WORLD METEOROLOGICAL ORGANIZATION
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RA-V WORKING GROUP ON THE PLANNING
AND IMPLEMENTATION OF THE WWW

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ITEM: 6.1

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# AUTOMATED UPPER AIR OBSERVATIONS FROM AIRCRAFT USING AIRCRAFT METEOROLOGICAL DATA RELAY (AMDAR)

*(Submitted by J. Stickland)*

## 1. Introduction

1.1 Meteorological observations obtained automatically from regular passenger jet and turbo-prop aircraft have proven to be an excellent means of supplementing upper air observations obtained by conventional means for many years. Not only is the data quality comparable to that of data obtained from conventional systems, but the system is also very cost effective. Such systems are known generically as Aircraft Meteorological Data Relay (AMDAR).

1.2 WMO Executive Council at its fifty-third Session was pleased to note that AMDAR had proved to be a very cost effective data source that responded to the needs of WMO programmes and brought benefits to end-users. Currently, 10 countries run operational AMDAR programs on 16 national and international airlines producing around 110,000 observations daily. Many more countries are encouraged to develop their own programs or to become involved in programs of targeted observations provided by visiting aircraft operated by other countries to help fill the data sparse areas of the world.

## 2. AMDAR

2.1 AMDAR makes use of the existing reliable sensors, computer processing power, and communications infrastructure on many modern aircraft to automatically produce and communicate high quality upper air observations for operational use by National Meteorological and Hydrological Services (NMHS). Observations during the ascent and descent phases of flight form profiles of temperature, wind speed and direction and are normally available in close-to-real-time. The AMDAR system therefore can provide a very valuable and cost effective supplementary component to national and regional upper air programs.

2.2 While many modern aircraft are appropriately equipped with the necessary hardware and communications, they usually lack software that forms the heart of the system. Software is the only component placed on board aircraft to make the system operational and it is now available either free of charge or at a very low cost from a variety of sources. A charge is usually levied by the airline to install and configure the software. It is also true that many aircraft do not have the appropriate hardware or communications systems and therefore are unsuitable for AMDAR unless they undergo a very expensive upgrade in avionics and communications systems.

2.3 Systems are currently operated by Australia, New Zealand, the US, South Africa, and European countries under the EUMETNET AMDAR programme while many other countries are either testing or developing their own systems.

2.4 The initiative to commence a national AMDAR program is usually taken by the NMHS. A number of countries have recently commenced by implementing targeted AMDAR programs. This effort is followed up later with the NMHS approaching local airlines to explore the possibility of developing a local AMDAR operational program on their own aircraft.

## 3. Targeted Observations

3.1 AMDAR has a clear advantage over most other in-situ observing systems in that it has the capability of providing data at very low cost at remote locations. A number of NMHSs have commenced their AMDAR programs by taking advantage of data provided by visiting AMDAR equipped aircraft from other countries that operate into local airports. This is usually achieved by arranging co-operative agreements with the NMHS or agency responsible for AMDAR in the country whose airlines are providing the data, eg. the Bureau of Meteorology in Australia or EUMETNET in Europe. In some cases data are provided free of charge, but it is normally expected that the country receiving the data reimburses the host country for the cost of providing it. It is now technically feasible to target observations at specific geographic areas and even individual airports.

## 4. Costs

4.1 Contracts are normally arranged between an NMHS and its airline(s) for a data delivery service and the airline charges for that service of which the cost of communications forms the major component. The cost per observation varies between airlines from less than US1cent to 11 cents, but the median cost is around 4cents. An observation consists of time, latitude, longitude, altitude, phase of flight, temperature, wind speed and direction, and where available, turbulence. A profile taken during aircraft ascent consists of around 30 observations, so the cost of a profile is $1.20. This figure is compared to the cost of a GPS radiosonde sounding of more than $200 if staff time is considered.

4.2 The cost effectiveness of AMDAR is demonstrated by considering a simple program of targeted observations. For a program of **4 profiles** per day (if they are available) for a year, the cost incurred is of the order of **$1,800**. This is compared to the cost of **one** GPS radiosonde sounding per day for a year at **$73,000**. The maximum height of an AMDAR profile is of course limited to the cruising level of the aircraft which can vary between 18,000 ft. and 35,000 ft. It also does not contain humidity observations, but never-the-less, the profiles of wind and temperature are very valuable for local operations and the use by NWP systems.

4.3 Observations are normally produced at 7 minute intervals while the aircraft is at cruising altitude wherever it operates, but these data can also be constrained to specific geographical areas if needed. The cost per observation using VHF radio links is still around 4 cents, but if there are no VHF ground stations in the area, data are normally transmitted through satellite systems and the cost increases by a factor of between 5 and 10.

## 5. Regional Co-operation

5.1 There are clear advantages to be gained through formation of co-operative regional AMDAR programs. These are designed to avoid the duplication of effort and wasted resources and to increase the cost effectiveness of coverage and processing data between adjacent countries. Co-operative arrangements for example exist between Australia and New Zealand in the provision of data by Australia in an area of interest to New Zealand. Australia also provides a data quality monitoring service for New Zealand.

## 6. AMDAR Bulletins

6.1 Coded AMDAR data are exchanged on the GTS in a range of bulletins containing messages in either FM42-XI text code or FM94 BUFR code. A list of bulletin headers appropriate for RAV is given below.

## 7. Assistance

7.1 The WMO AMDAR Panel consists a group of countries interested in promoting and assisting other WMO Members to develop their own AMDAR programs. The Panel employs a Technical Coordinator (TC) who, together with Panel members, provides technical information, advice and general assistance to those countries wishing to know more about AMDAR and to develop operational AMDAR programs. The AMDAR Technical Co-ordinator is available as an initial contact and welcomes any enquiries concerning AMDAR. If necessary, the Co-ordinator would be available to attend regional meetings or seminars on AMDAR with the view to developing regional or national programs. Countries in and near the RA-V region have also offered to provide advice and information.

### Contact Details

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## AMDAR BULLETINS DISTRIBUTED ON THE WMO GTS

| Bulletin Header | Originating Centre | Area/Zone |
|---|---|---|
| **FM42 Text** | | |
| UDAU01 | AMMC | Australia |
| UDPN01 | AMMC | North Pacific |
| UDAS01 | AMMC | Asia |
| UDPS01 | AMMC | South Pacific |
| UDIO01 | AMMC | Indian Ocean |
| UDOC01 | AMMC | Oceania |
| UDXX02 | EGRR | Global |
| UDPN02 | EGRR | Pacific North |
| UDPS02 | EGRR | Pacific South/Oceania |
| UDAS02 | EGRR | Asia |
| UDIO02 | EGRR | Indian Ocean |
| UDXX02 | EHDB | - |

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|---|---|---|
| UDXX01 | EUMS | - |
| UDXX02 | EUMS | - |
| UDPS01 | NXKL | South Pacific |
| UDAS02 | RJTD | Asia |
| UDIO02 | RJTD | Indian Ocean |
| UDPN02 | RJTD | North Pacific |
| UDPS02 | RJTD | South Pacific |
| **FM94 BUFR** | | |
| IUAX01 | EDZW | German |
| IUAX01 | EGRR | German |
| IUAX02 | KARP | US |