IASPEI Seismic Format (ISF)

FEATURES OF IASPEI SEISMIC FORMAT

IMS1.0 compliant	ISF messages comply with the IMS1.0 standard that was developed for exchanging data used to monitor the Comprehensive Test Ban Treaty. Thus, parsers that conform with the IMS1.0 standard will parse ISF messages without a fatal error, although they may ignore data in ISF extensions of IMS1.0.
IMS1.0 subset	IMS1.0 data types for radiogenic information and blocks for event screening are not part of ISF. Parsers than conform with the ISF standard will parse IMS1.0 messages, but may ignore information in IMS data types or blocks excluded from the ISF standard.
Formatted comments	IMS1.0 is extended by introducing formatting standards for additional types of data. IMS1.0 compliance is preserved by putting these formatted fields in IMS1.0 comment lines.
New sub-blocks	IMS1.0 parsers are expected to ignore unknown blocks and sub-blocks, which are recognised by preceding and folowing blank lines and the content of the header line. In the Bulletin datatype, ISF introduces an Effects block with macroseismic information and a phase information sub-block, with further information about phases in the arrivals block. In the Grouped Arrivals data type, ISF introduces an arrival information sub-block with further information about phases in the arrival block.
ISC/CSOI phase names	ISF messages include only seismic phase names from the phase name list maintained by the International Seismological Centre (ISC) and reviewed by the IASPEI Commission on Seismological Observation and Interpretation (CSOI). Most names correspond to ray paths in the earth. But a few (*e.g.*, “coda” and “amp”) are used to signal special meanings for other measurements. Phases with names not in the CSOI list may be ignored by ISF parsers.
ISC/CSOI parameters	Earthquake parameters and phase measurements in ISF formatted comments are only those from the lists maintained by the ISC and reviewed by the CSOI, where each is assigned a name, units and description. Units are not stated in ISF formatted comments. Parameters and measurements not in the ISC/CSOI lists may be ignored by ISF parsers. ISF writers exclude measurements not in the ISC/CSOI list from formatted comments.
FDSN channel codes	In both IMS1.0 and ISF messages, the channel field is filled only with channel codes that conform with the channel naming convention of the Federation of Digital Seismograph Networks, using the instrument type, sampling rate and component names from the FDSN lists.
ISF event type codes	The list of ISF event type codes, used in the origin block of the Bulletin datatype, are a superset of the IMS1.0 event types. ISF parsers may parse codes not in the list as “uk” (unknown).
WDC/ISC agency codes	ISF author fields all begin with internationally recognised agency codes. Further characters in author fields follow an underscore (_). The World Data Center/Denver for Seismology (WDC) and the ISC jointly maintain a list of recognised agency codes.
WDC/ISC station codes	Each phase line contains either an an internationally recognised station code or network code. The WDC and ISC jointly maintain lists of recognised station and network codes. Within its own network, each agency assigned an internationally recognised network code is free to assign station codes that conform with existing standards. ISF writers will not write phases with network/station codes that are not internationally recognised. ISF parsers may ignore phases with network/station codes that are not internationally recognised.

ISF COMMENTS

In ISF, an important extension of IMS1.0 is a set of rules for formatting comments to exchange types of data that are not accommodated in IMS1.0. The objective of the ISF standard is to allow recipients to utilise the full set of parameters in each message with minimal risk of misinterpretation. It would be possible to write an IMS1.0 message with custom, free-form comments containing data for which ISF includes special-purpose formatted comments. Such a message would not violate any of the ISF rules. Nevertheless, such messages fail to meet the ISF objectives, and might be described as incompletely formatted.

Comment Markers

Each ISF comment conforms with the IMS1.0 rules for comments within a bulletin:

- Each comment must be on a separate line
- Each comment line must begin with a single blank space
- Each comment must be enclosed within parentheses

Beyond the IMS1.0 comment rules the ISF standard includes additional rules to distinguish formatted comments. After the blank space and open parenthesis on each line, as required by IMS1.0, in an ISF formatted comment

- the first line begins with a hash mark (**#**) followed by a keyword identifying the type of formatted comment.
- each additional required line begins with a hash mark (**#**) and blank space at least as long as the keyword.
- each optional line begins with a plus sign (**+**) and blank space at least as long as the keyword.

On encountering the first line of an ISF formatted comment, a comment parser may be invoked. An ISF formatted comment parser must continue reading additional lines as part of the same ISF comment until encountering either a new ISF formatted comment, an unformatted comment, or a non-comment line.

Comment Terminators

The IMS1.0 standard does not state how parsers should handle bulletin comments that fail to be terminated with a close parenthesis. Such lines do not conform with the IMS1.0 standard and, conceivably, a strict IMS1.0 parser could reject that entire message as improperly formatted. In contrast, ISF comments are terminated by a carriage return. In order to conform with IMS1.0,

- ISF parsers are required to ignore a close parenthesis at the end of a comment line.
- ISF writers are required to insert a close parenthesis at the end of a comment line.

The IMS1.0 standard does not state whether or not pairs of parentheses are allowed within the outermost pair marking a comment. An IMS1.0 parser that ignores nesting of parentheses might terminate a comment at the first close parenthesis and neglect additional information on the line. The ISF standard avoids conflicts with this allowable behaviour by not requiring parentheses within any formatted comment. Nevertheless, unformatted comments in ISF messages may happen to include nested parentheses. This is allowed in ISF and provides no difficulty for ISF parsers, which define a comment as all characters between an initial open parenthesis and a carriage return, apart from an optional close parenthesis at the end of the comment.

ALIGNMENT

A fully compliant ISF writer aligns strings at the left side of character fields and aligns both integers and floating point numbers at the right side of numeric fields. A fully compliant ISF parser reads strings and numbers anywhere in a field, truncating both leading and trailing spaces before parsing. ISF writers do not use tab characters to align data in fields. ISF parsers may ignore any line that includes a tab character, and thus ignore any block or sub-block with a tab character in the header.

HTML COMMENTS

Comments incorporating HyperText Markup Language (HTML) include or provide links to further information avilaible on the internet related to particular data in the ISF message. Since they may provide information related to any type of data, HTML comments are permitted in any block or sub-block of any data type of an ISF message. In order to minimize unnecessary text around images and links that can be included using HTML, there is no keyword for HTML comments. Instead, ISF parsers should recognise that lines beginning " (<" are comments containing HTML, so that the recipient may choose to use the HTML separately, such as automated retrieval of additional information, incorporation into other products, or separate storage for later use. There is no limit on the number of characters in an HTML comment since they are generally meant to be interpreted by HTML-capable applications rather then viewed as test. Note that additional HTML tags at the beginning or end of an ISF message may be required in order for the HTML within ISF comments to be used by web browsers or other HTML-capable applications.

Example: Bulletin with HTML Comments

```
<HTML>
<BODY>
<PRE>

DATA_TYPE BULLETIN IMS1.0:short
 (<A HREF="http://www.seismology.harvard.edu/cgi-bin/CMT/form"><IMG SRC=<http://www.seismology.harvard.edu/top_sm.gif></A>)

Event   934906 Kuril Islands, Russia
   Date       Time        Err   RMS Latitude Longitude  Smaj  Smin  Az
1997/08/03 19:40:19.60   0.50        43.7300  147.4900   6.7   4.4
 (#PRIME)
 (<A HREF="ftp://www.iris.edu/">Spyder waveforms</A>)

Sta      Dist  EvAz Phase        Time      TRes  Azim AzRes   Slow   SR
JNK      2.02 267.0          19:41:16.2
 (<MAILTO="autodrm@anywhere.ac.ch">Waveforms from Swiss Seismological Service by e-mail)
JAK      2.17 251.0          19:41:21.5
JAR      2.74 262.0 P        19:41:03.0     0.8

STOP
</PRE>
</BODY>
</HTML>
```

BULLETIN DATA TYPE / ORIGIN BLOCK

Event Type Codes

Event type codes are used in columns 116-117 in origin lines. Most ISF event type codes are composed of a leading character that indicates the confidence with which the type of the event is asserted and a trailing character that gives the type of the event. The leading characters are

s = suspected
k = known
f = felt (implies known)
d = damaging (implies felt and known)

The trailing characters are

c = meteoritic event
e = earthquake
h = chemical explosion
i = induced event
l = landslide
m = mining explosion
n = nuclear explosion
r = rock burst
x = experimental explosion

A chemical explosion might be for mining or experimental, and it is possible to conceive of other types of events that might be assigned two or more different event type codes. This is deliberate, and matches the ambiguous identification of events in existing databases. The leading and trailing characters may be used in any combination. In addition, an ISF writer uses the the code “uk“ for events of unknown type while ISF parsers recognise both “uk“ and “u “ as events of unknown type and “ls” as known landslides.

Prime Origin Comments

Agencies may report several origins for each event, but residuals in the arrival block are reported with respect to just one of them. This will not necessarily be the preferred origin for all purposes, but it is necessary to designate the prime origin in order for the residuals to be useful. In ISF this origin is explicitly designated by a prime origin comment.

Table: Formatted Prime Origin Comment

Record	Position	Format	Description
1 (header)	3-8	a6	#PRIME

Example: Formatted Centroid Comment

```
 (#PRIME)
```

Centroid Origin Comments

Centroids and hypocentres represent different physical properties of an earthquake’s finite rupture zone. But the loctyp code on the origin line is intended to distinguish different methods for computing origins. Thus, loctyp cannot be used to distinguish centroids from hypocentres without overloading that attribute. Instead, centroids are distinguished with a special purpose formatted comment. The comment indicates only that the origin is a hypocentre without giving any further details, which are assumed to be given on the preceding origin line. Thus, the only required line is the header with the keyword CENTROID.

Table: Formatted Centroid Origin Comment

Record	Position	Format	Description
1 (header)	3-11	a9	#CENTROID

Example: Formatted Centroid Comment

```
 (#CENTROID)
```

Moment Tensor Origin Comments

Each moment tensor report is comprised of two header lines and a variable number of pairs of data lines. All of the moment tensors in one report are for the same origin, which precedes the report. Several items are omitted:

- Centroid, since it is presumed to precede in an origin line.
- The best fitting double-couple, since it could follow as a FAULT_PLANE comment.
- Principal axes, since they could follow as a PRINAX comment.
- M_W, since it could be included in the magnitude sub-block associated with the event.

Several redundant items are included:

- All three diagonal elements of the moment tensor are included since non-isotropic moment tensors may be reported occasionally
- Scalar moment, fraction CLVD and their uncertainties are included since these may be the most frequently used moment tensor parameters.

Table: Formatted Moment Tensor Comment

Record	Position	Format	Description
1 (header)	3-10	a8	`#MOMTENS`
	12-13	a2	`sc`
	18-19	a2	`M0`
	21-25	a5	`fCLVD`
	30-32	a3	`MRR`
	37-39	a3	`MTT`
	44-46	a3	`MPP`
	51-53	a3	`MRT`
	58-60	a3	`MTP`
	65-67	a3	`MPR`
	69-72	a4	`NST1`
	74-77	a4	`NST2`
	79-84	a6	`Author`
2 (header)	3	a1	`#`
	17-19	a3	`eM0`
	21-25	a5	`eCLVD`
	30-32	a3	`eRR`
	37-39	a3	`eTT`
	44-46	a3	`ePP`
	51-53	a3	`eRT`
	58-60	a3	`eTP`
	65-67	a3	`ePR`
	69-72	a4	`NCO1`
	74-77	a4	`NCO2`
	79-86	a8	`Duration`

(continued)

Table: Formatted Moment Tensor Comment (continued)

3 (data)	3	a1	#
	12-13	i2	scale factor (log10 of number by which moment tensor components and their uncertainties must be multiplied to obtain Newton-meters)
	15-19	f5.3	scalar seismic moment
	21-25	f5.3	fraction of moment released as a compensated linear vector dipole
	27-32	f6.3	radial-radial element of moment tensor
	34-39	f6.3	theta-theta element of moment tensor
	41-46	f6.3	phi-phi element of moment tensor
	48-53	f6.3	radial-theta element of moment tensor
	55-60	f6.3	theta-phi element of moment tensor
	62-67	f6.3	phi-radial element of moment tensor
	69-72	i4	number of stations used, type 1
	74-77	i4	number of stations used, type 2
	79-87	a9	agency that computed the moment tensor
4 (data)	3	a1	#
	15-19	f5.3	uncertainty of scalar seismic moment
	21-25	f5.3	uncertainty of fCLVD
	27-32	f6.3	uncertainty of radial-radial element
	34-39	f6.3	uncertainty of theta-theta element
	41-46	f6.3	uncertainty of phi-phi element
	48-53	f6.3	uncertainty of radial-theta element
	55-60	f6.3	uncertainty of theta-phi element
	62-67	f6.3	uncertainty of phi-radial element
	69-72	i4	number of components used, type 1
	74-77	i4	number of components used, type 2
	79-86	f8.2	presumed or computed source duration (seconds)

Example: Formatted Moment Tensor Comment

```
(#MOMTENS sc    M0 fCLVD    MRR    MTT    MPP    MRT    MTP    MPR NST1 NST2 Author  )
(#             eM0 eCLVD    eRR    eTT    ePP    eRT    eTP    ePR NCO1 NST2 Duration)
(#          27 2.109 0.345  1.601 -6.298  1.543 -3.456  8.901 -1.234   12  123 HRVD     )
(#             0.100 0.045  0.200  0.300  0.300  0.200  0.100  0.100   23  246    30.20)
```

Fault Plane Solution Origin Comments

Either one plane or two may be given.

Table: Fault Plane Solution Origin Comment

Record	Position	Format	Description
1 (header)	3-14	a12	`#FAULT_PLANE`
	16-18	a3	`Typ`
	20-25	a6	`Strike`
	29-31	a3	`Dip`
	36-39	a4	`Rake`
	42-43	a2	`NP`
	46-47	a2	`NS`
	49-53	a5	`Plane`
	55-60	a6	`Author`
2 (data)	3	a1	`# first plane, + second plane`
	16-18	a3	Fault plane solution computed from: `FM` = first motions `BB` = fit to broadband waveforms `BDC` = best double couple
	20-25	f6.2	Strike of either nodal plane (degrees, 0 to 360)
	27-31	f5.2	Dip of the same nodal plane (degrees, 0 to 90)
	33-39	f7.2	Rake of slip vector in the described plane (degrees, -180 to +180; required if only one plane is given)
	41-43	i3	For type=`FM`, number of P polarities For type=`BB`, number of stations For type=`BDC`, not used
	45-47	i3	For type=`FM`, number of S polarisations For type=`BB`, not used For type=`BDC`, not used
	49-53	a5	Plane identification `FAULT` = this is the preferred fault plane `AUXIL` = this is the auxiliary plane = neither plane is preferred as the fault
	55-63	a9	agency that computed the fault plane solution (neither required nor paresd for second plane)

Examples: Formatted Focal Mechanism Comment

```
(#FAULT_PLANE Typ Strike   Dip    Rake  NP  NS Plane Author)
(#            BDC 360.00 90.00 -180.00              USGS)

(#FAULT_PLANE Typ Strike   Dip    Rake  NP  NS Plane Author)
(#            FM    0.00 90.00          13   0 FAULT AEIC)
(+               90.00 90.00                   AUXIL)
```

Principal Axes Origin Comments

Principal axes can be computed from either a moment tensor or a fault plane solution. A bulletin may include the principal axes alone, or as well as the moment tensor or fault plane solution from which they were computed. Principal values are optional since they may not be available if the principal axes are computed from a fault plane solution based on first motions.

The error header and error lines are each optional. ISF writers should write the error header if the error data line is written. ISF parsers should be able to parse the error line regardless of whether or not the error header line is present.

Table: Formatted Principal Axes Origin Comment

Record	Position	Format	Description
1 (header)	3-9	a7	#PRINAX
	11-12	a2	sc
	15-19	a5	T_val
	21-26	a6	T_azim
	29-32	a4	T_pl
	35-39	a5	B_val
	41-46	a6	B_azim
	49-52	a4	B_pl
	55-59	a5	P_val
	61-66	a6	P_azim
	69-72	a4	P_pl
	74-79	a6	Author
2 (header)	3	a1	+
	17-19	a3	eTv
	24-26	a3	eTa
	30-32	a3	eTp
	37-39	a3	eBv
	44-46	a3	eBa
	50-52	a3	eBp
	57-59	a3	ePv
	64-66	a3	ePa
	70-72	a3	ePp
	74-78	a5	fCLVD

(continued)

Table: Formatted Principal Axes Origin Comment (continued)

3 (data)	3	a1	#
	11-12	i2	scale factor (log10 of number by which moment tensor components and their uncertainties must be multiplied to obtain Newton-meters; optional)
	14-19	f6.3	largest principal value (optional)
	21-26	f6.2	largest principal value axis azimuth
	28-32	f5.2	largest principal value axis plunge
	34-39	f6.3	middle principal value (optional)
	41-46	f6.2	middle principal value axis azimuth
	48-52	f5.2	middle principal value axis plunge
	54-59	f6.3	smallest principal value (optional)
	61-66	f6.2	smallest principal value axis azimuth
	68-72	f5.2	smallest principal value axis plunge
	74-82	a9	agency that computed the principal axes
4 (data)	3	a1	+
	15-19	f5.3	uncertainty of T principal value (optional)
	21-26	f6.2	uncertainty of T axis azimuth
	28-32	f5.2	uncertainty of T axis plunge
	35-39	f5.3	uncertainty of B principal value (optional)
	41-46	f6.2	uncertainty of B axis azimuth
	48-52	f5.2	uncertainty of B axis plunge
	55-59	f5.3	uncertainty of P principal value (optional)
	61-66	f6.2	uncertainty of P axis azimuth
	68-72	f5.2	uncertainty of P axis plunge
	74-78	f5.3	fraction of the moment release as compensated linear vector dipole (optional)

Example: Formatted Principal Axes Origin Comment

```
(#PRINAX sc  T_val T_azim  T_pl  B_val B_azim  B_pl  P_val P_azim  P_pl Author)
(+             eTv    eTa   eTp    eBv    eBa   eBp    ePv    ePa   ePp fCLVD)
(#       27  1.123   0.00  0.00 –0.123 180.00 90.00 –1.000  90.00  0.00 ERI)
(+           0.100  10.00 10.00  0.100  10.00 10.00  0.100  10.00 10.00 0.403)
(+       computed from moment tensor; T axis very uncertain)
```

Additional Parameter Origin Comments

After the keyword PARAM, each origin parameter comment consists of name followed by an equal sign and a value. The name is from a list of earthquake parameters maintained by the International Seismological Centre and reviewed by the IASPEI Commission on Seismological Observation and Interpretation. Spaces are not allowed before or after the equal sign, but are instead reserved as a separator between measurements. Uncertainty is optionally given following a plus sign. Units are not given for the measurements, but specified for each standard measurement name (e.g., STRESS_DROP must be given in Pascals). Values must be stated as real numbers including a decimal point and may include an exponent, indicated by an upper-case "E", *e.g.*, 1.0E27

Table: Formatted Additional Parameter Origin Comment

Record	Position	Format	Description
1 (data)	3-8	a6	#PARAM
	10-89	a80	*NAME=VALUE NAME=VALUE …*

Example: Formatted Additional Phase Measurement Comment

```
Event   934904 Irian Jaya region, Indonesia
   Date       Time        Err   RMS Latitude Longitude  Smaj  Smin  Az
1997/08/03 19:09:06.60   2.20  1.23  -0.5910  135.7600   4.8   4.3  90
 (#PARAM pP_DEPTH=20.2+10)
1997/08/03 19:09:07.90         1.43  -0.5570  135.7970
```

BULLETIN DATA TYPE / MAGNITUDE SUB-BLOCK

Magnitude Types

Each ISF magnitude type consists of a magnitude type, optionally concatenated with a magnitude type modifier. The magnitude types and type modifiers are from lists maintained by the International Seismological Centre and reviewed by the IASPEI Commission on Seismological Observation and Interpretation.

Example: ISF magnitude types

```
Magnitude  Err Nsta Author      OrigID
mb     5.0       12 NEIC       2010565
MSZ    5.3        1 NEIC       2010565
mb     4.8       16 ISC        2010569
MS     4.5       15 ISC        2010569
mL     5.5        1 DJA        2010568
mb     5.2        3 DJA        2010568
mbmle  4.8          EIDC       2010564
Mw     5.2          HRV        2010565
```

Stations Used Magnitude Comment

Stations used to compute individual magnitudes cannot be discovered by consulting defining/nondefining fields in the associated phase list. That mechanism would be unworkable, since magnitudes of several different types may have equal priority. Ambiguity may arise when trying to determine which stations contribute to each magnitude, especially when several types from several different agencies are given. This formatted comment provides a means of resolving the ambiguity. Each station is identified by an internationally registered code or by a network/code pairs, joined by a forward slash, where the network code is internationally registered. Station identifications are separated by whitespace.

Table: Formatted Stations Used Magnitude Comment

Record	Position	Format	Description
1 (data)	3-11	a9	#STATIONS
	13-92	a80	*NET/CODE NET/CODE NET/CODE …*
2 (data)	3-11	a1	**+**
	13-92	a80	*NET/CODE NET/CODE NET/CODE …*

Basis Parameter Magnitude Comment

The basis for some magnitudes is another earthquake parameter (*e.g.*, seismic moment, epicentral intensity, or seismic class) rather than ground motion amplitude averaged over a group of stations. It is sometimes useful to know both the type and value of parameter from which the magnitude was computed.

Table: Formatted Basis Paramter Origin Comment

Record	Position	Format	Description
1 (data)	3-11	a9	#BASIS
	13-92	a80	*PARAM=VALUE*

Example: Formatted Magnitude Comments

```
Magnitude  Err Nsta Author      OrigID
mb     5.0       12 NEIC       2010565
mb     4.8       16 ISC        2010569
 (#STATIONS CTA RANI WARB RMQ FORT)
 (+        STKA BBOO WOOL BAL YOU NJ2 SIMI MJAR TOO XAN)
MS     4.5       15 ISC        2010569
mL     5.5        1 DJA        2010568
mb     5.2        3 DJA        2010568
 (#STATIONS DJA/WAMI AEKI DJA/PANC)
MS     5.5          KRSC       2010564
 (#BASIS ENERGY_KLASS=12.2)
Mw     5.2          HRV        2010565
```

BULLETIN DATA TYPE / EFFECTS BLOCK

The Effects Block giving macroseismic observations is comprised of one header line, an optional summary data line, and any number of particular data lines. Each data line, including the summary, may be followed by comment lines giving further description of the effects. The descriptive comment lines provide further information about the immediately preceding data line; the author and location of the effects described are as given in the preceding data line.

Apart from the optional summary line, each data line must include one quantitative statement of the location of the observer, which may be latitude and longitude, distance and azimuth from the origin, country and postal code, or seismic network and station code. The location is preceded by a location type code.

There may be at most one summary data line, which is recognised by a unique location type code. The effects in the summary data line show the maximum known effects at any location, and may include effects not attributed to particular locations in further data lines in the block. The summary line may be followed by comment lines describing effects that are not attributed to any particular location.

Table: Effects Block

Record	Position	Format	Description
1 (header)	1-7	a7	`Effects`
	22-27	a6	`Loctyp`
	29-36	a8	`Location`
	48-56	a9	`Intensity`
	58-62	a5	`Scale`
	64-69	a6	`Author`
2 (data)	1	a1	heard flag (H or _)
	2	a1	felt flag (F or _)
	3	a1	damage flag (D or _) (includes livestock casualties)
	4	a1	human casualties flag (C or _)
	5	a1	uplift flag (U or _)
	6	a1	subsidence flag (S or _)
	7	a1	surface faulting flag (F or _)
	8	a1	tsunami flag (T, _, or Q for wave action that may have been a tsunami)
	9	a1	seiche flag (S, _, or Q for wave action that may have been a seiche)
	10	a1	volcanism flag (V or _)
	11	a1	acoustic waves flag (A or _)
	12	a1	gravity waves flag (G or _)
	13	a1	T-waves flag (T or _)
	14	a1	liquefaction flag (L or _)
	15	a1	geyser flag (G or _)
	16	a1	landslides or avalanches flag (S or _)

(continued)

Table: Effects Block (continued)

17	a1	sandblows flag (B or _)
18	a1	ground cracks flag (C or _) (excludes cracks due to surface faulting)
19	a1	earthquake lights flag (V or _)
20	a1	odours flag (O or _)

22-27	a6	location type: one of
		`Summar` (allowed only on the first line)
		`LatLon`
		`DistAz`
		`CoPost`
		`StaNet`

		location of conforming type: one of blank
29-46	f8.4 f9.4	latitude(<0 for S) longitude(<0 for W)
29-41	f8.2 f4.0	distance (kilometres) azimuth (degrees)
29-42	a3 a10	country postal-code
29-43	a9 a5	network-code station-code
48-51	f4.1	first value of maximum intensity
52	a1	intensity modifier: (often blank, if second intensity is given must be `-`, only other allowed value is +)
53-56	f4.1	second value of maximum intensity (permitted only if modifier is `-`)
58-62	a5	intensity scale
64-72	a9	author of the intensity data

Example: Macroseismic Effects Block

```
Effects              LocTyp Latitude Longitude Intensity Scale Author)
_F_CU_FTQ______SBC__ Summar                    11.0      MMS   NEIS)
___CU_FTQ______SBC__ LatLon +60.1234 -000.1234 10.0-10.5 EMS   T_Blair)
 (Big Ben toppled, stopped showing 05:01)
```

BULLETIN DATA TYPE / REFERENCE BLOCK

The reference block is an ISF extension of IMS1.0. It is used to cite further of information about the event, other than seismic bulletins. Such sources are generally papers in journals.

Table: Reference Block

Record	Position	Format	Description
1 (header)	1-4	a4	`Year`
	6-11	a6	`Volume`
	13-17	a5	`Page1`
	19-23	a5	`Page2`
	25-31	a7	`Journal`
2 (data)	1-4	i4	Year in which the paper was published
	6-11	i6	Volume number of the journal in which the paper was published
	13-17	i5	Page in the journal on which the paper begins
	19-23	i5	Page in the journal on which the paper ends
	25-90	a66	Name or abbreviated name of the journal in which the paper was published

Table: Formatted Author Reference Comment

Record	Position	Format	Description
1 (data)	3-9	a7	`#AUTHOR`
	11-90	a80	Surname,Initials, Surname,Initials, … with white space only between authors.
2 (data)	3	a1	+
	11-90	a80	further Surname, Initials, Surname, Initials, … (`, et al.` is appended to partial a author list)

Table: Formatted Title Reference Comment

Record	Position	Format	Description
1 (data)	3-8	a6	`#TITLE`
	11-90	a80	Title of the paper cited
2 (data)	3	a1	+
	11-90	a80	Further words of the title of the paper

Example: Reference Block with Author and Title Comments

```
Year Volume Page1 Page2 Journal
1992     17    23     0 Nat. Haz. Observer
 (#TITLE  Review of 'The Landers and Big Bear earthquakes of June 28, 1992)
 (+       by EQE International')
1992     73   417   418 EOS. Trans. Am. geophys. Un.
 (#AUTHOR Mori,J., Hudnut,K., Jones,L.M., et al.)
 (#TITLE  Rapid scientific response to Landers quake)
```

BULLETIN DATA TYPE / PHASE BLOCK

Seismological agencies often wish to exchange information about phases further to that in the phase lines in a Bulletin. There is too much of this to include by extension of the phase lines; they would be far too long to be readily printed or viewed on-line. Some of the information is also required for a large fraction of all phases. Including comments after many of the phase lines would significantly interfere with scanning the phases to judge the quality of the solution. The alternative adopted for ISF is a new sub-block. Formatted comments of the phase information sub-block are also permitted in the phase block.

Phase Information Sub-block

Each line in this sub-block is linked to a phase by sharing a common ArrID, just as each line in the magnitude sub-block is linked to an origin using by sharing a common OrigID.

Table: Phase Information Sub-block

Record	Position	Format	Description
1 (header)	1-3	a3	Net
	10-13	a4	Chan
	15	a1	F
	17-21	a5	Low_F
	23-27	a5	HighF
	29-36	a8	AuthPhas
	41-44	a4	Date
	50-54	a5	eTime
	56-60	a5	wTime
	62-66	a5	eAzim
	68-72	a5	wAzim
	75-79	a5	eSlow
	81-85	a5	wSlow
	92-95	a4	eAmp
	98-101	a4	ePer
	103-106	a4	eMag
	108-113	a6	Author
	119-123	a5	ArrID

(continued)

Table: Phase Information Sub-block (continued)

2 (data)	1-9	a9	WDC/ISC network code (station codes may be unique only within networks)
	11-13	a3	FDSN channel code
	15	a1	Filter type: C = causal 0 = zero phase
	17-21	f5.*	Minimum frequency of the filter pass band
	23-27	f5.*	Maximum frequency of the filter pass band
	29-36	a8	phase identification by the author, *i.e.*, the agency that read the waveform
	38-47	i4,a1,i2,a1,i2	arrival date (*yyyy/mm/dd*)
	49-54	f6.3	uncertainty of the phase arrival time
	56-60	f5.3	posterior weight of the time in computing the prime hypocenter (a dimensionless real number normally in the range 0.0 - 1.0; *not* a subjective description of relative quality)
	62-66	f5.1	uncertainty of the measured azimuth
	68-72	f5.3	posterior weight of the azimuth
	74-79	f6.1	uncertainty of the measured slowness
	81-85	f5.3	posterior weight of the slowness
	87-95	f9.1	Uncertainty of the measured amplitude
	97-101	f5.2	Uncertainty of the measured period
	103-105	f3.1	Uncertainty of the station magnitude
	107-114	a8	Author, *i.e.*, ISC/WDC code of the agency reading the waveform.
	116-123	a8	ArrID of the phase to which these uncertainties apply

Example: Phase Block, Phase Information Sub-block, and Phase Information Sub-block Formatted Comments

```
Sta     Dist  EvAz Phase        Time      TRes  Azim AzRes   Slow   SRes Def   SNR       Amp   Per Qual Magnitude    ArrID
KSAR   13.04  16.5 P       01:15:20.300   1.2 200.2   1.2   12.5   -0.3 TAS  47.5       1.5  0.33 a__             25616243
BJT    16.14 340.0 P       01:15:59.460   1.9 154.3  -1.9    9.0   -2.7 T__  26.3       1.3  0.33 a__             25616240
MJAR   17.24  44.5 P       01:16:09.650  -0.4 240.1   7.9   10.9   -0.1 T__   6.0       0.4  0.33 a__             25616246
CMAR   23.49 258.8 P       01:17:16.050   0.7  60.9   0.3    8.4    0.6 T__  35.6      10.5  0.83 a__ mb     4.1 25616266
CMAR   23.49 258.8 LR      01:27:05.155  -9.3  80.0  10.3   37.7   -0.4 ___            96.9 19.42 a__ Ms     3.4 25636151

Net      Chan F Low_F HighF AuthPhas    Date     eTime wTime eAzim wAzim  eSlow wSlow      eAmp  ePer eMag Author     ArrID
 (#OrigID 12345678)
IMS       BZH C  1.00  10.0 Pg       1997/01/01  0.200 0.000  10.0 0.400    2.5 0.400       0.1  0.05 1.0 EIDC     25636151
IMS       BZH C  1.00  10.0 pPKKPPKP 1997/01/01 99.200 0.000  10.0 0.400    2.5 0.400       0.1  0.05     EIDC     25616240
IMS       BZH C  1.00  10.0 P        1997/01/01  0.200 0.000  10.0 0.400    2.5 0.400       0.1  0.05     EIDC     25616246
IMS       BZH C  1.00  10.0 P        1997/01/01  0.200 0.000  10.0 0.400    2.5 0.400       0.1  0.05     EIDC     25616266
 (#MEASURE RECTILINEARITY=0.8)
IMS       BZH C  1.00  10.0 LR       1997/01/01        0.000  10.0 0.400    2.5 0.400 1234567.9  1.00     EIDC     25636151
 (#ORIG   PZH NRA0               1997/01/01 01:27:05.123 359.9       1234.5           123.4       1.3)
 (#MIN                                      -99.999      -100.0      -1000.0      -1234567.9-10.23)
 (#MAX                                      +99.999      +100.0      +1000.0      +1234567.9+10.23)
 (#COREC                                     +0.500      -100.0      -1234.5                      0.12)
```

OrigID Phase and Phase Information Comments

Some data in the phase block and phase information sub-block connect an arrival with an origin, *e.g.*, residuals. In IMS1.0 it is implicit that origin-specific data in the phase block refer to a primary or preferred origin. In ISF, a formatted comment may be used immediately after the phase block header or phase information sub-block header to state the OrigID explicitly. ISF also allows multiple phase blocks and phase information sub-blocks, but only if an OrigID comment is given for each one.

Table: Formatted OrigID Phase and Phase Information Comments

Record	Position	Format	Description
1 (data)	3-9	a7	`#OrigID`
	11-18	a8	origin identification

Measurement Range Phase Information Comments

Asymmetrical phase measurement uncertainties are stated as pairs of formatted comment lines in the phase information sub-block. The offsets from the preferred values to the minima and maxima are signed values, aligned under the uncertainties so that they are easy to read and so that the sub-block header identifies which uncertainties are being stated. There are no required fields; offsets to minimum and maximum arrival time, for example, could be stated without stating a range for any other parameters. All offsets are arithmetic (plus or minus) rather than geometric (times or divided by).

The basis for and use of ranges is not part of the format standard. For example, some agencies might compute minimum and maximum magnitudes based on the minimum and maximum amplitudes while others use the range of distances allowed by the minimum and maximum slownesses.

Table: Formatted Measurement Range Phase Information Comments

Record	Position	Format	Description
1 (data)	3-6	a4	`#MIN`
	48-54	f7.3	offset to minimum arrival time (seconds)
	61-66	f6.1	offset to minimum azimuth (degrees)
	73-79	f7.1	offset to minimum slowness (seconds/degree)
	86-95	f10.1	offset to minimum amplitude (nanometers)
	96-101	f6.1	offset to minimum period (seconds)
	102-105	f4.1	offset to minimum magnitude value
2 (data)	3-6	a4	`#MAX`
	48-54	f7.3	offset to maximum arrival time (seconds)
	61-66	f6.1	offset to maximum azimuth (degrees)
	73-79	f7.1	offset to maximum slowness (seconds/degree)
	86-95	f10.1	offset to maximum amplitude (nanometers)
	96-101	f6.1	offset to maximum period (seconds)
	102-105	f4.1	offset to maximum magnitude value

Additional Phase Measurement Comments

Measurements additional to those in the phase information lines may be placed in comments. After the keyword MEASURE, a phase measurement comment consists of standard measurement names, each followed by an equal sign and a value then, optionally, a plus sign and an uncertainty. The names are from a list maintained by the International Seismological Centre and reviewed by the IASPEI Commission on Seismological Observation and Interpretation. Spaces are not allowed before or after the equal sign or the plus sign, but reserved as a separator between measurements. Units are not given for the measurements, but specified for each standard measurement name.

Example: Additional Phase Measurement Comment

```
 (#MEASURE CODA_DURATION=5.4+0.2)
```

Measurement Correction Phase Information Comments

Corrections are model-based changes applied to phase measurements to remove bias from computed origin parameters. The basis for and use of corrections is not part of the format standard, *e.g.* some agencies might use static station corrections for time and slowness while others use source-dependent corrections. A bulletin might include both amplitude and magnitude corrections, one from focal mechanisms and the other on near-station attenuation.

Phase measurement corrections are stated as a single formatted comment line in the phase information sub-block. The corrections are aligned under the measured values so that they are easy to read and so that the sub-block header identifies which corrections are being stated. There are no required fields; amplitude correction, for example, could be stated without stating uncertainty in any other parameters. The values stated are arithmetic corrections, rather than corrected values. That is, the corrections were added to or subtracted from the measurements before being used to compute hypocentral parameters.

Table: Formatted Phase Measurement Correction Comment

Record	Position	Format	Description
1 (data)	3-8	a6	`#COREC`
	48-54	f7.3	arrival time correction (seconds)
	61-66	f6.1	observed azimuth correction (degrees)
	73-79	f7.1	observed slowness correction (seconds/degree)
	86-95	f10.1	amplitude correction (nanometers)
	96-101	f6.1	period correction (seconds)
	102-106	f5.2	magnitude value correction

Original Value Phase Information Comments

Agencies compiling bulletins may correct apparent blunders (*e.g.*, minute errors or non-standard units) or standardise presentation (*e.g.*, increment minute and subtract 60 from seconds). Some agencies translate local station codes or phase identifications to international standards. Original values can be useful for judging the reliability of "corrected" values. Since original values include blunders and local usage, they do not necessarily comply with conventions for dates and times, phase names, channels, station codes, etc. The originally reported slowness, ampliltude and period are not necessarily in the standard units.

Table: Formatted Original Phase Values

Record	Position	Format	Description
1 (data)	3-7	a5	`#ORIG`
	11-13	a3	originally reported channel code
	15-22	a8	originally reported station code
	38-47	i4,a1,i2,a1,i2	originally reported date (*yyyy/mm/dd*)
	49-60	i2,a1,i2,a1,f6.3	originally reported arrival time (*hh:mm:ss.sss*)
	62-66	f5.1	originally reported observed azimuth (degrees)
	74-79	f6.1	originally reported observed slowness (seconds/degree)
	87-95	f9.1	originally reported amplitude (nanometers)
	97-101	f5.2	originally reported period (seconds)
	103-105	f3.1	originally reported station magnitude

GROUPED ARRIVALS DATA TYPE

Many agencies using a geographically restricted network are able to locate local events, but not teleseisms. These can be reported in IMS1.0 using the data type "grouped arrivals", which is separate from the data type "bulletin".

Chronological Interpolation

The recipient of a message benefits from seeing how sets of arrivals that are related but not associated with a locatable event fit among local events. This can be accomplished within IMS1.0 by chronologically interpolating data sections of different types within an IMS1.0 message. In ISF, the interpolated position is based on primary origin times in the bulletin events and first arrival times in grouped arrivals.

IMS1.0 requires a stop line at the end of the last data section. Other data sections can omit the stop line and be ended implicitly by the start of a new data section, indicated by a data_type line.

Example: Use of Chronologically Interpolated data_types

```
DATA_TYPE BULLETIN IMS1.0:short

Event   934906 Kuril Islands, Russia
   Date       Time        Err   RMS Latitude Longitude  Smaj  Smin  Az
1997/08/03 19:40:19.60   0.50        43.7300  147.4900   6.7   4.4

Sta     Dist  EvAz Phase        Time      TRes  Azim AzRes   Slow   SR
JNK     2.02 267.0          19:41:16.2
JAK     2.17 251.0          19:41:21.5
JAR     2.74 262.0 P        19:41:03.0     0.8
JAR     2.74                19:41:35.5
JOB     2.79 254.0 P        19:41:03.4     0.5
JCH     3.22 251.0 P        19:41:09.4     0.4
JCH     3.22                19:41:47.0
JEM     3.62 243.0 P        19:41:15.1     0.5
URA3    3.82 249.0 P        19:41:18.6     1.1

DATA_TYPE ARRIVAL:grouped IMS1.0:short

Net      Sta   Chan Aux    Date       Time        Phase     Azim  Slow
JMA      JOD2           1997/08/03 20:00:53.3   P
JMA      JHU            1997/08/03 20:00:54.3   P
JMA      JHU            1997/08/03 20:01:05.5
JMA      KTJJ           1997/08/03 20:00:55.2   P

Net      Sta   Chan Aux    Date       Time        Phase     Azim  Slow
IMS      WRA            1997/08/03 20:10:50.1   P        343.0  10.0
AGSO     QIS            1997/08/03 20:11:11.2   P
CSN      BJT            1997/08/03 20:12:09.1   P        157.8   5.8

STOP
```

Grouped Arrival Information Sub-block

Each line in this sub-block is linked to an arrival by sharing a common ArrID. The grouped arrival information sub-block differs from the phase information sub-block to avoid duplicating fields in the grouped arrival block and since phase information are inapplicable without an origin.

TABLE: GROUPED ARRIVAL INFORMATION SUB-BLOCK

Record	Position	Format	Description
1 (header)	1	a1	`F`
	3-7	a5	`Low_F`
	9-13	a5	`HighF`
	16-21	a5	`eTime`
	24-28	a5	`eAzim`
	32-36	a5	`eSlow`
	44-47	a4	`eAmp`
	51-54	a4	`ePer`
	59-63	a5	`ArrID`
2 (data)	1	a1	Filter type: C = causal 0 = zero phase
	3-7	f5.*	Minimum frequency of the filter pass band
	9-13	f5.*	Maximum frequency of the filter pass band
	16-21	f6.3	uncertainty of the phase arrival time (seconds)
	24-28	f5.1	uncertainty of the measured azimuth (degrees)
	30-36	f7.1	uncertainty of the measured slowness (seconds/degree)
	39-47	f9.1	uncertainty of the measured amplitude (nanometers)
	50-54	f5.2	uncertainty of the measured period (seconds)
	56-63	a8	arrival identification

Grouped Arrival Comments

ISF allows all of the formatted comment types from the phase information block of the bulletin data type also to be included in the grouped arrivals data type. Original values formatted comments are in the grouped arrival block, while minimum, maximum and correction comments are in the grouped arrival information sub-block. The field in these comments are shifted from their positions in the phase information block comments to align them with with the analogous fields in the arrival block and arrival sub-block.

Example: Arrival Block, Arrival Information Sub-block, and Formatted Comments

```
Net       Sta   Chan Aux     Date       Time        Phase     Azim  Slow   SNR       Amp   Per Qual   Group C Author       ArrID
CTBT_IMS  ARCES BZH      1997/01/01 01:23:45.678 pPKKPPKP 123.5 123.5 123.5 1234567.9 12.45 aci              EIDC_REB  12345678
 (#ORIG   ARA0  PZH      2997/01/01 01:27:05.123 LR       359.9 123.5 123.5 1234567.9 12.45)
```

```
F Low_F HighF   eTime  eAzim   eSlow       eAmp   ePer  ArrID
C  1.00  10.0   0.200   10.0     2.5        0.1   0.05  25636151
 (#MIN        -99.999 -100.0 -1000.0 -1234567.9 -10.23)
 (#MAX        +99.999 +100.0 +1000.0 +1234567.9 +10.23)
 (#COREC       +0.500 -100.0 -1234.5 +1234567.9 +12.45)
```

Distance Range Grouped Arrival Comment

Often, an agency reporting grouped arrivals will be confident of identifying the arrivals as local, regional or teleseismic from the character of the waveforms that they have read. Nevertheless, they may not be able to identify particular phases without an origin estimate. ISF messages indicate this type of information using a comment immediately after the header line.

Note that within one grouped arrivals data section, arrivals may be grouped with several different events, which would be indicated by a new header line for event. By putting the distance range comment after the header, ISF allows each event to be given a separate distance range.

Table: Formatted Distance Range Grouped Arrival Comment

Record	Position	Format	Description
1 (data)	3-13	a11	`#DIST_RANGE`
	15-25	a11	Distance Range: `LOCAL` = 0 to 10 degrees from network `REGIONAL` = 10 to 30 degrees from network `TELESEISMIC` = >30 degrees from network

Example: Formatted Distance Range Grouped Arrival Comment

```
data_type arrival:grouped IMS1.0

Net       Sta   Chan Aux     Date      Time       Phase      Azim  Slow
 (#DIST_RANGE       LOCAL)
CTBT_IMS  ARCES SHZ      1997/01/01 00:00:00.000           234.5  34.5
```