

**WORLD METEOROLOGICAL ORGANIZATION**

**COMMISSION FOR INSTRUMENTS  
AND METHODS OF OBSERVATION**

***OPAG ON STANDARDIZATION AND INTERCOMPARISONS***

**TASK TEAM ON AIRCRAFT-BASED OBSERVATIONS  
FIRST SESSION**

**Geneva, Switzerland**

**18 to 20, February, 2014**

**FINAL REPORT**



**CONTENTS**

	<b>PAGE</b>
<a href="#">Agenda</a>	iii
<a href="#">General Summary</a>	1
<a href="#">List of Participants</a>	Annex I
<a href="#">TT-AO Work Plan, 2013-2014, (Version 2014.1D4)</a>	Annex II
<a href="#">Proposed Terms of Reference, CIMO Expert Team on Aircraft-based Observations</a>	Annex III
<a href="#">Actions from TT-AO Session 1</a>	Annex IV

## **AGENDA**

- 1 ORGANIZATION OF THE MEETING**
  - 1.1 Opening of the session**
  - 1.2 Adoption of the agenda**
  - 1.3 Working arrangements for the session**
- 2 REPORT OF THE CHAIR**
- 3 REPORTS ON PROGRESS & STATUS OF WORK PROGRAMME**
- 4 PLANNING & UPDATE OF THE WORK PROGRAMME**
- 5 REPORTING TO CIMO**
- 6 OTHER BUSINESS**
- 7 FINAL REPORT OF THE SESSION**
- 8 CLOSURE OF THE SESSION**

## GENERAL SUMMARY

### 1 ORGANIZATION OF THE SESSION

#### 1.1 Opening of the Session

The Chairman, Stewart Taylor, opened the session and welcomed all participants to the first session of the CIMO Task-Team on Aircraft-Based Observations (TT-AO).

Dr Wenjian Zhang, the Director of the Observing and Information Systems Department welcomed all participants to WMO. He reminded the participants about the increased importance of aircraft-based observation as has been demonstrated again, most recently by the evaluations presented at the fifth WMO Workshop on the Impact of Various Observing Systems on NWP (Sedona, 2012). He pointed out the important role the Task Team has in the technical aspects of aircraft-based observations, which includes standardization of software and practices. He also congratulated the task team on the recent publication of the report, *Benefits of AMDAR to Meteorology and Aviation*, (WIGOS Technical Report 2014-1) to which the members of TT-AO and the CBS Expert Team on Aircraft-Based Observations (ET-ABO) had contributed.

Mr Dean Lockett, Scientific Officer, Aircraft and Remotely-sensed Observations, provided the team with an introduction to WMO and its structure and briefly described the role of the team within the Aircraft-Based Observations programme (ABOP) in cooperation and collaboration with the CBS Expert Team on Aircraft-Based Observing Systems (ET-ABO). Further information on the ABOP was available on the WMO aircraft-based observations website:

[http://www.wmo.int/pages/prog/www/GOS/ABO/ABO\\_Work\\_Program.html](http://www.wmo.int/pages/prog/www/GOS/ABO/ABO_Work_Program.html)

The Team was informed of the upcoming CIMO sixteenth session (CIMO-XVI), 10-16 July 2014, St-Petersburg and the requirement for the team to provide a report via the OPAG on Standardization and Intercomparison and the CIMO Management Group – see item 5.

The Chairman invited all participants to introduce themselves and provide their experience and interest in aircraft-based observations. The list of participants is provided in [Annex I](#).

#### 1.2 Adoption of the Agenda

The Agenda was adopted as was made available within document 1.2, with two additions under Other Business - see item 6.

#### 1.3 Working arrangements of the Session

The participants agreed on the working arrangements for the session, which would be conducted in plenary throughout.

### 2 REPORT OF THE CHAIR

The Chair presented his report and emphasized that although the Team had been formed early in 2013, it already had established an approved work plan and budget<sup>1</sup>. Additionally, most tasks had been assigned to task leaders from within the Team and task plans had been developed and documented utilising the Aircraft-Based Observations Programme (ABOP) Projects & Collaboration wiki (Google Site). Throughout 2013, the Team had held online WebEx sessions to advance many of the work plan tasks and task plans.

The Chair also noted the following achievements/activities of the team:

- Organisation of the first session of the task team (this meeting).
- Completion of Tasks 7 and 9 resulting in the publication of the AMDAR Onboard Software specification (AOSFRS) as CIMO IOM Report No. 114.

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<sup>1</sup> CIMO TT-AO Work Plan, Version 2013.1A, May 2013 :

[http://www.wmo.int/pages/prog/www/CIMO/WorkingStructure/WorkPlans/CIMO-XV/CIMO\\_TT-AO\\_Work\\_Plan\\_May\\_2013\\_v2013.1A.pdf](http://www.wmo.int/pages/prog/www/CIMO/WorkingStructure/WorkPlans/CIMO-XV/CIMO_TT-AO_Work_Plan_May_2013_v2013.1A.pdf)

- The addition of Task 19, a follow on from the completion of the AOSFRS and involving work on harmonisation of AMDAR software specifications.

The meeting was informed that it was also necessary during 2013, due to the withdrawal of one member of the team, to find a new member that could lead the work associated with the development of turbulence monitoring. The Chair expressed thanks to Dr Greg Meymaris for agreeing to provide his valued experience and skills as a member of the team and for NCAR and the FAA for supporting his time and work commitment.

The Chair also mentioned the delay in advancing Task 11, development of software for Boeing 777 aircraft, which was initially associated with the WMO partners and Air France failing so far in agreeing on terms regarding the scope and cost of the work. More recently, it has been further impacted by current resource issues and prioritization of operational development within the airline.

A current high priority for the Team was to update the ARINC 620 specification (Task 19) which contains the uplink and downlink specifications associated with the Meteorological Report – see item 3.5.

### **3 REPORTS ON PROGRESS AND STATUS OF WORK PROGRAMME**

#### **3.1 Work Programme Status and Coordination and Harmonization with ET-ABO**

The Chair and the Secretariat briefly outlined the current team work plan and its relation to the team's Terms of Reference and also the operation of the AMDAR Trust Fund, which supports the work programme of the ABOP and requires that the two teams continue to harmonize their work plans and budgets annually.

#### **3.2 AMDAR Temperature Bias**

Dr Siebren de Haan presented to the session his initial planning (document 3.2) for work on the task to investigate the issues of AMDAR temperature bias (Task 3). This activity would consist of two primary elements:

1. Review of relevant reference material; and,
2. Consultation with avionics/sensor experts.

The task had commenced in the first quarter of 2014 with initial consideration of the methods that might be used to estimate and analyse the temperature bias. In order to determine the bias there is a requirement to compare the AMDAR data with a reliable standard of known uncertainty, allowing an estimation of the measurement "truth". Radiosonde observations are generally regarded as the standard for comparison for upper air data. However these observations also have biases arising out of known measurement issues. Another issue with the use of radiosonde for comparison is that these observations are sparse and thus collocation in space and time with aircraft observations would be problematic. The use of Numerical Weather Prediction (NWP) derived temperatures may overcome this issue, although using a model temperature as "truth" also presents difficulties and requires careful analysis of results. For example, the model temperature might be biased as a result of the assimilation of "biased" observations.

The impact of the Mach number in temperature bias had been investigated in a very preliminary research study undertaken. This study used additional data derived from FOQA (Flight Operations Quality Assurance) and Mode-S EHS reports. The latter requires a link between AMDAR identifier and tail number or ICAO 24-bit identifier.

Dr de Haan proposed the following actions:

1. Review of other relevant reference material;
2. Further investigation of the relation between Mach number and temperature bias;
3. Possible acquisition of FOQA data from specific AMDAR aircraft for further comparative analysis;
4. Determining means for matching AMDAR aircraft identities with aircraft identities for other available data sources to facilitate comparison; and,

5. Possible co-location comparison of AMDAR and radiosonde data.

The meeting agreed to the approach to the task and noted that it may be necessary to fund the purchase of FOQA data to support the study.

### **3.3 Planning & Implementation of Water Vapour Measurement**

Dr Axel Hoff presented to the session the preliminary work undertaken on developing an implementation plan for integration of water vapour measurement (WVM) as a component of the AMDAR system (document 3.3).

This work is formulated in the work plan under two tasks:

1. Tasks 4, AMDAR and WVM Integration into Existing Avionics and Airframes; and,
2. Task 5, AMDAR and WVM as Standard Accessory on Commercial Aircraft.

Task 4 would result in an implementation plan for existing operational AMDAR programmes to work within their programmes and collaboratively towards “retrofit” of WVM on existing AMDAR aircraft. It was pointed out that the greater the extent of the airborne modification, the greater would be the cost in the design and in the certification process for the sensor integration. The NMHSs would be faced with the task of convincing airlines to participate in such a retrofitting programme as well as the means for financing the process. However, the team agreed that, at least initially, this was likely to be the best way to advance WVM operation and the eventual integration of WVM into the manufacturing process, whereby WVM becomes an optional catalogue item that airlines can select when ordering new aircraft.

Task 5 involves that part of the implementation plan that would lead to WVM as a standard accessory on new commercial aircraft. An important aspect of this development would be ensuring that airlines and manufacturers are aware of the potential direct benefits and impacts that WVM might have for aviation and airline operations. Such possible direct applications include those that impact on flight safety and efficiency of operations, for example, de-icing management. Other benefits that might be considered important are those associated with environment management, such as detection of the risk for contrail formation.

The team revised the initial material that had been compiled and submitted and then together commenced formulating the aims, strategy, scope and task for the WVM implementation plan.

This included consideration of integrating the following strategies and activities.

#### ***Retrofit equipment:***

- Target newer aircraft families that are more likely to have the required avionics.
- Target airlines, preferably those already cooperating in AMDAR, with a suitable geographic coverage and sufficient aircraft of the target aircraft families.

#### ***Ex-works equipment:***

- Approach sufficiently large airlines that are, or would consider participating in the AMDAR programme and request that they consider requesting AMDAR and WVM as a delivered item on their future new aircraft orders. Such pressure would possibly lead to manufacturers working towards integration of WVM as a catalogue item and mean that costs are integrated into the overall costs of aircraft purchase. Such a strategy would require cooperation initially between the airline and the AMDAR programme manager and later between both parties and the aircraft and sensor manufacturer.
- Determine ways to quantify and promote the direct benefits to airlines and aircraft manufacturers that address safety (e.g. de-icing) and environmental (e.g. contrails formation) concerns.

#### ***Generally:***

- Promote AMDAR including WVM as a useful tool for airline flight operations.
- Develop business case material to describe the benefits to airlines of WVM.
- Complete the WVSS-II sensor scientific and operational validation process and publish the resulting report and studies.

- Determine the likely aircraft fleets and sizes that might be required to be equipped for providing the required operational WVM coverage, based on the requirements of data users and application areas such as NWP.
- Coordinate the attainment of airworthiness certificates (supplemental type certificates, STC) based on the target aircraft fleets. This could be achieved most efficiently if AMDAR programmes cooperate and collaborate with each other and with airlines and the manufacturer of the humidity sensors. Ownership of the STC by the sensor manufacturer is likely to provide the best means to reduce the costs associated with international transfer of STCs and their subsequent utilisation by several airlines and AMDAR programmes.

The Task Team agreed on the formation of a sub-group, consisting of Axel Hoff, Greg Meymaris, Steve Stringer (ET-ABO), Bryce Ford and Dean Lockett, that would undertake to finalise a draft of the implementation plan based on a typical project management framework. The team would undertake to have monthly WebEx sessions with the aim of finalizing the WVM implementation plan for inclusion within the ABOP Strategy and Implementation Plan (A-SIP) by the end of 2014.

### **3.4 Planning & Implementation of Turbulence Measurement**

In relation to the work plan Task 6 (Turbulence/EDR Implementation Plan development), Dr Gregory Meymaris briefed the task team regarding Eddy Dissipation Rate (EDR) software deployments, both existing and future, including the general, both programmatic and technical, steps required for implementation of EDR monitoring and reporting within the AMDAR programme. He explained that the application development and integration within the Aircraft Condition Monitoring System (ACMS) of aircraft posed the biggest problem in this endeavour and that these factors and the costs would vary considerably between different aircraft and avionics. The aircraft would also require a reliable and routine ACMS recording capability of the high-rate input data so as to enable and verify the software algorithm tuning.

The meeting was presented with the initial considerations and draft implementation plan that was submitted (document 3.4) and the team discussed and formulated some of the aims, strategies and key tasks that should be associated with the plan. These included:

- Pursue a pilot programme to deploy EDR on an E-AMDAR airline.
- Include in the pilot programme an NMHS that can ingest the data in their model, at least as a research effort.
- Undertake outreach activities to promote the benefits and impacts of turbulence monitoring and reporting for both the aviation industry and data users (e.g. publications, meetings, etc.).
- Assemble business case documentation.
- Work with avionics manufacturers to make EDR an accessory option.
- Incorporate outcomes from the EDR standardization and EDR Technical Transfer projects.

The team decided that a sub-group should be formed to assist Dr Meymaris with further development of the implementation plan and would consist of Greg Meymaris, Dean Lockett, Stewart Taylor and possibly an appropriate member of ET-ABO, to be confirmed. The team requested that the next draft of the implementation plan should be available by the first week of April and circulated to the sub-group for review.

### **3.5 AMDAR Onboard Software Standards**

The AMDAR Onboard Software Functional Requirements Specification (AOSFRS<sup>2</sup>) supersedes the AAA (ACARS Aircraft AMDAR) standard and is now the primary WMO standard for AMDAR software. However, the Meteorological Report version 5 in the ARINC 620 is now inconsistent with

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<sup>2</sup> Available from :

[http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/index\\_en.html#amdar\\_stds](http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/index_en.html#amdar_stds)

the AOSFRS and requires updating. The Airlines Electronic Engineering Committee (AEEC), Data Link Systems Sub-Committee is currently in the process of updating ARINC 620 and the team has the opportunity to specify the update to the Meteorological Report through this process.

A drafting team consisting of Stewart Taylor, Axel Hoff and Dean Lockett met in December 2013 to undertake an initial draft to be incorporated within Supplement 8 to ARINC 620, however, more work is required to complete the update, after which a review by ET-ABO, TT-AO and other stakeholders would be required. It had been expected that this work would be required to be completed by the end of March 2014 in order to meet the expected timeline of the AEEC Data Link Systems Sub-Committee. In addition to this work, it would be necessary to complete a minor update of the AOSFRS to incorporate a small number of corrections and additions.

The team agreed that the timeline for completing the update of the ARINC 620 and the AOSFRS may be too demanding. However, if the update did not occur within Supplement 8, it may be several years before the next update was commenced and completed. It was agreed that the Secretariat would contact ARINC to request an update on the current timeline expectations for Supplement 8 after which the drafting team would determine a possible course of action and report to the Task Team.

### **3.6 Future Communications & Technology Impact on AMDAR**

A draft proposal for a Description of Work (DoW) for a consultant to undertake the study Currently Developing and Future Communications and Technology Impact on AMDAR was presented by the Secretariat. The team discussed the task and the proposed text and made some modifications to the DoW. The team agreed that the Secretariat should finalise the DoW and circulate to ET-ABO and TT-AO for final review and suggestions for candidate consultants. It was agreed that the team should aim to have a WMO SSA in place for commencement early in the 2nd half of 2014.

### **3.7 Development of Avionics AMDAR Applications**

The TT-AO discussed how to have more active co-operation with avionics vendors, particularly for the development of standardised avionics applications for AMDAR in accordance with the AOSFRS document and in line with Task 10 of the work plan.

There was agreement that TT-AO should take a more proactive approach with vendors, with TT-AO representatives to perhaps arrange face to face meetings with Teledyne, Rockwell Collins and Honeywell in 2014.

### **3.8 Impact Assessments of TAMDAR**

The Task Leader Gilles Fournier presented the progress achieved so far on Task 14 of the work plan. The main point of contact to obtain progress on is Mr Steve Stringer, E-AMDAR Program Manager, Met Office. Deployment of TAMDAR sensors on both the FAAM British Aerospace BAe146 (for test and comparison with the WVSS-II - already installed) and the Flybe fleet is progressing slower than expected. The earliest installation date on the FAAM BAe146 is not likely to occur before the 14<sup>th</sup> May, 2014 maintenance slot.

For the Flybe TAMDAR deployment, as of the end of January 2014, Panasonic had 4 TAMDAR sensors installed on ERJ-190 aircraft. Panasonic is also looking to install systems on the Flybe DHC-8 Q400 aircraft once they have a Supplemental Type Certificate (STC) for this aircraft. There is potential for a TAMDAR fleet of over 100 aircraft if the whole Flybe fleet was to be equipped.

Met Office has license to use the TAMDAR data in R&D mode only and will need permission from Panasonic to publish papers. If all goes well, an analysis should be completed by the end of 2014 with a full report now expected in mid-2015 at the earliest, thus delaying Task 14 deliverable to CIMO to Q2 of 2015.

It was also noted that Panasonic is planning deployment of TAMDAR systems on Icelandair and expects installations to begin in mid-to-late 2014 with the entire 27 B757 aircraft fleet equipped by May 2015.

### **3.9 Planning for AMDAR Inter-comparison Activities**

The Task Leader Siebren de Haan presented the progress on this task (work plan, Task 15) which involved the following initial activities:

1. Determine requirements
2. Analyse options
3. Draft Plan.

During the meeting, it was agreed the task should now incorporate an implementation phase, leading to the production of a CIMO IOM report.

Wind temperature, humidity (when available), and possibly EDR, would be compared, with atmospheric pressure being used as the reference parameter for altitude. Comparison would be made against (operational) numerical model information, for which the quality performance would be known by means of long term statistics of comparison with other wind, temperature and humidity observations (such as radiosonde).

The accuracy of the horizontal position of the AMDAR observation needs to be determined. Simple checks are proposed, including comparison with Mode-S EHS and/or ADS-B positional information.

The team agreed that this work should progress under the task leader including the finalisation of the draft plan followed by implementation and the production of an IOM report based on the tasks and timeline outlined in the table below.

### **Task 15 Planning**

Task	Description	ready
1	Define period for AMDAR inter-comparison	Q2-2014
2	Define reference models	Q2-2014
3	Gather AMDAR observations	Q2-2014
4	Acquire AMDAR tail-numbers , through 1. Officially distributed list, or 2. Combination of Mode-S EHS/ADS-B data sets	Q3-2014
5	Collocate with Mode-S EHS or ADS-B for position comparison	Q3-2014
6	Compare wind, temperature and humidity with model parameter 1. Develop comparison software and tools 2. Define binning strategies etc.	Q4-2014
7	Reporting	Q2-2015

### **3.10 Paper on Validation of WVSS**

Mr Bryce Ford, Task Leader on Task 16 of the work plan, informed the meeting that he had circulated a first draft outline of the proposed paper to the team in December 2013. The comments received in response would be taken into account in the structure and content of the document, which incorporates the aims to summarise both the technical and operational performance of the WVSS-II water vapour sensor. A new draft outline would be circulated to TT-AO by the end of March 2014, with the overall aim to finalise the paper for publication as a CIMO IOM report by the end of the 2<sup>nd</sup> quarter of 2014.

### **3.11 Development of a Standard for AMDAR Data Optimisation**

The Secretariat presented document 3.11 to the meeting, which describes the expected work required to complete Task 12 of the TT-AO work plan, encompassing the development of a WMO standard for a specification of requirements for an AMDAR Data Optimisation System (ADOS). The task has not yet been assigned to a Task Leader. A suggestion for the basic elements of the specification was made. It was also suggested that it would likely be possible, with appropriate approvals, to use existing national specifications for ADOS as a starting point, building and generalizing these to develop the required global specification. Those programmes that operate

ADOS might be approached with this aim, including the Bureau of Meteorology, Australia and the E-AMDAR programme. It is also possible that a specification might have been developed for the USA MDCRS Programme.

The team agreed that, even though this work remained relatively low priority in comparison to other tasks, it would likely become a vital requirement for the global programme in the coming years as programmes developed and sought to increase efficiency and decrease costs. Therefore an attempt should be made to identify a leader for the task from within the wider ABOP. The Secretariat would send an e-mail to both ET-ABO and TT-AO requesting a volunteer to lead the task. If this was unsuccessful, then the task would be subcontracted to a consultant through a SSA in late 2014 or early 2015.

### **3.12 Representation at Aviation Forums**

The Chair presented his report (document INF.3.12) from his attendance as WMO and E-AMDAR representative at the AEEC Data Link Users Forum in September 2013. He highlighted a number of items of specific interest to the AMDAR community.

It was also agreed that a task or activity should be established within the TT-AO work plan for the team to investigate further the aims of the AEEC Aeronautical Operational Control (AOC) sub-committee in relation to the provision of meteorological data as an AOC standard and, if and when appropriate, ensure that a representative of the team attends AEEC AOC meetings (Task 20).

### **3.13 Review and Update of Regulatory Material**

Over 2013, members of TT-AO and ET-ABO have produced a revised version of Part II, Chapter 3 of the CIMO Guide (WMO-No. 8, Guide to Meteorological Instruments and Methods of Observation) on Aircraft Observations. The revision was submitted to the CIMO Guide Editorial Board on 1 November, 2013 and have agreed to include the revision in the next update of the CIMO Guide. Once reviewed and approved by CIMO (July 2014) the updated CIMO guide will be available at <http://www.wmo.int/pages/prog/www/IMOP/CIMO-Guide.html>. This task is therefore considered to be completed.

However, the meeting was informed that ET-ABO has a parallel task to conduct a comprehensive review of WMO ABO and AMDAR regulatory material, including material from the AMDAR Reference Manual (task 27 of ET-ABO Work Plan 2013-1). This work will be conducted with a view to the wider task of the development of the Manual and Guide on WIGOS, for which the Manual and Guide on the GOS will be revised and incorporated. While the majority of the content is expected to be relevant to the Manual and Guide on the GOS, there may be some technical information that might later be considered for review by TT-AO and inclusion in a future update of the CIMO Guide.

## **4 PLANNING AND UPDATE OF THE WORK PROGRAMME**

### **4.1 Revised Work Programme**

The team undertook a review of the new draft work plan and budget, version 2014.1 based on the discussion and outcomes of agenda item 3. The updated work plan is provided within Annex II. The team agreed that this plan and its associated budget would comprise the team's contribution to the Aircraft-Based Observations Programme work plan and budget for 2014.

## **5 REPORTING TO CIMO**

The Secretariat informed the meeting of the requirement for the Task Team to report to the 16<sup>th</sup> Session of CIMO, 14-16 July, 2014, St.-Petersburg via the OPAG-SI Co-chair and the CIMO Management Group, which will meet over 10-14 March 2014, Payerne, Switzerland. The Chairman would have the responsibility for providing this report, assisted as required by TT-AO and the Secretariat.

The team agreed on the following recommendations to be made to CIMO-MG:

1. Given the ongoing nature of the work of the team, the Task Team should be replaced by an Expert Team on Aircraft-based Observations (ET-AO) for the next CIMO inter-

sessional period, with a similar ongoing functionality as a component of the ABOP in cooperation with CBS/ET-ABO.

2. The CIMO-MG should consider for adoption the updated Terms of Reference as provided within Annex III.
3. The work of the Theme Lead on Aircraft Measurements was now incorporated into the work plan of the task team and so it is recommended that the Theme Lead role within OPAG-SI can be discontinued.

The Chair would ensure that the contribution of TT-AO to the report made to CIMO-MG would include those requirements and elements provided in Annex III of document 5, including summary of the team's achievements, problems encountered and risks, recommendations and topics for the future work plan.

## **6 OTHER BUSINESS**

### **E-AMDAR discussions with Airbus**

The Chair advised the team that in May (12-15<sup>th</sup>) 2014 he would participate in an In-service Aircraft for a Global Observing System (IAGOS) Workshop (Toulouse) where representatives of Airbus would be present and there would be an opportunity to discuss with them matters relating to the ABOP, including the WVM Implementation Plan and any relevant information from the upcoming 2014 NOAA Aircraft Data Workshop (April 29-30<sup>th</sup>).

Following this meeting, Airbus and representatives from the Purchasing and Contracts departments from AMDAR participating airlines (e.g. Air France and Lufthansa) would be invited to the next E-AMDAR Technical Advisory Group (E-TAG) meeting in Toulouse in early June to discuss aspects on how the WVM Implementation Plan may work.

### **ABOP representation at CIMO TECO 2014**

The meeting discussed the upcoming Technical Conference (TECO) that will be held in conjunction with the CIMO-XVI session in St.Petersburg in July 2014 and whether it might be appropriate to have representation from TT-AO at the conference. It was agreed that there appeared to be little value in such representation from the ABOP, given that there was little likelihood of any outreach opportunities with the aviation industry. However, the Secretariat would ensure that news or reports from WMO Members or Secretariat staff of any material relevant to ABOP and/or TT-AO would be relayed to the team.

## **7 FINAL REPORT OF THE SESSION**

The meeting agreed that an initial draft of the final report of the Task Team session was expected to be compiled over the week following the session, with the aim of having the report ready for publishing by mid-March.

The additional actions from the session are provided in the table within Annex IV.

## **8 CLOSURE OF THE SESSION**

The Chair and the Secretariat thanked all team members and participants for their attendance at the session and for their contribution to the ongoing work programme of TT-AO.

The Chair closed the Session on Thursday the 20<sup>th</sup> February 2014 at 15.37.

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## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

## ANNEX II

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
1	(a)	Coordinate with CBS ET-ABO on Work Plan & Budget	Ch-TT-AO, SO/ARO	<ol style="list-style-type: none"> <li>Rep. of TT to attend ET-ABO meetings;</li> <li>Work Plan &amp; Budget for 2014-15 to be compiled &amp; approved.</li> <li>Regular Work Plan WebEx sessions to be held.</li> </ol>	Harmonised Work Plan & Budget for the ABO Program. Report to TT-AO	Q3 2013	Ongoing	50	<ul style="list-style-type: none"> <li>May require TF funding for member of TT to attend ET-ABO-1</li> <li>Chair attended ET-ABO-1</li> </ul>	2.1K		2.3K
2	(a)	Meeting of TT-AO	Ch-TT-AO, SO/ARO	Meeting of TT-AO, Feb 2014	<ol style="list-style-type: none"> <li>Work Program advanced;</li> <li>Report to CIMO</li> </ol>	Q3 2013	Q3 2014	10	Meeting to be held 18-20 Feb 2014.		15K	
3	(b)	Investigate AMDAR Temperature Bias	S.d.Haan	<ol style="list-style-type: none"> <li>Review of relevant reference material</li> <li>Consultation with avionics/sensor experts</li> </ol>	Report to TT-AO and CIMO	Q1 2014	Q2 2015	5	May require funding to complete a study on onboard issues, such as deicing. Ref: <a href="#">WMO AMDAR Panel Aircraft Observing System Data Management Workshop, Section 5.1</a> ,			

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

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4	(b)	AMDAR and water vapor measurement (WVM) integration into existing avionics and airframes	A.Hoff, G.Meymaris, S.Stringer, B.Ford, SO/ARO	<ol style="list-style-type: none"> <li>Drafting and review of plan.</li> <li>Finalise plan as part of the ABOP Strategy &amp; Implementation Plan (A-SIP)</li> </ol>	Strategic Plan	2012	Q2 2014	25	<p>This needs to be harmonized with the the A-SIP.            Ref: WMO AMDAR Panel Session 15 Fin. Rep. 4.2.1.</p> <p>Incorporate:</p> <ul style="list-style-type: none"> <li>Ownership of STCs</li> <li>Collaboration on STC costs</li> <li>Integration into airframes AMDAR Software requirements</li> </ul>			
5	(b)	AMDAR and water vapor measurement (WVM) as standard accessory on commercial aircraft	A.Hoff, G.Meymaris, S.Stringer, B.Ford, SO/ARO	<ol style="list-style-type: none"> <li>Drafting and review of plan.</li> <li>Finalise plan as part of the ABOP Strategy &amp; Implementation Plan (A-SiP)</li> </ol>	Strategic Plan	2012	Q4 2014	10	<p>Incorporate:</p> <ul style="list-style-type: none"> <li>Formulation of IP into WMO Project in collaboration with ICAO</li> </ul> <p>Ref: WMO AMDAR Panel Session 15 <a href="#">Fin. Rep</a> 4.2.1.</p>			

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
6	(b)	Turbulence (EDR ) Implement. in AMDAR - Develop IP for EDR	G Meymaris, S.Taylor, T.Farrar, SO/ARO	<ol style="list-style-type: none"> <li>Drafting and review of plan.</li> <li>Teleconferencing of collaborators. Liaise with NCAR on software requirements;</li> <li>Identify possible airline partner for trial.</li> </ol>	EDR IP	Q3 2013	Q2 2014	10	<p>Possibly include:</p> <ul style="list-style-type: none"> <li>A trial program with a European airline (the E-AMDAR Team are discussing possibility with Air France).</li> </ul> <p>Ref: WMO AMDAR Panel Session 15 <a href="#">Fin. Rep</a> 4.2.2.</p>			
7	(b)	Review & approve EDR spec. in AMDAR Onboard Software Functional Requirements Specification (AOSFRS)	S.Taylor, A.Hoff, G.Fournier, J.Xu	<ol style="list-style-type: none"> <li>Review EDR algorithms within the AOSFRS.</li> </ol>	EDR spec. in AOSFRS	Q1 2013	Q3 2013	100	<ul style="list-style-type: none"> <li>Linked to Task 9.</li> <li>AOSFRS pub. as IOM Report 114.</li> </ul>			
8	(b)	Study on Current & Future Comms & Technology Impact on AMDAR	SO/ARO, S.Taylor	<ol style="list-style-type: none"> <li>Write Statement of Work</li> <li>Identify consultants</li> <li>SSA in place</li> </ol> <p>Monitor progress</p>	Study and recommendations produced	Q3 2013	Q1 2015	0	<p>Ref: WMO AMDAR Panel Session 15 <a href="#">Fin. Rep</a> 4.3.2.</p>	0K (15K)	30K	

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
9	(c)	Finalise and publish AOSFRS <sup>3</sup>	S.Taylor, A.Hoff, G.Fournier, J.Xu	<ol style="list-style-type: none"> <li>1. Conduct final review of AOSFRS;</li> <li>2. Publish AOSFRS as approp.</li> </ol>	AOSFRS Published	2012	Q2 2013	100	<ul style="list-style-type: none"> <li>• In combination with ET-ABO;</li> <li>• Final review of spec.;</li> <li>• Publication of spec;</li> <li>• AOSFRS pub. as IOM Report 114?</li> </ul>	22.7K (23K)		
10	(c)	Approach to avionics manufacture AOSFRS implem.	S.Taylor, SO/ARO	<ol style="list-style-type: none"> <li>1. Approach Teledyne Controls re AOSFRS implementation;</li> <li>2. Approach other avionics vendors</li> </ol>	Integration of AMDAR into avionics systems.	Q3 2013	N/A	Ongoing	Work towards availability of AMDAR software as a catalogue item of delivery for avionics systems.		5K	

<sup>3</sup> AMDAR Onboard Software Functional Requirements Specification, see : WMO AMDAR Panel Session 15 [Fin. Rep](#) 4.4.7.

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
11	(c)	Boeing 777 AMDR Software Dev.	Ch-TT-AO, Ch/ET-ABO, SO/ARO,	<ol style="list-style-type: none"> <li>Finalise negotiations with AFR and KLM in consult. with E-AMDAR &amp; Meteo-France</li> <li>Review quotation;</li> <li>Provide advice on specifications and requirements.</li> </ol>	B777 AMDAR Software application	2012	Q2 2015 (delayed – next AFR-KLM meeting to be finalized)	20	<ul style="list-style-type: none"> <li>Combined action with ET-ABO</li> <li>Project has been delayed</li> </ul> Ref: WMO AMDAR Panel Session 15 <a href="#">Fin. Rep</a> 4.4.7.	0K (20K)		20K
12	(c)	Develop and specify standard for AMDAR Data Optimisation System	S.Taylor, A Hoff	<ol style="list-style-type: none"> <li>Determine requirements (consult with FPs);</li> <li>Draft specification;</li> </ol> Conduct review; Publish spec.	Addition to CIMO Guide (spec of ADOS).	Q3 2013	Q3 2015	0	The aim is to develop a functional specification that can be included in the Manual on WIGOS or in CIMO Guide			
13	(d)	Monitor & Review reports from WVSS testing	A.Hoff	<ol style="list-style-type: none"> <li>Review reports.</li> <li>Report to TT-AO-1</li> <li>Provide summary report on DENCHAR test results</li> </ol>	Report to CIMO	Q3 2013	Q3 2014	Ong.	Ref: WMO AMDAR Panel Session 15 <a href="#">Fin. Rep</a> 4.2.1.			

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
14	(d)	Monitor & report on impact assessment results of TAMDAR humidity & other parameters by MetOffice	G.Fournier	<ol style="list-style-type: none"> <li>1. Review reports and analyse results.</li> <li>2. Report to TT-AO-1</li> </ol>	Report to CIMO	Q3 2013	Q2 2015	0				
15	(e)	Develop & Implement plans for AMDAR & WVSS inter-comparison	S.d.Haan	<ol style="list-style-type: none"> <li>1. Determine requirements;</li> <li>2. Analyse options;</li> <li>3. Draft Plan;</li> <li>4. Implement &amp; report (IOM).</li> </ol>	AMDAR & WVSS Inter-comparisons Plan	Q4 2013	Q2 2015	0				
16	(e)	Prepare a paper on the status of WVSS-II validation	B. Ford & Collaborators	<ol style="list-style-type: none"> <li>1. Prepare outline and scope</li> <li>2. Identify contributors</li> <li>3. Research and draft</li> <li>4. Review</li> <li>5. Publish</li> </ol>	IOM Report	Q3 2013	Q2 2014	50	Provide a summary on all scientific and operational aspects of the WVSS-II sensor and prepare a paper to be published as an IOM report.			

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
17	(f)	Review & Update Aircraft-based Obs Reg. Mat. In CIMO Guide	G.Fournier, J.Xu, S.Taylor, SO/ARO	<ol style="list-style-type: none"> <li>1. Review current status of material and identify requirements for update;</li> <li>2. Coordinate &amp; undertake update;</li> <li>3. Review and complete;</li> <li>4. Provide to WMO Reg. Mat. Board.</li> </ol>	CIMO Guide on Aircraft-based Observations updated.	Q1 2014	Q2 2014	100	<ul style="list-style-type: none"> <li>• Chapter has been submitted to CIMO Ed. Board</li> </ul>			
18	(g)	Attend meetings of relevance to AMDAR Technical Dev.	TT-AO, SO/ARO	<ol style="list-style-type: none"> <li>1. Develop list of aviation committees and reps on P&amp;C wiki</li> </ol>	Meetings attended. Reports produced for CIMO and Secretariat	Q2 2013	Ongoing	N/A	<p>This may include:</p> <ul style="list-style-type: none"> <li>• Meeting with avionics vendors;</li> <li>• Others.</li> <li>• SO/ARO &amp; S.Taylor to meet Dec in Offenbach for Task 19.</li> </ul>	2.5K(est) (15K)	10K	10K
19	(c)	Update of AEEC ARINC 620 Specification	S.Taylor, SO/ARO, A. Hoff	<ol style="list-style-type: none"> <li>1. Work with AEEC DataLink Systems Sub-Committee to update the Met. Report in the ARINC 620 standard to version 6.</li> </ol>	Met. Report V6 defined in the AEEC ARINC 620 spec.	Q4 2013	Q4 2014	20	<ul style="list-style-type: none"> <li>• Will require travel support for work team and to attend AEEC meetings</li> </ul>	See Item 18  (Cost of Dec 17/18 <sup>th</sup> meeting)	Item 18	Item 18

## CIMO TT-AO Work Plan, 2013-2014, (Version 2014.1D4, Draft, February 2014, TT-AO-1)

No.	ToR	Task Description	Person Responsible	Action	Deliverables / Outcome	Commence	Deadline for Delivery	Status (%)	Comments	2013 Budget Expend	2014 Budget Estimate	2015 Budget Estimate
20	(c)	Interaction with AEEC AOC	TT-AO	<ol style="list-style-type: none"> <li>1. Review existing documents and reports to determine requirements for TT-AO</li> <li>2. Seek membership of AOC and attend meetings</li> </ol>		Q2 2014		Ong.	<ul style="list-style-type: none"> <li>• SSC and AOC are trying to harmonize requirements for data link in A633 and A620.</li> <li>• TT-AO should determine implications for AMDAR.</li> </ul>		Item 18	Item 18

**TASK TEAM ON AIRCRAFT-BASED OBSERVATIONS, TT-AO, TERMS OF REFERENCE**

- (a) Develop and manage the workplan and associated activities of the TT-AO, as well as the budget for the corresponding expenditure of the AMDAR Trust Fund in line with the Trust Fund's Terms of Reference, in collaboration with CBS ET-Aircraft-Based Observations;
  - (b) Oversee the scientific and technical development and maintenance of aircraft-based observing systems, from a point of view of instruments and methods of observation, and inform the Commission of latest developments;
  - (c) Work closely with ET-A1 in conducting the development and maintenance of technical standards associated with aircraft-based observations, and provision of related specifications to meet user requirements;
  - (d) Provide the technical review of approved aircraft-based humidity capabilities,
  - (e) Liaise closely with ET-A3 for testing and validation of the AMDAR system and aircraft based humidity sensors;
  - (f) Provide input for updates of the CIMO Guide relevant to aircraft-based observations, including identification of standards for inclusion in the CIMO Guide and other WMO regulatory documents; and,
  - (g) Assist and provide support for training and outreach activities to support the use of aircraft-based observations.
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**Proposed Terms of Reference, CIMO Expert Team on Aircraft-based Observations**

- (a) Develop and manage the work plan and associated activities of the Expert Team, including the budget for associated expenditure of the AMDAR Trust Fund in line with the Trust Fund's Terms of Reference and in collaboration with the CBS Expert Team on Aircraft-Based Observing Systems (ET-ABO);
- (b) Oversee and report to the Commission on the scientific and technical development of aircraft-based observing systems, including AMDAR, Mode-S, ICAO ADS and TAMDAR, particularly with respect to instruments and methods of observation;
- (c) Oversee and report to the Commission on the development, scientific testing and validation and intercomparison of existing and new methods of observation for aircraft-based observing systems, including humidity, turbulence and ice accretion.
- (d) Based on user requirements, oversee and conduct the development, maintenance and provision of technical standards and specifications associated with aircraft-based observations;
- (e) Compile and review updates and new material on aircraft-based observations for inclusion in the CIMO Guide and other WMO regulatory documents;
- (f) Conduct and provide support for training and outreach activities of the Commission and WMO to support the use of aircraft-based observations; and,
- (g) Work in collaboration and cooperation with other teams of the Commission and WMO on the above activities as appropriate and as necessary.

## Actions from TT-AO Session 1

Task No. (Item Ref.)	Action	Responsible	Complete	TT-AO WorkPlan Task
1 (3.1)	TT-AO to continue to harmonize work plan and budget with ET-ABO. Budget for ABOP to be updated and approved based on team work plans by end of March	Ch-TT-AO, ET-ABO, SO/ARO	31 March 2014	
2 (3.3)	Sub-group to work towards completion of WVM IP and insertion into A-SIP by end of 2014.	Sub-group: A. Hoff, G. Meymaris, S. Stringer and SO/ARO	Dec 2014	Task 4 Task 5
3 (3.4)	Produce new draft of EDR IP.	G. Meymaris	Early April, 2014	Task 6
	Sub-group to revise and update draft.	G. Meymaris, S. Taylor, T. Farrar, SO/ARO	End of April	
4 (3.5)	Approach AEEC DataLink Systems Sub-Committee for updated timeline for A620 Supp. 8.	SO/ARO	28 Feb 2014	
	Determine new timeline for completion of A620 Met. Report V6 and updated of AOSFRS V1.1 (Task 19)	Ch-TT-AO	14 Mar 2014	Task 19
5 (3.6)	Finalise DoW for study on developing technology (Task 8)	SO/ARO	March 2014	
	Identify and assess candidate consultants.		July 2014	Task 8
	SSA to be put in place.		Q4 2014	
6 (3.7)	TT-AO to continue to meet with avionics vendors/software developers, particularly targeting Honeywell, Rockwell Collins and Teledyne	Ch-TT-AO, SO/ARO	Q4 2014	Task 10
7 (3.10)	Draft of WVSS-II validation paper to be circulated to TT-AO	B. Ford	Q2 2014	Task 16
8 (3.11)	Seek ABOP member to lead task on development of ADOS spec. (Task 12)	SO/ARO	Q1 2015	Task 12
	If unsuccessful, advance process to put in place an SSA			

	for the work.			
8 (3.12)	Add new Task 20 to work plan of TT-AO defining collaboration with AEEC AOC.	Ch-TT-AO	Q1 2014	Task 20
9 (5)	Provide input to report of Co-chair OPAG-SI to CIMO-MG	Ch-TT-AO	3 March 2014	
10 (6)	S. Taylor to meet with Airbus to discuss involvement in AMDAR and WVM development.	Ch-TT-AO	Q2 2014 (May)	Task 4 Task 5
11 (6)	Report of any news or reports of relevance to TT-AO work to be made to TT-AO.	SO/ARO	Q3 2014	
12 (7)	Completion of TT-AO-1 Final Report	TT-AO, SO/ARO	Mid-March 2014	