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FM 95-XIII Ext. CREX - Character Form for the Representation and Exchange of Data

CODE FORM:

SECTION 0	Indicator section
SECTION 1	Data description section
SECTION 2	Data section
SECTION 3	(Optional section)
SECTION 4	End section

NOTES:

- (1) CREX is the name of a character code for the representation and exchange of meteorological and other data.
- (2) CREX uses many of the principles of FM 94 BUFR.
- (3) CREX may be used for the exchange of data for which there is no suitable existing WMO code form.
- (4) A CREX message shall consist of one or more subsets of related meteorological data defined, described, and represented by a single CREX entity. For observational data, each subset shall correspond to one report.
- (5) A CREX message consists of sections:

<u>Section Number</u>	<u>Name</u>	<u>Contents</u>
0	Indicator section	'CREX'
1	Data description section for CREX Edition 1:	CREX Master Table number, Edition number, Table Version number, data category, then a collection of descriptors which define the form and content of data subsets making the data section, and an optional check digit indicator "E"
	Data description section for CREX Edition 2:	CREX Master Table number, Edition number, Table Version number, BUFR Master Table number, version number of local table, data category and sub-category, originating centre and sub-centre, sequence number of message, number of subsets, date and time, then a collection of descriptors which define the form and content of data subsets making the data section, and an optional check digit indicator "E"
2	Data section	A set of data items defined by Section 1
3	Optional section	"SUPP" followed by additional items for local use
4	End section	'7777'

- (6) It will be noted that CREX representation is suitable for the manual encoding and visual display of meteorological and other data.

REGULATIONS:

95.1 General

- 95.1.1 The beginning and ending of the data representation form shall be identified by the characters 'CREX' and '7777' respectively.
- 95.1.2 Information within CREX shall be character coded.
- 95.1.3 A group is a sequence of one or more contiguous characters corresponding to a single data descriptor or data value. Groups shall be separated from each other by one or more space characters. Multiple space characters shall be used when needed to improve human readability.
- 95.1.4 The subset terminator shall be represented by the character string '+'. The subset terminator shall not be used when the subset is the last subset.

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95.1.5 The section terminator shall be represented by the character string '++'. The section terminator shall additionally function as a subset terminator for the last subset.

95.2 Section 0 - Indicator Section

95.2.1 Section 0 shall be 4 characters long consisting of the character sequence "CREX".

95.3 Section 1 - Data Description Section

Regulations for CREX Edition1:

95.3.1 The Data description section shall begin with the CREX table descriptor starting with the letter T and followed by a 6 digit number (tteevv) without separator character. The first two digits (tt) shall define the CREX Master Table used (tt = 00 if the standard WMO FM 95 CREX tables are used). The next two digits (ee) shall indicate the CREX edition number used and the last two digits (vv) shall indicate the CREX TableVersion number used.

95.3.2 Immediately following the CREX table descriptor and a space character as separator, Section 1 shall contain a three digit reference to CREX Table A, preceded by the letter A.

95.3.3 Data description syntax for CREX:

95.3.3.1 After the CREX table descriptor and the CREX Table A descriptor, Section 1 shall have one or more data descriptor(s). Data descriptors shall be preceded by a space character as separator. Data descriptors shall occupy 6 characters. Each descriptor shall have 3 parts: F (1 letter), xx (2 digits), yyy (3 digits or – (minus sign) followed by 2 digits for C02yyy data description operator for negative scales – see CREX Table C).

Regulations for CREX Edition2:

95.3.1 Table Indicators

95.3.1.1 The Data description section shall begin with the CREX table descriptor starting with the letter T and followed by a 10 digit number (tteevvbbww) without separator character. The first two digits (tt) shall define the CREX Master Table used (tt = 00 if the standard WMO FM 95 CREX tables are used). The next two digits (ee) shall indicate the CREX edition number used, the next two digits (vv) shall indicate the CREX table version number used, the next two digits (bb) shall indicate the BUFR Master Table version number used and the last two digits (ww) shall indicate the version number of local table (*however for use of local table see notes 6 and 7 of CREX Table B*).

95.3.1.2 Immediately following the CREX table descriptor and a space character as separator, Section 1 shall contain a six digit (nnmmmm) preceded by the letter A. The first three digits (nnn) define the data category referenced to CREX Table A. The next three digits (mmm) shall indicate the sub-category from Common table C-13.

95.3.2 Other indicators

95.3.2.1 Immediately following the CREX table descriptors and a space character as separator, Section 1 shall contain an eight digit number (ooooopp) preceded by the letter P. The first five digits (ooooo) define the originating centre from Common table C-11. The next three digits (ppp) shall indicate the originating sub-centre from Common table C-12.

95.3.2.2 Immediately following the CREX indicator for originating centre and a space character as separator, Section 1 shall contain a two digit number (uu) preceded by the letter U. The two digits (uu) define the sequence number of the message (00 for original message, uu for updated version).

95.3.2.3 Immediately following the CREX indicator for the sequence number and a space character as separator, Section 1 shall contain a three digit number (sss) preceded by the letter S. The three digits (sss) define the number of subsets in the report.

95.3.2.4 Immediately following the CREX indicator for the number of subsets and a space character as separator, Section 1 shall contain an eight digit number (yyymmdd) preceded by the letter Y. The first four digits (yyyy) define the year of the most typical time for the CREX message content. The next two digits (mm) define the month and the last two digits (dd) define the day.

95.3.2.5 Immediately following the CREX indicator for the date and a space character as separator, Section 1 shall contain a four digit number (hhnn) preceded by the letter H. The first two digits (hh) define the hour of the most typical time for the CREX message content and the next two digits (nn) define the minutes.

95.3.3 Data description syntax for CREX:

95.3.3.1 After the CREX indicators defining the most typical time for the CREX message content, Section 1 shall have one or more data descriptor(s). Data descriptors shall be preceded by a space character as separator. Data descriptors shall occupy 6 characters. Each descriptor shall have 3 parts: F (1 letter), xx (2 digits), yyy (3 digits or – (minus sign) followed by 2 digits for C02yyy data description operator for negative scales – see CREX Table C).

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- 95.3.3.2 The first part (F) of a data descriptor shall be: B, C, D or R.
- 95.3.3.3 If F = B, the descriptor shall function as “element descriptor”, and it shall define a single data item by reference to CREX Table B named: Bxxyyy.
- 95.3.3.4 If F = C, the descriptor shall function as “operator descriptor”, and it shall define an operation by reference to CREX Table C named: Cxxyyy.
- 95.3.3.5 If F = R, the descriptor shall function as “replication descriptor”. The 2 digits “xx” shall define the number of following descriptors to be repeated the number of times defined by the 3 digits “yyy”. If “yyy” equal “000”, the descriptor defines a delayed replication. Delayed replication is the replication of data values of which the number of replication is known only in the observed report and will therefore be part of the data section (for example: number of levels in a sounding). A corresponding number of four digits in the data section shall then define the number of replications of the data values corresponding to the following xx descriptors in the data description section.
- 95.3.3.6 If F = D, the descriptor shall function as “sequence descriptor”, and it shall define a list of element descriptors, replication descriptors, operator descriptors and/or sequence descriptors by reference to CREX Table D and named: Dxxyyy.
- 95.3.4 CREX Tables B shall define the element descriptors. If one entry in CREX Table B and one entry in BUFR Table B have the same table reference, the element name shall be the same in both tables. CREX table B entries shall contain:
- the table reference (B xx yyy);
 - the element name (64 characters maximum);
 - the units to be used for data representation in CREX, or instead, a reference to a Code Table or Flag Table which will then define the possible data value for the element;
 - the scale factor to be applied to the data value for CREX purposes; the scale defines the precision of the value. No decimal points shall be used in the data section, so a positive scale means that so many figures after the decimal point are included (e.g. scale=2 means values coded in hundredths, e.g. height coded in centimeter). A negative scale means that so many figures before the decimal point are not included (e.g. heights in hundreds of meters would have scale = -2).
 - the number of characters to be used in CREX to represent the corresponding data value (without counting the sign).
 - Reference values for CREX elements are always zero and there shall be no column for this attribute in CREX tables.
- Note:** Each entries in CREX table B defining element descriptor should correspond with entries in BUFR table B and be listed in the same table, in Part B, Binary Codes, BUFR/CREX Table B.
- 95.3.4.1 **Units should be based on standard international units of the SI system. Alternatively, in exceptional cases, consideration may be given to other standard common units used by the data producer and the users, where a convincing case can be made that those units are more appropriate. In that case, priority shall be given to units contained in WMO Common Table C-6 or, in the case of descriptors for aviation products, ICAO Annex 5.**
- 95.3.4.2 An operator descriptor shall be used to define change of unit, scale, or data width. The change shall apply only to the data value of the element referenced in the following element descriptor. The “yyy” digits of the operator descriptor shall define the new unit (yyy being equal to the code figure of the new unit defined in Common Code Table C-6 listing all the possible units), the new scale or the new data width. The original Table B unit, scale or data width shall be back in force again for that element when subsequently referenced in the data description section until a new change occurs.
- Note:** Change of unit, scale or data width should be avoided; it should be only a last resort solution. These changes are not recommended in a common CREX Table D sequence. The change operators should not be used when the end user of the message would be a human reader.
- 95.3.4.3 CREX Code Tables shall have the same code figures as BUFR Code Tables. As CREX Code Tables are generally longer than corresponding BUFR Code Tables (for example: 99 entries rather than 63), the value corresponding to 'Missing' and the values over within the BUFR Code Table shall be declared “Not used” within the corresponding CREX Table ('63' to '99' Not used in the example).

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95.3.4.4 CREX Flag Tables shall be the same as BUFR Flag Tables. However, in CREX, Flag Tables shall be expressed using the octal representation in the following way: a set of three bits being represented by a figure from 0 to 7 (the leftmost bit being the first bit in the table rank), zeros being added on the left when the number of flags is not a multiple of 3:

000	=	0 (no bit set)
001	=	1 (bit 3 sets)
010	=	2 (bits 2 sets)
011	=	3 (bits 2 and 3 sets)
100	=	4 (bits 1 set)
101	=	5 (bits 1 and 3 sets)
110	=	6 (bits 1 and 2 sets)
111	=	7 (all bits and set)

For example, the seven flags table sequence "1100110" transformed with the addition on the left of two zeros to "001100110" would be translated to "146" in octal.

Missing value for a Flag Table shall be indicated by a set of solidi "/" covering the data width.

95.3.5 Element descriptors corresponding to the following classes in CREX Table B shall remain in effect until superseded by redefinition:

<u>Class</u>	
00	Reserved
01	Identification
02	Instrumentation
03	Reserved
04	Location (time)
05	Location (horizontal-1)
06	Location (horizontal-2)
07	Location (vertical)
08	Significance qualifiers
09	Reserved

Note: Redefinition is effected by the occurrence of element descriptors which contradict the preceding element descriptors from these classes. If two or more elements from the same class do not contradict one another, they all apply.

95.3.5.1 The consecutive occurrence of two identical element descriptors or identical sets of element descriptors from classes 04 to 07 inclusive shall denote a range of values bounded by the corresponding element values. This enables the definition of layers and simple time periods.

95.3.5.2 The definition of line, areas, volumes and more complex time attributes shall be accomplished using descriptors from class 04 to 07 in association with suitable descriptors from class 08.

95.3.5.3 The consecutive occurrence of two or more non-identical element descriptors from classes 04 to 07 inclusive shall infer that all such elements remain in effect until redefined, unless such elements define an increment.

95.3.5.4 Data items defined by element descriptors in class 10 or above shall not behave as co-ordinates with respect to subsequent data.

95.3.5.5 Increments:

Any occurrence of an element descriptor from classes 04 to 07, which defines an increment, shall indicate that the location corresponding to that class be incremented by the corresponding data value. In the case of successive increments from the same class, this means that each increment shall apply in a cumulative manner, with all preceding increments remaining in effect.

Displacements:

In contrast, any displacement descriptor from classes 04 to 07 does not redefine the location corresponding to that class, but shall define only a transient displaced location from the location corresponding to that class. In the case of successive displacements from the same class, this means that each displacement shall apply independently and in a non-cumulative manner to the location corresponding to that class.

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- 95.3.5.6 Time or location increment descriptors, from classes 04 to 07 inclusive, may be associated with replication descriptors in the following way: when an increment descriptor immediately precedes a replication descriptor, or is separated from it by one or more operator descriptors from Table C, this shall infer that such increments be applied for each replication; the application of the increments shall have effect from the beginning of each defined replication, including the first.
- 95.3.5.7 If a CREX message is made up of more than one subset, each subset shall be treated as though it was the first subset encountered.
- 95.3.6 A check digit indicator is optional at the end of section 1. If present, it shall take the form of the single character "E".
- 95.4 **Section 2 - Data Section**
- 95.4.1. The data section shall be comprised of one or more subsets of groups. Each group shall represent one data value. The sequence of data values shall correspond in order to the list of descriptors defined by Section 1 and shall be terminated by subset terminator, or, in the case of the last subset, by the section terminator.
- 95.4.2 Each data value shall be coded using the number of characters defined in the CREX Table B entry of the corresponding direct element descriptor in Section 1 or of the corresponding element descriptor within a sequence of descriptors defined by a sequence descriptor in Section 1. **However, values of the CREX Table B entry, which are equal to or beyond the missing value of the corresponding BUFR Table B entry, shall not be used.** If the data value is a number defining a delayed replication (descriptor "Rxx000" in section 1), it shall comprise four digits.
- 95.4.3 Each numerical data value shall include leading zeroes when the number of digits required to represent the value is smaller than the number of characters defined in the corresponding CREX Table B entry or for the delayed repetition number, to keep the number of characters representing the data value always equal to the original data width defined in CREX Tables or regulations, in order to facilitate the presentation alignment and the decoding process.
- 95.4.4 Positive numerical data values shall be unsigned. Negative numerical data values only shall be signed and represented with the negative sign immediately preceding the data value.
- 95.4.5 Each data value having unit defined as character shall include trailing blanks when the number of characters required to represent the data value is smaller than the number of characters defined in the corresponding CREX Table B entry, to keep the number of characters representing the data value always equal to the original data width defined in CREX Tables, in order to facilitate the presentation alignment and the decoding process.
- 95.4.6 A missing value shall be represented as a group of solidi "/" characters equal in number to the number of characters normally required to represent the value concerned.
- 95.4.7 If the check digit indicator "E" is present at the end of section 1, a check digit shall be added in front of each data value, immediately preceding the first character of each data value. The check digit shall take the value of the unit digit of the ordered number of the data value, counting along the data subset in which it is contained, starting from 0 (the digit increases from 0 to 9 cyclically). The check digit shall precede immediately the negative sign if the data value is negative.
- 95.5 **Section 3 - Optional Section**
- 95.5.1 Section 3 is optional and if present, shall contain additional items as may be defined within each Centre for specific use.
- 95.5.2 Section 3, if present, shall start with the four character sequence "SUPP" and shall end with a section terminator.
- 95.6 **Section 4 - End Section**
- 95.6.1 Section 4 shall be 4 characters long coded as '7777'. Section 4 shall not have a section terminator.

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SPECIFICATIONS OF SECTIONS:

NOTES:

- (1) Each section contains one or more groups of characters separated by one separator character.
- (2) In the following, each group is numbered as group 1, group 2 and so on, from the beginning of the section.
- (3) Edition 1 of CREX may be used up to the first Tuesday of November 2012. Edition 2 may be used starting on 2 November 2005. **A CREX 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, preferably the last edition of CREX which is number 2, after 2 November 2005. Specific features for edition 1 and edition 2, when different will be clearly indicated in sequence.
- (4) When accuracy of the time does not define a time unit, then the value for this unit is set to zero (e.g. SYNOP observation at 09 UTC, then Minute =0, Second=0).

Section	Group No.	Content	Meaning	
Section 0 - Indicator	1	CREX	CREX:	Beginning of the CREX message
Section 1 - Data Description for CREX Edition 1	1	Ttteevv	T: tt:	Indicator for CREX Tables CREX Master Table used (00 for WMO standard FM 95 CREX tables)
	2	Annn	A: nnn:	CREX Edition number (01) CREX Master Table Version number (see Note 1) Indicator for CREX Table A entry Data category from CREX Table A
	3 to n	B xyyy, C xyyy, D xyy, and/or R xyy:	B, C, D: xyyy:	Indicators for CREX Tables B, C or D entries 5 digits each which indicates references from CREX Tables B,C, and/or D
	(n + 1)	(E)	R: xx: yyy:	Indicator for replication number of replicated descriptors number of replications (delayed replication if yyy=0)
			E:	Optional check digit indicator

Note:

- (1) For Master Table 0, the master table version numbers are as follows:

0	Experimental
1	Version implemented on 3 May 2000
2	Version implemented on 7 November 2001
3	Version implemented on 4 November 2003
4	Version implemented on 2 November 2005
5	Version implemented on 7 November 2007
6	Pre-operational to be implemented by next amendment

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Section	Group No.	Content	Meaning	
Section 1: Data Description for CREX Edition 2	1	Ttteevvbbww	T: tt: ee: vv: bb: ww:	Indicator for CREX Tables CREX Master Table used (00 for WMO standard FM 95 CREX tables) CREX Edition number (currently 02) CREX Master Table Version number (see Note 1) BUFR Master Table version number (see Note (5) under Section 1 of the BUFR regulations for Edition 4) Version number of local table
	2	Annnmmm	A: nnn: mmm:	Indicator for CREX Table A entry Data category from CREX Table A International data sub-category from Common table C-13
	3	Pooooopp	P: ooooo: ppp:	Indicator for originating centre Originating centre from Common table C-11 Originating sub-centre from Common table C-12
	4	Uuu	U: uu:	Indicator for sequence number of message Update sequence number (00 for original message, uu for updated version)
	5	Ssss	S: sss:	Indicator for number of subsets Number of subsets included in the report
	6	Yyyyymmdd	Y: yyyy: mm: dd:	Indicator for date Year ! Month ! Day ! <i>Most typical time for the CREX</i>
	7	Hhhnn	H: hh: nn:	Indicator for time ! <i>message content (see note 4 above)</i> Hour ! Minute !
	8 to n	Bxyyy, Cxyyy, Dxyyy, and/or Rxyyy	B,C,D,: xyyy: R: xx: yyy:	Indicators for CREX Tables B,C,D, entries 5 digits each which indicates references from CREX Tables B,C, and/or D Indicator for replication number of replicated descriptors number of replications (delayed replication if yyy=0)
n+1	(E)	E:	Optional check digit indicator	
Section 2: Data	1 to m	(d) Data values	d: Data values	Optional check digit Data values corresponding to section 1 descriptors
Section 3: Optional	1	SUPP	SUPP:	The four letters SUPP indicate the presence of a supplementary optional section.
	2 to p	Items for local use		Additional items for local use developed by generating Centre
Section 4: End	1	7777	7777:	End of CREX

Note:

- (1) For Master Table 0, the master table version numbers are as follows:
- 0 Experimental
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VISUALISATION OF CREX CODE FORM

(Bold characters are fixed alphanumeric characters ; features in brackets are optional)

FOR EDITION 1 :

CREX++

Ttteevv Annn

Rxxyyy (E)++

or Bxxyyy

or Cxxyyy

or Dxxyyy

((d)Datavalues+)

.....

.....

((d)Datavalues+)

(d)Datavalues++

(SUPP Items for local use++)

7777

FOR EDITION 2 :

CREX++

Ttteevvbbww Annnmmm Pooooopp Uuu Ssss Yyyymmdd Hhhnn

Rxxyyy (E)++

or Bxxyyy

or Cxxyyy

or Dxxyyy

((d)Datavalues+)

.....

.....

((d)Datavalues+)

(d)Datavalues++

(SUPP Items for local use++)

7777

Note: If there is more than one subset, there shall be one "+" padded at the end of each subset, except for the last one (see regulations 95.1.4, 95.1.5 and 95.4.1).

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CREX TABLES, CODES TABLES, FLAG TABLES AND TEMPLATE EXAMPLES

FM 95 CREX refers to three types of tables: CREX tables, code tables and flag tables.

CREX Tables

Tables containing information used to describe, classify and define the contents of a CREX message are called CREX tables. Four CREX tables are defined: Tables A, B, C and D. Entries numbering shall be the same in CREX Tables and BUFR tables for the same entity represented. Table B entries shall be listed in the BUFR/CREX Table B, in Part B, Binary Codes. Table D common sequences shall not be defined in both CREX Table D and BUFR Table D unless otherwise a conversion between both Tables D is not simple, that is, the conversion is not completed by simple replacement of part "F" of each descriptor. If a CREX Table D sequence is not defined in BUFR Table D, it shall be assigned a number not used by any BUFR sequences. Similarly, new BUFR Table D sequences shall be assigned a number not used by any CREX Table D sequences.

Code Tables and Flag Tables

CREX Table B defines some elements by means of code tables or flag tables. Within this general description are included code tables referenced by code figures, and flag tables where each bit is set to 0 or 1 to indicate a false or true value with respect to a specific criterion. Within CREX all code tables and flag tables refer to elements defined within CREX Table B; they are numbered according to the xx and yyy values of the corresponding Table B reference.

Code Tables in CREX

CREX Code Tables have the same code figure as BUFR Code tables and are not reproduced. Values of the CREX code, which are equal to or beyond the missing value of BUFR code figure, shall not be used. Missing value in CREX for code table shall be indicated by a set of solidi "/" covering the data width.

Flag Tables in CREX

CREX Flag Tables shall be the same as BUFR Flag Tables. However Flag Tables in CREX shall be expressed using octal representation in the following way: a set of three bits being represented by a figure from 0 to 7 (the leftmost bit being the first bit in the table rank), zeros being added on the left when the number of flags is not a multiple of 3:

000	=	0 (no bit set)
001	=	1 (bit 3 sets)
010	=	2 (bits 2 sets)
011	=	3 (bits 2 and 3 sets)
100	=	4 (bits 1 set)
101	=	5 (bits 1 and 3 sets)
110	=	6 (bits 1 and 2 sets)
111	=	7 (all bits and set)

For example, the seven flags table sequence "1100110" transformed with the addition on the left of two zeros to "001100110" would be translated to "146" in octal.

CREX Flag Tables are the same as BUFR Flag Tables and are not reproduced here.

In CREX, missing value for flag table shall be indicated by a set of solidi "/" covering the data width.

CREX Template Examples

Examples of templates of some CREX messages are listed as models in the Attachment to help users to understand the CREX code.