

SPECIFICATIONS OF OCTET CONTENTS

Notes:

- (1) Octets are numbered 1, 2, 3, etc., starting at the beginning of each section.
- (2) In the following, bit positions within octets are referred to as bit 1 to bit 8, where bit 1 is the most significant and bit 8 is the least significant bit. Thus, an octet with only bit 8 set to 1 would have the integer value 1.
- (3) For encoding data, BUFR edition 3 may be used up to the first Tuesday of November 2012. Edition 4 may be used as from 2 November 2005. A BUFR message shall not mix features of both editions; the content shall be consistent and in accordance with a single edition. It is recommended to use, if possible, the latest edition of BUFR.
- (4) Specific features for different editions, when different, will be clearly indicated below in sequence.

Section 0 – Indicator section

Octet No.	Contents
1–4	BUFR (coded according to the CCITT International Alphabet No. 5)
5–7	Total length of BUFR message (including Section 0)
8	BUFR edition number (3 or 4) (See Note 3 above)

Section 1 – Identification section for BUFR edition 3

Octet No.	Contents
1–3	Length of section
4	BUFR master table (zero if standard WMO FM 94 BUFR tables are used – see Note 2)
5	Originating/generating sub-centre: Code table 0 01 034 (defined, if necessary, by associated originating/generating centre – see Note 3 of Common Code table C–1 in Part C/c.)
6	Originating/generating centre: Code table 0 01 033 (Common Code table C–1 in Part C/c.)
7	Update sequence number (zero for original BUFR messages; incremented for updates)
8	Bit 1 = 0 No optional section = 1 Optional section follows Bits 2–8 Set to zero (reserved)
9	Data category (Table A)
10	Data sub-category (defined by local automatic data processing (ADP) centres)
11	Version number of master table used – see Notes 2 and 4
12	Version number of local tables used to augment the master table in use – see Note 2
13	Year of century
14	Month
15	Day
16	Hour
17	Minute
18–	If not required by ADP centres for local use, octet 18 only shall be included and set to zero with reference to Regulation 94.1.3

} Most typical for the BUFR message contents

Notes:

- (1) If a BUFR message is corrected, the corrected message shall be represented in full with the update sequence number incremented by one. Operator 2 04 YYY qualified by descriptor 0 31 021 may be used to indicate which value or values were corrected.
- (2) A BUFR master table may be defined for a scientific discipline other than meteorology. This shall be indicated by non-zero numeric values in octet 4. Such a table will be developed, in coordination with the WMO/CBS Expert Team on Data Representation and Codes, when a recognized organization exists with the necessary expertise to maintain such a master table, and when at least one of the following situations also exists:

- Requirements cannot be met using Master Table 0.
- There is expected to be a minimal amount of overlap with respect to the entries in Master Table 0.

The current list of master tables, along with their associated values in octet 4, is as follows:

0	Meteorology maintained by the World Meteorological Organization (WMO)
10	Oceanography maintained by the Intergovernmental Oceanographic Commission (IOC) of UNESCO

Whenever a new master table is developed, the following criteria shall apply:

- Table C may not be changed, nor may Classes 00 and 31 of Table B. These would remain identical for any of the master tables.
- For Classes 01 through 09 (coordinate classes) and Class 33 of Table B, and for Categories 00 and 01 of Table D, these classes and categories must have the same name and be used for the same types of descriptors as in Master Table 0; however, individual descriptors within these classes and categories would be left to the discretion of the Organization defining the particular master table in question.
- For Table A and all remaining classes of Table B and categories of Table D, these would be left to the discretion of the Organization defining the particular master table in question.

For all master tables (including Master Table 0):

- Each revision of the master tables shall be given a new version number.
 - Local tables shall define those parts of the master table which are reserved for local use, thus version numbers of local tables may be changed at will by the originating centre. If no local table is used, the version number of the local table shall be encoded as 0.
- (3) To specify year 2000, octet 13 of the section (Year of the century) shall contain a value equal to 100. To specify year 2001, octet 13 of the section shall contain a value equal to 1 (by international convention, the date of 1 January 2000 is the first day of the hundredth year of the twentieth century and the date of 1 January 2001 is the first day of the first year of the twenty-first century); it is to be noted also that year 2000 is a leap year and that 29 February 2000 exists.
- (4) For Master Table 0, the master table version numbers are as follows:
- | | |
|----|---|
| 0 | Experimental |
| 1 | Version implemented on 1 November 1988 |
| 2 | Version implemented on 1 November 1993 |
| 3 | Version implemented on 2 November 1994 |
| 4 | Version implemented on 8 November 1995 |
| 5 | Version implemented on 6 November 1996 |
| 6 | Version implemented on 5 November 1997 |
| 7 | Version implemented on 4 November 1998 |
| 8 | Version implemented on 3 May 2000 |
| 9 | Version implemented on 8 November 2000 |
| 10 | Version implemented on 7 November 2001 |
| 11 | Version implemented on 5 November 2003 |
| 12 | Version implemented on 2 November 2005 |
| 13 | Version implemented on 7 November 2007 |
| 14 | Version implemented on 4 November 2009 |
| 15 | Version implemented on 15 September 2010 |
| 16 | Version implemented on 4 May 2011 |
| 17 | Version implemented on 2 November 2011 |
| 18 | Pre-operational to be implemented by next amendment |

Section 1 – Identification section for BUFR edition 4

Octet No.	Contents
1–3	Length of section
4	BUFR master table (zero if standard WMO FM 94 BUFR tables are used – see Note 2)
5–6	Identification of originating/generating centre (see Common Code table C-11)
7–8	Identification of originating/generating sub-centre (allocated by originating/generating centre – see Common Code table C-12)
9	Update sequence number (zero for original BUFR messages; incremented for updates)

10	Bit 1 = 0	No optional section
	= 1	Optional section follows
	Bits 2-8	Set to zero (reserved)
11	Data category (Table A)	
12	International data sub-category (see Common Code table C-13 and Note 3)	
13	Local data sub-category (defined locally by automatic data-processing (ADP) centres – see Note 3)	
14	Version number of master table – see Notes 2 and 5	
15	Version number of local tables used to augment master table in use – see Note 2	
16–17	Year (4 digits)	} Most typical time for the BUFR message contents – see Note 4
18	Month	
19	Day	
20	Hour	
21	Minute	
22	Second	
23–	Optional – for local use by ADP centres	

Notes:

- (1) If a BUFR message is corrected, the corrected message shall be represented in full with the update sequence number incremented by one. Operator 2 04 YYY qualified by descriptor 0 31 021 may be used to indicate which value or values were corrected.
- (2) A BUFR master table may be defined for a scientific discipline other than meteorology. This shall be indicated by non-zero numeric values in octet 4. Such a table will be developed when a recognized organization exists with the necessary expertise to maintain such a master table, and when at least one of the following situations also exists:
 - Requirements cannot be met using Master Table 0.
 - There is expected to be a minimal amount of overlap with respect to the entries in Master Table 0.

The current list of master tables, along with their associated values in octet 4, is as follows:

0	Meteorology maintained by the World Meteorological Organization (WMO)
10	Oceanography maintained by the Intergovernmental Oceanographic Commission (IOC) of UNESCO

Whenever a new master table is developed, the following criteria shall apply:

- Table C may not be changed, nor may Classes 00 and 31 of Table B. These would remain identical for any of the master tables.
- For Classes 01 through 09 (coordinate classes) and Class 33 of Table B, and for Categories 00 and 01 of Table D, these classes and categories must have the same name and be used for the same types of descriptors as in Master Table 0; however, individual descriptors within these classes and categories would be left to the discretion of the Organization defining the particular master table in question.
- For Table A and all remaining classes of Table B and categories of Table D, these would be left to the discretion of the Organization defining the particular master table in question.

For all master tables (including Master Table 0):

- Each revision of the master tables shall be given a new version number.
 - Local tables shall define those parts of the master table which are reserved for local use, thus version numbers of local tables may be changed at will by the originating centre. If no local table is used, the version number of the local table shall be encoded as 0.
- (3) The local data sub-category is maintained for backwards-compatibility with BUFR editions 0-3, since many ADP centres have made extensive use of such values in the past. The international data sub-category introduced with BUFR edition 4 is intended to provide a mechanism for better understanding of the overall nature and intent of messages exchanged between ADP centres. These two values (i.e. local sub-category and international sub-category) are intended to be supplementary to one another, so both may be used within a particular BUFR message.
 - (4) When accuracy of the time does not define a time unit, then the value for this unit shall be set to zero (e.g. for a SYNOP observation at 09 UTC, minute = 0, second = 0).
 - (5) For Master Table 0, the master table version numbers are as follows:

0	Experimental
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1	Version implemented on 1 November 1988
2	Version implemented on 1 November 1993
3	Version implemented on 2 November 1994
4	Version implemented on 8 November 1995
5	Version implemented on 6 November 1996
6	Version implemented on 5 November 1997
7	Version implemented on 4 November 1998
8	Version implemented on 3 May 2000
9	Version implemented on 8 November 2000
10	Version implemented on 7 November 2001
11	Version implemented on 5 November 2003
12	Version implemented on 2 November 2005
13	Version implemented on 7 November 2007
14	Version implemented on 4 November 2009
15	Version implemented on 15 September 2010
16	Version implemented on 4 May 2011
17	Version implemented on 2 November 2011
18	Pre-operational to be implemented by next amendment

Section 2 – Optional section

Octet No.	Contents
1–3	Length of section
4	Set to zero (reserved)
5–	Reserved for local use by ADP centres

Section 3 – Data description section

Octet No.	Contents
1–3	Length of section
4	Set to zero (reserved)
5–6	Number of data subsets
7	Bit 1 = 1 Observed data = 0 Other data Bit 2 = 1 Compressed data = 0 Non-compressed data Bits 3–8 Set to zero (reserved)
8–	A collection of element descriptors, replication descriptors, operator descriptors and sequence descriptors, which define the form and contents of individual data elements comprising one data subset in the Data section

Notes:

- (1) The collection of descriptors, beginning at octet 8, is called the “data description”.
- (2) Each descriptor occupies 2 octets and contains 3 parts:

F 2 bits	X 6 bits	Y 8 bits
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- (3) If F = 0, the descriptor is an element descriptor. The values of X and Y refer directly to a single entry in Table B, X indicating the class and Y the entry within that class.
- (4) If F = 1, the descriptor is a replication descriptor defining the replication data description operator according to Regulations 94.5.4.1 and 94.5.4.2. The values of X and Y define the scope of the operator and the number of replications, respectively. If Y = 0, delayed replication is defined; the next element descriptor will define a data item giving the

number of replications; this descriptor may also indicate (by its value of Y) that the following datum is to be replicated together with the following descriptor.

- (5) If $F = 2$, the descriptor is an operator descriptor. The value of X indicates an operation in Table C. The meaning of Y depends on the operation.
- (6) If $F = 3$, the descriptor is a sequence descriptor. The values of X and Y refer directly to a single entry in Table D. Each entry in Table D contains a list of element descriptors, data description operators, and/or sequence descriptors. A sequence descriptor is defined to be equivalent to the corresponding list of descriptors at the Table D entry.
- (7) "Other data", as identified in octet 7, could, for example, be forecast information generated from a numerical model.

Section 4 – Data section

Octet No.	Contents
1–3	Length of Data section (octets)
4	Set to zero (reserved)
5–	Binary data as defined by sequence descriptors

Notes:

- (1) The binary data in non-compressed form may be described as follows:

$$\begin{array}{l}
 R_{11}, R_{12}, R_{13}, \dots R_{1s} \\
 R_{21}, R_{22}, R_{23}, \dots R_{2s} \\
 \dots \dots \dots \\
 \dots \dots \dots \\
 \dots \dots \dots \\
 R_{n1}, R_{n2}, R_{n3}, \dots R_{ns}
 \end{array}$$

where R_{ij} is the j^{th} value of the i^{th} data subset, s is the number of values per data subset, and n is the number of data subsets in the BUFR message; the data subsets each occupy an identical number of bits, unless delayed replication is used, and are *not* necessarily aligned on octet boundaries.

- (2) The binary data in compressed form may be described as follows:

$$\begin{array}{l}
 R_1^0, \text{NBINC}_1, I_{11}, I_{12}, \dots, I_{1n} \\
 R_2^0, \text{NBINC}_2, I_{21}, I_{22}, \dots, I_{2n} \\
 \dots \dots \dots \\
 \dots \dots \dots \\
 \dots \dots \dots \\
 R_s^0, \text{NBINC}_s, I_{s1}, I_{s2}, \dots, I_{sn}
 \end{array}$$

where $R_1^0, R_2^0, \dots, R_s^0$ are local reference values for the set of values for each data element (number of bits as Table B). $\text{NBINC}_1, \dots, \text{NBINC}_s$ contain, as 6-bit quantities, the number of bits occupied by the increments ($I_{11}, \dots, I_{1n}, \dots, I_{s1}, \dots, I_{sn}$). s is the number of data elements per data subset and n is the number of data subsets per BUFR message. If $\text{NBINC}_1 = 0$, all values of element I are equal to R_1^0 ; in such cases, the increments shall be omitted. For character data, NBINC shall contain the number of octets occupied by the character element. However, if the character data in all subsets are identical NBINC=0.

- (3) Associated fields are treated as separate data items and precede the data;

e.g.

ASSOCIATED FIELDS	DATA
N bits	M bits

Binary data with associated fields may be described as follows:

$$\begin{array}{l}
 A_{11}, R_{11}, A_{12}, R_{12}, \dots A_{1s}, R_{1s} \\
 A_{21}, R_{21}, A_{22}, R_{22}, \dots A_{2s}, R_{2s} \\
 \dots \dots \dots \\
 \dots \dots \dots \\
 \dots \dots \dots
 \end{array}$$

$$A_{n1}, R_{n1}, A_{n2}, R_{n2}, \dots, A_{ns}, R_{ns}$$

where A_{ij} R_{ij} is the j^{th} combined associated field value and data value of the i^{th} data subset, s is the number of values per data subset, and n is the number of data subsets in the BUFR message.

- (4) Binary data in compressed form with associated fields may be described as follows:

$$A_1^0, \text{NBINC}_{A1}, I_{A11}, I_{A12}, \dots, I_{A1n}$$

$$R_1^0, \text{NBINC}_{R1}, I_{R11}, I_{R12}, \dots, I_{R1n}$$

. . . .

. . . .

. . . .

$$A_s^0, \text{NBINC}_{As}, I_{As1}, I_{As2}, \dots, I_{Asn}$$

$$R_s^0, \text{NBINC}_{Rs}, I_{Rs1}, I_{Rs2}, \dots, I_{Rsn}$$

where $A_1^0, R_1^0, \dots, A_s^0, R_s^0$ are local reference values for the set of associated field values and the set of values for each data element.

R^0 uses bit length from Table B. A^0 uses bit length from descriptor 2 04 YYY.

Section 5 – End section

Octet No.	Contents
1–4	7777 (coded according to the CCITT International Alphabet No. 5)