation depth	4	ULONG	Installation depth of transducer relative the sea surface	0.0001 m	[0.0000 to 10000.0000 m]
120	Platform identifier	2	USHORT	Unique identifier of the installation platform of the transducer 65535 = unavailable	Unitless	[0 – 65535]
122	Transducer shape	2	USHORT	0= other 1= oval (which includes circular transducer) 2= rectangular 3= cross array 4= ring … 65535= not available	Unitless	[0 – 65535] Presently: [0 – 4]
124	Transducer face alongship angle offset	4	LONG	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane of the attitude sensor co-ordinate system. Positive angles indicate the forward side is above the horizontal.	0.0001 deg	[-180.0000 to +180.0000 deg]

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit Range
128	Transducer face athwartship angle offset	4	LONG	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane of the attitude sensor co-ordinate system. Positive angles indicate the starboard side is above the horizontal.	0.0001 deg	[-180.0000 to +180.0000 deg]
132	Transducer rotation angle	4	LONG	Mechanical angle of rotation of alongship axis of transducer relative to alongship axis of attitude sensor co-ordinate system. Positive angles are clockwise rotation (to starboard).	0.0001 deg	[-180.0000 to +180.0000 deg]
136	Remarks	40	CHAR	SW version (example: “1.2.34.5678”)	ASCII	40 characters
176	Tuple attribute	4	LONG	Attribute of the tuple	Unitless	[-2147483648 to 2147483647]
180	Backlink	4	ULONG	Tuple size: 184 bytes	Byte	184

Table 5. Multi-beam echo sounder - Channel tuple 2200– a new tuple for adoption in 2005.

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit range
0	Tuple size	4	ULONG	Tuple data size: 258 bytes	Byte	178
4	Tuple type	2	USHORT	Tuple type code: **2200.** Tuple type code for the Simrad MBES	Unitless	2200
6	Software channel identifier	2	USHORT	Unique identifier for this software data channel	Unitless	[0 to 65535]
8	Echosounder document identifier	4	ULONG	Identification number for the parent echosounder document	Unitless	[0 to 4294967295]
12	Frequency channel name	48	CHAR	Example:	ASCII	50 characters
60	Data type	2	USHORT	Type of data sampled: 0 = Electrical phase angles [Units: 180/128 degree] 1 = Electrical power [Units: dB re 1W] 2 = Sv [Volume backscattering strength in dB] 3 = TS [point target strength in dB] 4 = Complex voltage [Complex voltage from quadrants in split beam. Units: V]	Unitless	[0 to 65535]
62	Beam type	2	USHORT	Type of data sampled: 0 = Single beam of fan 1 = Split beam of fan 2 = Single reference beam 3 = Split beam reference beam	Unitless	[0 to 65535]
64	Acoustic frequency	4	ULONG	Acoustic frequency	Hz	[1000 to 1000000 Hz]
68	Start sample	4	ULONG	Number of samples offset from transducer face. 0=no offset	Unitless	[0 to 4294967295]
72	Transducer main beam axis alongship angle offset	4	LONG	Mechanical offset angle of the main axis of the acoustic beam in the alongship plane relative to the perpendicular to the transducer face. Zero (0) is perpendicular to the transducer face. Positive angles indicate the down-propagating sonar beam is oriented forward.	0.0001 deg	[-180.0000 to +180.0000 deg]
76	Transducer main beam axis athwartship angle offset	4	LONG	Mechanical offset angle of the main axis of the acoustic beam in the athwartship plane relative to the perpendicular to the transducer face. Zero (0) is perpendicular to the transducer face. Positive angles indicate the down-propagating sonar beam is oriented to starboard.	0.0001 deg	[-180.0000 to +180.0000 deg]
80	Absorption coefficient	4	ULONG	Absorption of sound in the propagation medium	0.0001 dB/km	[0.0000 to 300.0000 dB/km]
84	Bandwidth	4	ULONG	Channel bandwidth	Hz	[100 to 100000 Hz]
88	Transmission power	4	ULONG	Transmit power referred to the transducer terminals	W	[0 to 10000 W]
92	Transducer alongship angle sensitivity	4	ULONG	Electrical phase angle in degrees for one mechanical angle in the alongship (fore-aft) direction.	0.0001 El./mec. deg	[0.0000 to 100.0000]

Offset (byte)	Field	Length (bytes)	Format	Content	Encoded units	Limit range
96	Transducer athwartship angle sensitivity	4	ULONG	Electrical phase angle in degrees for one mechanical angle in the athwartship (fore-aft) direction.	0.0001 El./mec. deg	[0.0000 to 100.0000]
100	Transducer alongship 3 dB beam width	4	ULONG	Half power (3dB) beam width of the transducer in the alongship direction.	0.0001 deg	[1.0000 to 99.9999 deg]
104	Transducer athwartship 3 dB beam width	4	ULONG	Half power (3dB) beam width of the transducer in the athwartship direction.	0.0001 deg	[1.0000 to 99.9999 deg]
108	Transducer equivalent two-way beam angle	4	LONG	Equivalent two way beam opening solid angle. MacLennan and Simmonds, "Fisheries Acoustics"1992, Section 2.3.	0.0001 dB	[-100.0000 to 0.0000 dB]
112	Transducer gain	4	ULONG	Transducer gain used in power budget calculations for calculation of TS.	0.0001 dB	[0.0000 to 99.9999 dB]
116	Transducer sA correction	4	LONG	Correction to transducer gain to obtain transducer gain used in power budget calculations for calculation of Sv (and sA). Transducer Sv gain = Transducer gain + Transducer sA correction.	0.0001 dB	[-10.0000 to +10.0000 dB]
120	Bottom detection minimum depth	4	ULONG	Minimum depth required for bottom detection.	0.0001 m	[0.0000 to 15000.0000 m]
124	Bottom detection maximum depth	4	ULONG	Maximum depth required for bottom detection.	0.0001 m	[0.0000 to 15000.0000 m]
128	Bottom detection minimum level	4	LONG	Bottom detection minimum level used in the bottom detector function. Ref. EK60 manual	0.0001 dB	[-80.0000 to 0.0000 dB]
132	Alongship TX weighting identifier	2	USHORT	Unique identification number for transducer alongship TX weighting array	Unitless	[0 to 65535]
134	Athwartship TX weighting identifier	2	USHORT	Unique identification number for transducer athwartship TX weighting array	Unitless	[0 to 65535]
136	Alongship RX weighting identifier	2	USHORT	Unique identification number for transducer alongship RX weighting array	Unitless	[0 to 65535]
138	Athwartship RX weighting identifier	2	USHORT	Unique identification number for transducer athwartship RX weighting array	Unitless	[0 to 65535]
140	Remarks	40	CHAR	Character string used for any comments to this channel.	ASCII	40 characters
180	Tuple attribute	4	LONG	Attribute of the tuple	Unitless	[-2147483648 to 2147483647]
184	Backlink	4	ULONG	Tuple size: 188 bytes	Byte	188

Table 6. Multi-beam echo sounder - Echo sounder transducer weighting array tuple 2210– a new tuple for adoption in 2005.

Offset (byte)	**Field**	**Length (bytes)**	**Format**	**Content**	**Encoded units**	**Limit range**
0	Tuple size	4	ULONG	Tuple data size: variable	Byte	[14 – 4294967295]
4	Tuple type	2	USHORT	Tuple type code: **2210.**	Unitless	2210
6	Transducer weighting array identifier	2	USHORT	Unique identification number for transducer weighting array	Unitless	[0 to 65535]
8	Number of weighting values	4	ULONG	Mean speed of sound. 0.0 = Profile used, 6553.5 = Not available	Unitless	[0 to 4294967295]
12	Weighting value	2	USHORT	Weighting value	0.0001	[0 to 6.5535] practical range [0 to 1.0000]
...	Weighting value	2	USHORT	Idem		
...	Optional field: Space	2	USHORT	When needed: Space to allow the next field to be aligned on an address that is a multiple of 4.	Unitless	0
...	Tuple attribute	4	LONG	Attribute of the tuple: 0 = original tuple, e.g., nothing special to mention 1 = edited tuple Other attributes could be labelled by a code (e.g., tuple data quality). Negative codes should be used for special cases.	Unitless	[-2147483648 – 2147483647]
...	Backlink	4	ULONG	Tuple size: variable (multiple of 4 bytes).	byte	[14 – 4294967295]

Table 7. Specification of attribute field to include patch tuples.

Tuple attribute (ULONG)																																	
Content	Undefined																												Patched	Temporary	Edited	Value
Bit	b31	b30	b29	b28	b27	b26	b25	b24	b23	b22	b21	b20	b19	b18	b17	b16	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	Code
Original	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edited	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Temporary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
Temporary + Edited	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
Patched	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4
Patched + Edited	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	5
…																																	…
b0 (1)	Tuple has been edited (0 = original tuple)																																
b1 (2)	Temporary tuple (unofficial).																																
b2 (4)	Tuple has been patched. Therefore another tuple must refer to this tuple																																
b3 (8)	Undefined																																
…	…																																
b31 (2147483648)	Undefined																																

Annex 3 – Treatment of Angle Variables in the HAC Standard Format, Version 1.50", April 2004

Treatment of angle variables in HAC tuple descriptions
Excerpts from "Description of the HAC Standard Format, Version 1.50", April 2004

Tuple type	Offset	Field	Content
1000	32	Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane. Negative is below the horizontal and 0 degree is in the fore direction.
1000	34	Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane. Negative is below the horizontal and 0 degree is in the starboard direction.
1000	36	Alongship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the alongship plane. Negative is in the aft direction. Zero (0) is perpendicular to the transducer face.
1000	38	Athwartship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the athwartship plane. Negative is in the port direction below the horizontal. Zero (0) is perpendicular to the transducer face.
1001	32	Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane. Negative is below the horizontal and 0 degree is in the fore direction. **-3276.7 = not available**
1001	34	Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane. Negative is below the horizontal and 0 degree is in the starboard direction. **-3276.7 = not available**
1001	36	Alongship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the alongship plane. Negative is in the aft direction. Zero (0) is perpendicular to the transducer face. **-3276.7 = not available**
1001	38	Athwartship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the athwartship plane. Negative is in the port direction below the horizontal. Zero (0) is perpendicular to the transducer face. **-3276.7 = not available**
2000	28	Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane. Negative is below the horizontal and 0 degree is in the fore direction.
2000	30	Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane. Negative is below the horizontal and 0 degree is in the starboard direction.
2000	32	Alongship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the alongship plane. Negative is in the aft direction. Zero (0) is perpendicular to the transducer face.
2000	34	Athwartship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the athwartship plane. Negative is in the port direction below the horizontal. Zero (0) is perpendicular to the transducer face.
2001	36	Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane. Negative is below the horizontal and 0 degree is in the fore direction. -3276.7 = not available
2001	38	Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane. Negative is below the horizontal and 0 degree is in the starboard direction. -3276.7 = not available
2001	42	Alongship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the alongship plane. Negative is in the aft direction. 0 = perpendicular to the transducer face. -327.67 = not available.
2001	44	Athwartship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam of the transducer relative to the vertical in the athwartship plane. Negative is in the port direction below the horizontal. Zero (0) is perpendicular to the transducer face. -327.67 = not available.
9001	64	Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane of the attitude sensor co-ordinate system. Negative is below the horizontal and 0 degree is in the fore direction. -327.68 = not available
9001	66	Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane of the attitude sensor co-ordinate system. Negative is below the horizontal and 0 degree is in the starboard direction. -327.68 = not available
9001	70	Alongship angle offset of the main axis of the acoustic beam	Offset angle of the main axis of the acoustic beam in the alongship plane and perpendicular to the transducer face. Negative is in the aft direction below the horizontal. 0 = perpendicular to the transducer face. -327.68 = not available.

Tuple type	Offset	Field	Content
9001	72	Athwartship angle offset of the main axis of the acoustic beam	Offset angle of the main axis of the acoustic beam in the athwartship plane and perpendicular to the transducer face. Negative is in the port direction below the horizontal. 0 = perpendicular to the transducer face. -327.68 = not available.
41	20	Pitch	Inclination of the platform relative to the horizontal plane in the fore-and-aft direction. Negative angles are below the horizontal and positive above. 3276.7 = unavailable.
41	22	Roll	Inclination of the platform relative to the horizontal plane in the starboard-and-port direction. Negative angles are below the horizontal and positive above. 3276.7 = unavailable.
41	26	Yaw	Yaw of the platform. 3276.7 = unavailable.
10140	14	Pitch	Inclination of the platform relative to the horizontal plane in the fore-and-aft direction. Negative angles are below the horizontal and positive above. -3276.8 = unavailable.
10140	16	Roll	Inclination of the platform relative to the horizontal plane in the starboard-and-port direction. Negative angles are below the horizontal and positive above. -3276.8 = unavailable.
10140	20	Yaw	Yaw of the platform. Negative yaw angles clockwise (to starboard) and positive angles are counter-clockwise (to port). –3276.8 = unavailable.

Analysis

The first 20 lines in the table of extracts are five repeats of four lines, namely:

- Alongship angle offset of the transducer face
- Athwartship angle offset of the transducer face
- Alongship angle offset of the main axis of the acoustic beam
- Athwartship angle offset of the main axis of the acoustic beam.

With all of these, the wording in Field is consistent and clear. However the detailed descriptions in Content are ambiguous and inconsistent. Let us consider them in pairs.

For offset angle of the face, the concerns are:

- "Negative is below the horizontal" is ambiguous. A transducer face is either horizontal or tilted with part up and part down. That is, if the offset angle is non-zero, some part of the face is always below the horizontal. A clear statement would be "Positive means side closest to the bow is above the horizontal", or, for the athwartship angle, be "Positive means starboard side is above the horizontal".
- "0 degree is in the fore (or starboard) direction" does not seem to mean anything. Zero offset angle, really means that the face is horizontal.
- The first four times, the angle is said to be measured with respect to the horizontal. In tuple 9001, the reference is the horizontal in the alongship (or athwartship) plane of the attitude sensor co-ordinate system.
- The resolution is 0.1 deg in the first four tuples, 0.01 deg in tuple 9001.
- The value that indicates that data are not available is not always stated and not always the smallest possible value.

For offset angle of the axis of the acoustic beam, the concerns are:

- The sign convention is clear, except that the phrase "below the horizontal" is used inconsistently, and does not seem to add clarity. A clear statement would be "Positive means the down-propagating sonar beam goes forward", or, for the athwartship angle, "Positive means the down-propagating sonar beam goes to starboard".
- In the first four tuples, the offset angle is said to be measured with respect to the vertical. If it were, there would be no point in recording the offset angle of the face. The offset axis of the beam angle is either measured from a ship coordinate system, or is the sum of the offset angle of the face with respect to the ship and an offset from the face. Since the offset angle of the face is included in this standard, the second is clearly implied. Thus the phrase "relative to the vertical" should be removed from all these descriptions. There is no need to replace it with anything, because zero is already defined as perpendicular to the face.
- The offset could be due to beamforming, that is, it might not be simply mechanical.
- The resolution is 0.1 deg in the first four tuples, 0.01 deg in tuple 9001.
- The value that indicates that data are not available is not always stated and not always the smallest possible value.

The last six lines in the table of extracts are two repeats of three lines, namely the pitch, roll and yaw of the ship platform. Concerns are:

- In describing pitch and roll, the standard says, “Negative angles are below the horizontal and positive above”, which is ambiguous for the same reasons given above. Secondarily, it is redundant to define both signs. The usual conventions for pitch and roll angles, as used by Simrad, are that pitch is positive bow-up and roll is positive port-up. Clear statements would be “Positive angles indicate bow up” and for roll, “Positive angles indicate port up”.
- In describing yaw in tuple 41, no sign convention is given.
- In describing yaw in tuple 10140, the sign convention is opposite to that used universally for heading. For example, a ship heading at 30° that is momentarily at 31° would, by this definition, have a yaw of -1°, which seems strange.
- The value that indicates that data are not available is not always stated and not always the smallest possible value.

Recommendations

The Simrad co-ordinate system has the x-axis positive forward, the y-axis positive to starboard, and the z-axis positive down. This is a right-handed system. In this system, pitch is positive bow up, roll is positive port up, and yaw is positive clockwise. It is reasonable to suggest that we should not use any other co-ordinate system, or to describe these angles in novel or unusual ways.

Therefore, it is recommended that all the occurrences of angle offsets in the standard be described consistently, with the words in the table below. For example, offset 34 in tuple 1001 is an athwartship angle offset of the transducer face and would be described the corresponding entry in the table below.

Field	Content
Alongship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the alongship plane of the attitude sensor co-ordinate system. Positive means side closest to the bow is above the horizontal.
Athwartship angle offset of the transducer face	Mechanical offset angle of the transducer face relative to the horizontal in the athwartship plane of the attitude sensor co-ordinate system. Positive means starboard side is above the horizontal.
Alongship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam in the alongship plane relative to the perpendicular to the transducer face. Positive means the down-propagating sonar beam goes forward. Zero (0) is perpendicular to the transducer face.
Athwartship angle offset of the main axis of the acoustic beam	Mechanical offset angle of the main axis of the acoustic beam in the athwartship plane relative to the perpendicular to the transducer face. Positive means the down-propagating sonar beam goes to starboard. Zero (0) is perpendicular to the transducer face.
Pitch	Inclination of the platform relative to the horizontal plane in the fore-and-aft direction. Positive angles indicate bow up.
Roll	Inclination of the platform relative to the horizontal plane in the starboard-and-port direction. Positive angles indicate port up.
Yaw	Yaw of the platform. Positive angles indicate yaw to starboard.

If it is deliberate that the resolution is 0.1 deg in the first four tuples and 0.01 deg in tuple 9001, then this distinction should be maintained. If it is an oversight, then the all these fields should probably use the finer resolution. The values indicating that the data are unavailable needs to be added at the end of each entry under Content. These should be the most negative values possible.

These recommendations will be adopted for the drafting of the new standard document.