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| WORLD METEOROLOGICAL ORGANIZATIONCOMMISSION FOR BASIC SYSTEMS-----------------------------FIRST MEETING OFINTER-PROGRAMME EXPERT TEAM ONCODES MAINTENANCEGENEVA, SWITZERLAND, 24 - 28 JULY 2017 |  | IPET-CM-I / Doc. 2.4 (2)(10. 04. 2019)-------------------------ITEM 2.4ENGLISH ONLY |

FM 94 BUFR / FM 95 CREX

Additions to BUFR / CREX tables

**Development and Validation of a BUFR sequence for AMDAR Profile products**

*Submitted by Richard Weedon – UK Met Office*

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**Summary and Purpose of Document**

This proposal outlines the work undertaken to develop and validate a new BUFR sequence for the representation of AMDAR BUFR data as a profile product.

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**ACTION PROPOSED**

The meeting is requested to consider the proposal and validation evidence. If all agree, pre-operational status is requested.

**ANNEXES:**

 1.

**DISCUSSIONS**

In submitting this proposal and requesting pre-operational status we (UK Met Office) acknowledge the fact that the accepted protocols are being circumvented. The new sequence will be needed in the immediate future, and the meeting is respectfully asked to take this into account.

The AMDAR profile product was conceived and developed by the EUMETNET Observations team, as a means of solving problems encountered in the visualisation of AMDAR Ascent and Descent data, especially on Forecaster Display Stations.

 The EUMETNET Obs PM undertook a survey amongst all members to ascertain whether the development of an AMDAR Profile product similar to that provided by (TEMP) SONDE would be of use. The reply from the survey was an overwhelming yes, which has led to the development of the sequence below.

The sequence was initially put to the members of the IPET-CM at which time feedback was requested. A summary of the feedback / questions received is given in the validation report.

**PROPOSAL**

The BUFR data encoded by this sequence will be distributed on the GTS with the TTAAii CCCC IUO[A-L]01 EGRR, where [A-L] represents the same geographical area as the normal AMDAR BUFR data.

The new sequence is listed below along with an additional entry to Common Code Table 0 33 026.

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| **BUFR template for aircraft ascent/descent profile** **with latitude and long given for each level****(3 11 012)** |
| **Table References** | **Element Name** | **Element Description** |
| 3 01 150 | 0 01 125  | WIGOS identifier series | Numeric, 0 |
|  | 0 01 126  | WIGOS issuer of identifier | Numeric, 0 |
|  | 0 01 127  | WIGOS issue number | Numeric, 0 |
|  | 0 01 128 | WIGOS local identifier (character) | CCITT IA5 |
| 0 01 008 |  | Aircraft registration number or other identification |  |
| 0 01 111 |  | Origination airport | To be reported in case of an ascent profile |
| 0 01 112 |  | Destination airport | To be reported in case of an descent profile |
| 3 01 011 |  | Year, month, day | Date/Time and position of first level in profile (for ascent profile first report/take off, for descent profile last report/touch down) |
| 3 01 013 |  | Hour, Min, second |
| 3 01 021 |  | Latitude/Longitude |
| 0 08 004 |  | Phase of flight  | Ascent or descent profile |
| 1 10 000 |  | Delayed replication of 6 descriptors |  |
| 0 31 002 |  | Extended delayed descriptor replication factor | Number of levels following |
|  |  | ***(Aircraft ascent/descent profile data for one level with lat. long. Indicated)*** |
| 3 01 011 |  | Year, month, day | Date of single level report |
| 3 01 013 |  | Hour, Min, second | Time of single level report |
| 3 11 007 | 0 07 010 | Flight level | Pressure altitude |
|  | 3 01 021 | Latitude/Longitude |  |
|  | 0 11 001 | Wind direction |  |
|  | 0 11 002 | Wind speed  |  |
|  | 0 02 064 | Roll angle quality |  |
|  | 0 12 101 | Temperature/dry-bulb temperature |  |
|  | 0 12 103 | Dew-point temperature | Value derived from Mixing ratio, limited to Td ≤ T  |
| 2 01 144 |  | Change data width |  |
| 2 02 133 |  | Change scale |  |
| 0 13 002 |  | Mixing ratio | Originally measured value |
| 2 02 000 |  | Cancel change scale |  |
| 2 01 000 |  | Cancel change data width |  |
| 0 13 003 |  | Relative humidity | Value derived from Mixing ratio, limited to ≤ 100% |
| 0 33 026 |  | Moisture quality | Code table (report code figure 10 if Td > T, see code table below) |

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| **0 33 026** |
| **Moisture Quality** |
| **Code Figure** |  |
| 0 | Normal Operations – Measurement Mode |
| 1 | Normal Operations – Non Measurement Mode |
| 2 | Small RH |
| 3 | Humidity Element is wet |
| 4 | Humidity Element Contained |
| 5 | Heater Fail |
| 6 | Heater Fail and wet/contaminated Humidity Element  |
| 7 | At Least one of the input parameters used in the calculation of the mixing ratio is invalid.  |
| 8 | Numeric Error |
| 9 | Sensor not installed |
| 10 | Calculated RH > 100% |
| 11  | Input laser power too low |
| 12 | Probe VW temperature out of range |
| 13 | Probe VW pressure out of range |
| 14 | Spectral line out of range |
| 15 | No laser output |
| 16 - 62 | Reserved |
| 63 | Missing Value |

**Validation Report** – BUFR sequence for AMDAR Profile products

1. **Responsible Organization(s)**

UK Met Office

 Deutscher Wetterdienst (DWD)

1. **Requirements and Proposals**

The validated sequence will provide the means of visualizing AMDAR Ascent and Descent data in a more effective manner.

The validation of the new sequence requires additions to common code table 0 33 026.

1. **Description of the proposal**

See ‘Discussions’ and ‘Proposals ‘in the above document.

1. **Proposed implementation date and procedure.**

November 2019 Fast Track 2019-2

1. **Result and period of discussions**

Prior to the validation, the sequence was circulated to Team Members. A record of the feedback received and answers given are as listed below –

* **Why do we need a new template? What is proposed application/user requirement that this will address?**
When the E-AMDAR Programme was first established in 1999 the main purpose was to serve NWP user needs and to provide single level AMDAR (aircraft) data. User needs have evolved over the years. Today especially the forecasting sections of NMHSs have strong needs to use AMDAR profile data in a similar way and in addition to radiosonde soundings (i.e. profiles) but not all NMHSes seem to be in the position to produce and display AMDAR profiles for forecasting purposes because AMDAR data are only distributed as single level reports. Besides the use of AMDAR data in near-real time for forecasting new user needs have evolved requiring AMDAR data for airport wind shear analyses or for aviation accident investigations. For the latter purpose non-real time AMDAR profile data are required. The majority of NMHSs store AMDAR data as single level reports but not as profiles. SS: Many European (smaller) NMHSs do not have the capability to visualise the single level data as a profile, hence the need to generate a new ‘Profile Product’ that can be viewed in similar way to a radiosonde ascent.

The use of the WIGOS AMDAR BUFR template (sequence 3 11 010) doesn´t allow the reporting of all levels of a particular profile in one BUFR message with replications of the various parameters needed for a profile product as it is the case for radiosonde soundings. Therefore, this sequence doesn´t seem to be appropriate for reporting AMDAR profile data. Due to the fact that aircraft humidity observations are of large interest the already existing BUFR sequences for AMDAR profile data reporting 3 11 008 and 3 11 009 are not sufficient because these don´t consider any humidity values. Furthermore, other essential information on departure or destination airport and time of each reported level are missing in these sequences as well. Therefore it is proposed to introduce a new sequence for AMDAR profile data reporting

* **Is the template only for AMDAR? Or can it be used for Aircraft Derived Data or ADS-C?**From my perspective the template could be also used for profiles consisting of Aircraft Derived Data or ADS-C data. SS: When we eventually have operational Mode-S data (within next few years in Europe) I would very much expect profiles at some/many airports will be generated using Mode-S only,  or even as a combination of Mode-S/AMDAR.
* **Why is the aircraft identifier required if the WIGOS identifier is already present?**At the moment WIGOS station identifier aren´t implemented and used for AMDAR aircraft. To be able to start using the new sequence as soon as possible after validation and approval the aircraft identifier is still required. Furthermore, at least in E-AMDAR some airlines create the BUFR single level reports by using identifiers according to their airlines´ database which considers the aircraft identifier only. The WIGOS identifier will be added to the AMDAR profile data BUFR message generated out of the single level reports by the EUMETNET AMDAR Data Acquisition System before ingesting the profiles to the GTS
* **Why is dew point temperature reported rather than the measured parameter?**The proposed sequence considers the reporting of the originally measured parameter mixing ratio. Due to the fact that forecasters prefer a similar display of AMDAR profile data as for radiosonde soundings it is proposed to report dew point temperature and relative humidity in addition. Hence, the comment ‘Value derived from Mixing ratio’ was added to the element description. SS: As mentioned by Tanja, the measured parameter, water vapour mixing ratio, is reported along with the derived values of Dewpoint temperature and Humidity. This sensor producing humidity is the approved WVSS-II, reported in g/kg.

[The only sensor currently endorsed by WMO for aircraft humidity measurement outputs the data as a water concentration [g/kg = grams water per kilogram of air].  This will mean that the dewpoint will need to be calculated/derived.]

**Software**

Met Office: BUFR / GRIB Decoder

DWD : DWD BUFR Software

BOM: BOM Decoder (Written in Python, developed by BOM)

**Test Files:**

MET20190215122611A.dat (BUFR - Encoded by UK Met Office)

MET20190215122611A.dat-reencoded.bufr (BUFR re-encoded by DWD)

**Decode evidence:**

311012\_decode\_stdout.txt

(Decode of MET20190215122611A.dat by UK Met Office)

BOM-AMDAR-Decode.doc

(Decode of MET20190215122611A.dat from BOM)

MET20190215122611A.dat.readbufrx.txt

(Decode of MET20190215122611A.dat from DWD)

MET20190215122611A.dat-reencoded.bufr.readbufrx.txt

(decode of MET20190215122611A.dat-reencoded.bufr (BUFR re-encoded by DWD))

MET20190215122611A.dat-reencoded.bufr.readbufrx.Int.txt

(Decode of MET20190215122611A.dat-reencoded.bufr through DWD Java tools)