Doc 10045
MET/14

INTERNATIONAL CIVIL
AVIATION ORGANIZATION

METEOROLOGY (MET) DIVISIONAL MEETING (2014)

Montréal, 7–18 July 2014

REPORT

Approved by the Meeting and published by
authority of the Secretary General

MONTRÉAL **2014**

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Doc 10045, ***Report of the Meteorology (MET) Divisional Meeting (2014)***

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

METEOROLOGY DIVISIONAL MEETING (2014) (MET/14)

Montréal, 7 to 18 July 2014

SUPPLEMENT NO. 1

1. The Council, at the fourth meeting of its 203rd Session on 3 November 2014, and the Air Navigation Commission at the seventh meeting of its 197th Session on 30 September 2014, under authority delegated by the Council, took action as indicated hereunder on the recommendations of the Meteorology Divisional Meeting (2014) (MET/14).

2. RECOMMENDATIONS FOR AMENDMENT OF STANDARDS AND RECOMMENDED PRACTICES AND PROCEDURES (RSPP)

2.1 The Air Navigation Commission conducted a preliminary review of proposed amendments to Standards, Recommended Practices and Procedures arising from Recommendation 5/1 of MET/14, and agreed that they should be transmitted to Contracting States and relevant international organizations for comment, together with the Commission's comments and proposals thereon. Following receipt of these comments, a further review will be conducted by the Commission, which will then present its final proposals to the Council for adoption of amendments to Annex 3 — *Meteorological Service for International Air Navigation*, Annex 11 — *Air Traffic Services,* the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) and the *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400).

3. RECOMMENDATIONS OTHER THAN FOR AMENDMENT OF STANDARDS AND RECOMMENDED PRACTICES AND PROCEDURES (RSPP)

3.1 The Council noted that the following will be the allocation of follow-up responsibility for non-RSPP recommendations made under Agenda Items 1 to 5 of the MET/14 meeting:

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	**COUNCIL**	**SECRETARIAT**
Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation				
1/1	Updating the GANP and ASBU methodology to reflect ASBU MET module dependencies with other modules.	Parts a) to c): approved and requested the Secretary General to take appropriate action.	Parts a) to c): noted.	Parts a) to c): include interdependencies between meteorology and non-meteorology specific modules of the aviation system block upgrade (ASBU) methodology in the next update of the *Global Air Navigation Plan* (GANP) (Doc 9750).
1/2	Inclusion of a MET-specific module related to Block 2 of the ASBU methodology.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Parts a) and b): noted.	Parts a) and b): develop a meteorology-specific ASBU module corresponding to the Block 2 timeframe (2023-2028) in the next update of the GANP.
1/3	Evolution of aeronautical meteorological service provisions.	Approved and requested the Secretary General to take appropriate action.	Noted.	Ensure that all ICAO provisions developed relating to meteorology are consistent with the "One Sky" concept, Resolution A38-11 of the 38th ICAO Assembly and the GANP.
Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision				
2/1	Development of the WAFS in support of the ASBU methodology through to 2018.	Approved and requested the Secretary General to take appropriate action.	Noted.	Oversee the operation and further development of the world area forecast system (WAFS) through to 2018 consistent with the GANP, with a focus on the further improvement to WAFS gridded global forecasts of icing and turbulence.
2/2	Operation and further development of the aeronautical fixed service satellite distribution system and the Internet-based services.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Parts a) and b): noted.	Oversee the operation and further development of the satellite distribution system and the associated Internet-based services consistent with the GANP.

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	COUNCIL	SECRETARIAT
2/3	Withdrawal of the SADIS 2G satellite broadcast and formal testing of the exchange of global OPMET information and WAFS forecasts on the AMHS.	Parts a) to c): approved and requested the Secretary General to take appropriate action.	Parts a) to c): noted.	Parts a) and b): ensure that necessary steps are taken to terminate the satellite broadcast of OPMET information and WAFS forecasts by 2019 and urge States/users that have not already done so to migrate to the use of the Internet-based services. Part c): undertake formal testing of the ATS message handling system (AMHS) for the exchange of OPMET information and WAFS forecasts to determine the capability and minimum specifications to distribute such data in the future.
2/4	Review of MET information service provision framework to reflect GANP objectives.	Parts a) to d): approved and requested the Secretary General to take appropriate action.	Parts a) to d): noted.	Parts a), b) and d): review the existing requirements for aeronautical meteorological information to ensure consistency with GANP objectives, including for the WAFS, IAVW, space weather and the provision of information concerning other hazardous meteorological phenomena. This should include the development of guidance for States on how obligations may be met relating to sub-regional, regional, multi-regional and global services, including cost recovery and other governance considerations. Part c): ensure that the outcomes of a), b) and d) are reflected in the next update of the GANP.
2/5	Further development of the WAFS in support of ASBU Blocks 1 and 2.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Parts a) and b): noted.	Oversee the operation and further development of the WAFS in the period 2018 to 2028 consistent with the GANP, with a focus on the improvements to global forecasts of cumulonimbus clouds, icing and turbulence, calibrated probabilistic forecasts, and finer temporal and spatial resolution of forecasts.
2/6	Further development of the international airways volcano watch (IAVW).	Approved and requested the Secretary General to take appropriate action.	Noted.	Oversee the operation and further development of the IAVW consistent with the GANP, with a focus on volcanic ash detection, observation and forecasting techniques, collaborative decision analysis and information sharing.

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	COUNCIL	SECRETARIAT
2/7	Development of provisions for information concerning space weather.	Parts a) to d): approved and requested the Secretary General to take appropriate action.	Parts a) to d): noted.	Parts a), b) and c): develop provisions to meet the requirements of aviation for space weather information, including determination of the capabilities of global and regional centres providing such information and the cost recovery and governance arrangements necessary. Part d): consider the use of space weather information and the impacts of space weather events on international air navigation.
2/8	Further development of provisions for information on the release of radioactive material into the atmosphere.	Approved and requested the Secretary General to take appropriate action.	Noted.	Further develop provisions for information on the release of radioactive material into the atmosphere consistent with the GANP.
2/9	Implementation of a regional advisory system for select en-route hazardous meteorological conditions.	Parts a) to c): approved and requested the Secretary General to take appropriate action.	Parts a) to c): noted.	Develop provisions supporting the implementation of a phenomenon-based regional advisory system for select en-route hazardous meteorological conditions, including guidance supporting the selection of regional hazardous weather advisory centres. The information produced by the system should be integrated into the SWIM environment.
2/10	Development of meteorological service for the terminal area.	Parts a) to d): approved and requested the Secretary General to take appropriate action.	Parts a) to d): noted.	Part a): include meteorological service for the terminal area in the next update of the GANP. Parts b) to d): develop requirements for meteorological information in the terminal area to meet future ATM requirements as envisaged by the GANP. Guidance should be developed on verification methodology. Information produced should be integrated into the SWIM environment.
2/11	Advanced planning relating to the aeronautical meteorological component of ASBU Block 3.	Approved and requested the Secretary General to take appropriate action.	Noted.	Undertake advanced planning in the 2015 to 2020 timeframe for the identification of technical requirements and aeronautical meteorological service capabilities for meteorological information for the period beyond 2028.

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	COUNCIL	SECRETARIAT
2/12	Development of the WAFS in support of the aviation system block upgrades (ASBUs) beyond 2028.	Approved and requested the Secretary General to take appropriate action.	Noted.	Oversee the operation and further development of the WAFS in the period beyond 2028, with focus on the use of ensemble forecasting, fully automated output and high spatial and temporal resolution forecasts.
2/13	Development of provisions for aeronautical meteorological information services in the context of CDM and common situational awareness.	Approved and requested the Secretary General to take appropriate action.	Noted.	Ensure that provisions developed for aeronautical meteorological information services promote collaborative decision making and common situational awareness.
2/14	Human factors considerations for the development of aeronautical meteorological service provisions.	Approved and requested the Secretary General to take appropriate action.	Noted.	Ensure that human factors considerations are central to the development of provisions for aeronautical meteorological information services.
Agenda Item 3: Integrating meteorological information exchange developments into the future system-wide information management environment				
3/1	Aeronautical meteorological information to support trajectory-based operations.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Parts a) and b): noted.	Part a): finalize a draft concept of operations and roadmap identifying requirements for meteorological information to support trajectory-based operations. Part b): using the results of a) above, establish ATM requirements for meteorological information and meteorological service capabilities to meet those requirements.
3/2	Inclusion of aeronautical meteorological information in the future SWIM-enabled environment.	Parts a) to d): approved and requested the Secretary General to take appropriate action.	Parts a) to d): noted.	Ensure that all meteorological information services are integrated into the SWIM environment, including consideration of the communications infrastructure requirements, governance and the roles of the existing information exchange centres such as the regional OPMET databanks and inter-regional OPMET gateways.
3/3	Further development of the SWIM concept relating to meteorology.	Approved and requested the Secretary General to take appropriate action.	Noted.	Ensure that governance and technical issues are addressed in relation to the implementation of the meteorological component of SWIM.

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	COUNCIL	SECRETARIAT
Agenda Item 4: Institutional issues				
4/1	Review of the working arrangements between ICAO and WMO.	Parts a) and b): noted and supported.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Undertake a review and, as necessary, update of the *Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization* (Doc 7475), in coordination with the World Meteorological Organization (WMO).
4/2	Definition of meteorological authority.	Approved and requested the Secretary General to take appropriate action.	Noted.	Clarify the provisions in relation to the notion of a meteorological authority.
4/3	Oversight of aeronautical meteorological service provision.	Approved and requested the Secretary General to take appropriate action.	Noted.	Dispatch a State letter urging State to ensure that personnel performing safety oversight functions are adequately qualified and competent, meeting the requirements of Annex 19 — *Safety Management* and develop guidance, as necessary.
4/4	Guidance/guidelines on the recovery of costs of aeronautical meteorological service provision.	Noted and supported.	Approved and requested the Secretary General to take appropriate action.	Develop guidance, through the Air Transport Bureau (ATB) and in coordination with WMO, addressing equitable cost recovery practices where aeronautical meteorological service is fulfilled on a multi-regional, regional or sub-regional (multi-State) basis.
4/5	Evolving competency of aeronautical meteorological personnel.	Noted and supported.	Approved and requested the Secretary General to take appropriate action.	Assist WMO in the further development of a competency framework for aeronautical meteorological personnel in view of future changes in working practices arising from a highly-collaborative, highly-automated operating environment.
4/6	English language proficiency of aeronautical meteorological personnel.	Approved and requested the Secretary General to take appropriate action.	Noted.	Consider the development of guidance concerning the required level of English language proficiency for aeronautical meteorological personnel to. *Note.— The development of such guidance would be intended to mitigate the risk of misunderstandings between the aeronautical meteorological service provider and the user that may impact the level of weather-related situational awareness and flight safety, as well as promote inter-State coordination, as needed.*

RECOMMENDATIONS ADOPTED BY MET/14		SUGGESTED FOLLOW-UP ACTION		
		ANC	COUNCIL	SECRETARIAT
4/7	Provision and use of aeronautical meteorological information for aeronautical purposes only.	Approved and requested the Secretary General to take appropriate action.	Noted.	Dispatch a State letter to remind States of their obligations in respect of the provision and use of aeronautical meteorological information for aeronautical purposes only.
Agenda Item 5: Standards, Recommended Practices and Procedures				
5/2	Reorganization of provisions relating to aeronautical meteorology.	Parts a) and b): approved and requested the Secretary General to take appropriate action.	Parts a) and b): noted.	Restructure Annex 3 and develop a new *Procedures for Air Navigation Services — Meteorology* (PANS-MET) that more clearly identifies functional- and performance-requirements and technical specifications (means of compliance).

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REPORT OF THE
METEOROLOGY (MET) DIVISIONAL MEETING (2014)

LETTER OF TRANSMITTAL

To: President, Air Navigation Commission

From: Chairman, Meteorology Divisional Meeting (2014)

I have the honour to submit the report of the Meteorology Divisional Meeting (2014) which was held in Montréal from 7 to 18 July 2014.

Peter Lechner
Chairman

Montréal, 18 July 2014

TABLE OF CONTENTS

LIST OF RECOMMENDATIONS

1/1	Updating the GANP and ASBU methodology to reflect ASBU MET module dependencies with other modules)	1.3-1
1/2	Inclusion of a MET-specific module related to Block 2 of the ASBU methodology	1.3-2
1/3	Evolution of aeronautical meteorological service provisions	1.4-1
2/1	Development of the WAFS in support of the ASBU methodology through to 2018	2.1-1
2/2	Operation and further development of the aeronautical fixed service satellite distribution system and the Internet-based services	2.1-2
2/3	Withdrawal of the SADIS 2G satellite broadcast and formal testing of the exchange of global OPMET information and WAFS forecasts on the AMHS	2.1-3
2/4	Review of MET information service provision framework to reflect GANP objectives	2.2-1
2/5	Further development of the WAFS in support of ASBU Blocks 1 and 2	2.2-3
2/6	Further development of the international airways volcano watch (IAVW)	2.2-4
2/7	Development of provisions for information concerning space weather	2.2-5
2/8	Further development of provisions for information on the release of radioactive material into the atmosphere	2.2-6
2/9	Implementation of a regional advisory system for select en-route hazardous meteorological conditions	2.2-7
2/10	Development of meteorological service for the terminal area	2.2-8
2/11	Advanced planning relating to the aeronautical meteorological component of ASBU Block 3	2.3-1
2/12	Development of the WAFS in support of the aviation system block upgrades (ASBUs) beyond 2028	2.3-1
2/13	Development of provisions for aeronautical meteorological information services in the context of CDM and common situational awareness	2.4-1
2/14	Human factors considerations for the development of aeronautical meteorological service provisions	2.4-2
3/1	Aeronautical meteorological information to support trajectory-based operations	3.1-1
3/2	Inclusion of aeronautical meteorological information in the future SWIM-enabled environment	3.2-2
3/3	Further development of the SWIM concept relating to meteorology	3.2-3
4/1	Review of the working arrangements between ICAO and WMO	4.1-2
4/2	Definition of meteorological authority	4.2-1
4/3	Oversight of aeronautical meteorological service provision	4.2-2
4/4	Guidance/guidelines on the recovery of costs of aeronautical meteorological service provision	4.2-2
4/5	Evolving competency of aeronautical meteorological personnel	4.2-4
4/6	English language proficiency of aeronautical meteorological personnel	4.2.5
4/7	Provision and use of aeronautical meteorological information for aeronautical purposes only	4.2-6
5/1	Amendment 77 to Annex 3/Technical Regulations [C.3.1] and consequential amendments to Annex 11, PANS-ABC and PANS-ATM	5.1-1
5/2	Reorganization of provisions relating to aeronautical meteorology	5.2-2

RSPP

REPORT OF THE METEOROLOGY (MET) DIVISIONAL MEETING

Montréal, 7 to 18 July 2014

HISTORY OF THE MEETING

1. DURATION

1.1 The Meteorology Divisional Meeting (2014) (MET/14) was opened by the First Vice President of the Council, Mr. V. M. Aguado, at 1000 hours on 9 July 2014 in the Assembly Hall of the Headquarters of the International Civil Aviation Organization (ICAO) in Montreal. At the first Plenary, the meeting was also addressed by the President of the World Meteorological Organization (WMO), Mr. D. Grimes, the President of the Air Navigation Commission, Mr. F. Zizi, and the President of the WMO Commission for Aeronautical Meteorology, Mr. Chi-Ming Shun. The meeting was held in part conjointly with the Fifteenth Session of the Commission for Aeronautical Meteorology (CAeM-15) of the WMO. The closing Plenary was held on 18 July 2014.

2. REPRESENTATION

The MET/14 meeting was attended by 293 participants from 89 States and 7 international organizations. The list of participants is on page iv-1.

3. OFFICERS

The following officers were elected at the first Plenary meeting to serve both the Plenary and the MET Committee:

Chairman:	Mr. P. Lechner
First Vice-Chairman:	Mr. W. Maynard
Second Vice-Chairman:	Mr. D. Egere

4. SECRETARIAT

4.1 The Secretary of the meeting was Mr. G. Brock, Chief, Meteorology Section, ICAO assisted by Mr. D. Ivanov, Chief, Aeronautical Meteorology Division, WMO. Mr. Brock and Mr. Ivanov were assisted by:

Agenda Item	Item Secretary	Assisted by
1	Mr. N. Halsey	Mr. P. Dunda and Mr. J. Armoa
2	Mr. R. Romero	Mr. N. Halsey and Mr. G. Vega
3	Mr. N. Halsey	Mr. R. Romero
4	Mr. R. Romero	Mr. N. Halsey and Mr. A. B. Okossi
5	Mr. R. Romero	Mr. V. Ahago and Mr. N. Halsey

4.2 General administrative arrangements for the meeting were made under the direction of Dr. F. Liu, Director, Bureau of Administration and Services. Language services were provided under the direction of Mr. L. Cherif, Deputy Director, Languages and Publications, assisted by Mr. V. Samochkine, Chief, Interpretation Section, Mr. A. El Sehemawi (Chief, Arabic Translation Section), Mr. W. Wen

(Chief, Chinese Translation Section), Mr. A. Detchou (Chief, French Translation Section), Ms. J. Antony (Chief, Russian Translation Section) and Ms. A. De Cuadra-Lindstrom (Chief, Spanish Translation Section).

4.3 The physical arrangements for the meeting were made by Mr. M. Romero, Chief, Conference, Security and General Services Section, Mr. S. Dehinde, Chief, Information and Communication Technology Section, and Ms. D. Rahmani, Supervisor, Document Management and Outsourcing Section. Other specialist officers of the ICAO Secretariat provided advice to the meeting as required.

5. ADOPTION OF THE AGENDA

5.1 The agenda developed by the Air Navigation Commission and submitted to States in advance of the meeting was adopted without change at the first Plenary meeting.

6. WORKING ARRANGEMENTS

6.1 The organization plan developed by the Air Navigation Commission and submitted to States in advance of the meeting was approved without change at the first Plenary meeting.

6.2 A coordinating group was established in accordance with the *Directives to Divisional-type Air Navigation Meetings and Rules of Procedure for their Conduct* (Doc 8143), and met as necessary during the course of the meeting. The coordinating group comprised the Chairman and Vice-Chairmen of the meeting (Plenary Committee and subordinate MET Committee), the Secretary of the meeting and representatives of the various Secretariat services catering to the meeting. The coordinating group was able to coordinate the activities of the meeting using the services and accommodations available.

7. OPENING REMARKS

7.1 First Vice President of the Council of ICAO, Mr. Victor Manuel Aguado

On behalf of the Council of the International Civil Aviation Organization and its President, Dr. O. Benard Aliu, I have the privilege to welcome you to Montreal and to ICAO headquarters, and the honour to declare the 2014 Meteorology Divisional Meeting open. This meeting is being held conjointly with the 15th Session of the World Meteorological Organization Commission for Aeronautical Meteorology. You will be aware that WMO is a sister United Nations organization with whom ICAO has had formal working arrangements since 1953 and you may recall that the last MET Divisional Meeting in 2002 was also held in Montreal conjointly with the 12th Session of this WMO technical commission. I wish to extend a warm welcome to all of you.

I would like to extend a special welcome to Mr. David Grimes, President of the World Meteorological Organization. Mr. Grimes has been Canada's Permanent Representative with WMO since December 2006 and was elected to serve as the organization’s President in 2011 for a four-year term. I also extend a special welcome to Mr. Chi-Ming Shun, President of the WMO Commission for Aeronautical Meteorology and Mr. Farid Zizi, President of the Air Navigation Commission of ICAO. It is a pleasure to have the presence of Mr. Grimes, Mr. Chi-Ming Shun and Mr. Zizi during this opening session.

It goes without saying that the work to be undertaken during this meeting will have implications for both ICAO and WMO. With the customary assistance and cooperation of WMO, we believe that the output of the meeting will be responsive to the evolving requirements for aeronautical MET services and therefore of utmost importance for the future of international air transport.

As you may imagine, since the last MET Divisional Meeting in 2002 the world has changed, and consequently, international civil aviation has changed even more. In spite of some local and regional economic ups and downs, aviation has been growing globally at an annual rate close to 5 per cent. Since 2002, passenger and cargo traffic has doubled reaching in 2013 the level of 3.1 billion passengers/year carried by 37 million flights, with an overall economic impact of more than US $ 2.4 trillion. And most probably by the time we meet again at the next MET Divisional Meeting, the volume of the industry would have doubled once more. In the meantime, the technology that is available at our finger tips today would have not been dreamt of only a few years ago.

This broad perspective leads us to the fundamental challenge we collectively will be facing, that is how to enable the sustainable growth of aviation. To face that challenge we need to address with vigour the efforts to enhance the safety and efficiency of air navigation while reducing the impact of aviation on the environment, and that is why aeronautical meteorology becomes critical in those three strategic objectives.

This meeting comes at a very important, very relevant time when our Member States are embarking on the implementation of sector-wide air transport improvements over the period to 2028 and beyond, as detailed in the fourth edition of ICAO's Global Air Navigation Plan. The fourth edition of the Plan, which was approved by the Council and endorsed by the 38th Session of the ICAO Assembly in October 2013, explores the need for more integrated civil aviation planning at a global, regional and State level. It also identifies solutions by introducing a novel aviation system block upgrades methodology. This methodology is based on defining quantum leaps in operational performance, making sure of the convergence of procedures and standards with technological development, all together delivering cost effective operational gains.

The GANP and other complementary ICAO publications such as the Global Aviation Safety Plan are intended to set the roadmap and assist Member States in the realization of a "One Sky" concept for international air navigation. This is a concept that, while fully embracing the formal responsibilities of the State, understands and addresses the international flows of traffic well beyond national frontiers.

During the course of this meeting you will therefore elaborate on technical issues of direct relevance to the modernization strategy put forward in the GANP, including the enhancement of existing MET services and the development of new services that will be required. And, you will also address a number of institutional issues that are either already present or that are likely to emerge as MET service provision adapts to the evolving needs of the aviation user community and as the underlying science and technology advance. So, issues concerning the working arrangements between ICAO and WMO, the cost recovery and the oversight of MET services, and the competence of personnel engaged in the provision of MET services, all of which are considered to be fundamental cornerstones, will be addressed amongst others.

In all, this meeting comes at a fitting moment to address the short-, medium- and long-term enhancements to MET service provision that are needed to ensure safer and more efficient international civil aviation for the next 15 years and beyond.

The President of the Air Navigation Commission, Mr. Farid Zizi, will provide a more detailed explanation of your agenda shortly.

With forty-eight working papers to be addressed, your programme over the coming days is extensive and interesting. The Council of ICAO recognizes the great importance of your work for the enhanced safety and efficiency of international civil aviation. Rest assured therefore that the Air Navigation Commission and then the Council will review the recommendations arising from the meeting with keen interest. Now, it only remains for me to wish you a successful meeting and, last but not least, a very pleasant stay in Montréal.

7.2 President of WMO, Mr. David Grimes

Mr. Victor Aguado, First Vice-President of ICAO Council, Mr. Farid Zizi, President of the Air Navigation Commission, Dr. Xu Tang, Director Weather and Disaster Risk Reduction Service Department and representative of the WMO Secretary General, Dr. Chi-Ming Shun, President of the WMO Commission for Aeronautical Meteorology, distinguished experts and guests.

It is a great pleasure for me to welcome you all, on behalf of the World Meteorological Organization, to the Meteorology Divisional Meeting (2014), organized and held conjointly between the International Civil Aviation Organization and the WMO. I would like to express my thanks to our colleagues from ICAO for hosting this meeting on their premises and for the excellent working arrangements.

Mr. Aguado already outlined the link of the Divisional Meeting with the most important developments in air transport such as the implementation of the Global Air Navigation Plan through the Aviation System Block Upgrades methodology. I would highlight also that the integration of the aeronautical meteorological information in the System-Wide Information Management (SWIM) is regarded as a key enabler.

The provision of services to aviation has been a significant driver for global meteorology stimulated by the rapid growth of civil aviation since the 1950's. The cooperation established at the early stages between WMO and ICAO helped develop a sound international regulatory framework designed to contribute to the safety of international air navigation as set out in Annex 3 to the ICAO Convention and WMO Technical Regulations, Volume II. The regulatory framework as defined in these two documents serves as a model in the development technical regulations for other service domains.

A week ago, we concluded the 66th session of the WMO Executive Council and I am happy to inform you that aviation meteorology not only remains one of our priorities but the level of engagement of the Council in the issues being discussed here at the MET Divisional meeting was both deep and informed. One of our conclusions was to reinforce aviation meteorology, particularly the implementation of Quality Management Systems, professional competencies and improvement in service delivery remain a priority for the Organization as reflected in our draft Strategic Plan of WMO for the period 2016–2019. This strategic plan will to be concluded next year when all 191 Member States and Territories come together for the Seventeenth World Meteorological Congress. The decisions and recommendations of this conjoint meeting will be fully integrated into our planning process.

This being said, we recognize that the current challenges related to ensuring compliance with the ICAO and WMO requirements on quality and competency require continued focused attention and concerted action. Whereas WMO has invested significant effort through the CAeM, our Education and Training programme and enabled investments from donors, there remains much work to accomplish. I assure you the Organization remains focused on the quality of services rendered by NMSs and the competency its personnel that underpin safe operations.

An important part of this conjoint Meeting is the examination of the requirements for the provision of space weather information for ionospheric disturbances. The international meteorological community has

worked hard during the last decade to mature operational space weather services. By monitoring and predicting the impact of solar flares, solar radiation and geomagnetic storms on a wide range of temporal and spatial scales. We will enable informed decisions on potential disturbances or outages of the communication and navigation systems. This is essential to mitigate the safety risks and I might add that this is particularly important for operations over Polar Regions.

Advisories and warnings for volcanic ash, tropical cyclones and radioactive releases in the atmosphere are other examples of specialized services provided by regional centres around the world. Recent events illustrate the disruptive nature of these hazards to the global air navigation system. ICAO and WMO are proud of the cooperative effort in supporting the International Airways Volcano Watch system developed in close cooperation with other stakeholders such as IATA and IFALPA. I look forward to the outcomes of this session that relate to advances in these services that are critical for the safety and efficiency of air operations.

Recently the Council of ICAO expressed concern over climate change. The science informs us that perturbations in the climate system influence weather patterns including the frequency and intensity of extreme events with consequences on aviation operations and infrastructure. WMO and its partners have established the Global Framework for Climate Services in 2012 with the vision to enable better management of the risks of climate variability and change, and facilitate adaptation to climate change through the provision of science-based climate information and prediction to assist planning and policy making on the global, regional and national scale.

Keeping air travellers and aircraft safely separated from meteorological hazards in the future will require improved accuracy and resolution of the meteorological data and forecasts. This will also require a more efficient, interoperable delivery system to get information that is “fit for purpose” to decision-makers. This means that we need to plan the deployment of information and communication technology (ICT) and our respective research and development activities to operationalize common solutions.

Aeronautical meteorological services are evolving and WMO Members recognize they must adapt to the changes envisaged in the future global air traffic management concept. The meteorological community will respond to the challenges of the evolving ATM with stepwise improvements of existing services and the introduction of new arrangements and services.

I leave you with an important message from the recent WMO Executive Council. The significant investment by NMSs in infrastructure and human resources is essential to the industry. The cost-recovery from aviation is outlined in ICAO’s Manual on Air Navigation Service Economics and the WMO Guide on Aeronautical Meteorological Service Cost Recovery. These frame the mechanisms by which a sound financial relationship exists to support a substantial part of the investment by NMSs. The guidance developed by ICAO and WMO suggest that cost recovery mechanisms by the Member States should be developed in a fair, equitable and transparent manner. Unfortunately, this is not always the case and this has had a negative impact on their capacity to provide quality service to aviation.

I believe that a viable national meteorological service is an essential partner in sustaining the basic infrastructure for data acquisition and the dissemination of meteorological information for safe and efficient air operations. Our mutual interests will be best served if National Meteorological Services remain reliable partners and providers of high quality MET information and services to the aviation sector. I trust the Conjoint meeting will pay due attention to this issue and that adequate cost-recovery mechanisms are developed to ensure that NMSs continue to contribute to the safety of the ANS and air travelers worldwide.

In conclusion, I believe that this Conjoint Meeting will be a key event for the aviation MET community. As president of WMO I look forward to your guidance to ensure that ICAO and WMO remain in

harmony and that an ordered transformation in the changing global Air Traffic Management environment is achieved.

I wish you much success over the next ten days and trust you will have some opportunity to experience the bon vivant of this great city.

7.3 President of the Air Navigation Commission of ICAO, Mr. Farid Zizi

On behalf of the Air Navigation Commission it is my great pleasure to address the opening of this Meteorology Divisional Meeting. I would like to inform you that the Air Navigation Commission has closely followed the developments leading up to this meeting and has been directly involved in the development of the agenda and the organizational plan.

As the First Vice President of the Council has already indicated, the implementation of complementary and sector-wide air transport improvements over the next 15 years or more will rely, in part, on the provision and enhancement of aeronautical meteorological services, particularly if the desired improvements in aviation safety and air navigation capacity and efficiency are to be realized to their full potential. It is for this reason that the theme running through your agenda is how MET service provision needs to be maintained or, in many cases, enhanced or adjusted over the coming years. The proposals that you will discuss are intended to ensure that identified user requirements for a globally interoperable air traffic management system can be fulfilled through sound scientific, technological and operational capabilities from the MET perspective. This is one of the reasons why the working arrangements that ICAO has with WMO are so very important, since ICAO takes the lead in establishing the requirements for MET service for international air navigation and WMO takes the lead in specifying the technical methods and practices to be used to fulfil the requirements. This is also why you will be invited to consider that a review and update of the working arrangements should be undertaken in order to ensure their continued relevance in a changing world.

The potential operational benefits arising from the recommendations that you make during the meeting are to be kept always in the forefront of your considerations. Every proposed measure to improve aviation safety or air navigation capacity and efficiency through changes to existing MET services or the establishment of new MET services must be carefully assessed including, as necessary, the cost impacts.

During the course of the meeting you will be working as one committee, a MET Committee. You will address a total of five agenda items plus you will conduct a review of the draft report during the MET Committee phase.

Under Agenda Item 1 you will be given a brief overview of the 2013 edition of the Global Air Navigation Plan and the aviation system block upgrades (called “ASBU”) methodology, particularly as it related to MET. As part of Agenda Item 1 you will also consider aspects related to the development and upkeep of broad system-level, functional and performance requirements. You will initiate consideration of how ICAO provisions for MET could be structured in the spirit of recent Assembly resolutions, including through the proposed development of a new PANS-MET. You will return to some of these items under Agenda Item 5.

Under Agenda Item 2 you will give due consideration to the short-, medium- and long-term enhancement of MET services which are considered necessary or desirable to realize operational improvements within the modernization strategy contained in the GANP. So, supported by a series of transitional roadmaps and concepts of operation, you will give due consideration to the enhancement or adaptation of existing MET systems and services as well as the development of new MET systems and services needed to support the realization of a global ATM system over the next 15 years or so. Given the trend to a more collaborative and more automated operating environment, you will give due consideration to some of the issues that already exist or that may arise from a MET service provider perspective and a user perspective in the context of supporting collaborative decision making and common situational awareness.

Under Agenda Item 3, and closely related to the previous agenda item, you will turn your attention to the integration of digital MET information into the future system-wide information management environment, which will underpin the global ATM system that I have mentioned already. You will discuss some of the human-to-human and machine-to-machine interactions, and the information exchange services and models needed to foster the integration of MET into SWIM. In a related issue, you will also consider MET information integration in the context of trajectory-based operations. Enhanced MET information will play an important role in supporting trajectory-based operations, so it may be expected that you will address some of these issues also under Agenda Item 2, with their integration into a 'total system' falling under this agenda item.

Under Agenda Item 4 you will address a range of institutional issues – some old, some new – facing MET service provision, particularly as the aviation community progresses with the implementation of a globally interoperable, harmonized ATM system. In addition to the ICAO-WMO working arrangement that has been mentioned already, you will discuss issues such as the oversight of MET, the cost recovery of MET (particularly in the context of multi-regional, regional and sub-regional MET service provision), MET personnel competency and English language proficiency, and the provision and use of MET information for aeronautical purposes only. These are important issues that will have a bearing on the work of ICAO and WMO over the coming years; therefore, clear recommendations on the aeronautical MET community's expectations from this meeting will be essential.

Finally, under Agenda Item 5 you will consider a consolidated proposed amendment to Annex 3 as well as consequential amendments to other ICAO provisions. The proposals put forward for your consideration have arisen principally from the ICAO MET expert groups over the past 12 to 18 months and are directly relevant to the discussions that you will have during the meeting. You will also return to an issue initially discussed under Agenda Item 1 – namely the proposed development of a new PANS-MET concurrent with a restructuring of Annex 3. The recommendations that you make in this regard will have a great bearing on your work and the work of the Secretariat over the coming years.

By close of business next Monday you will have concluded your deliberations of Agenda Items 1 to 5. Following the Fifteenth Session of the WMO Commission for Aeronautical Meteorology next Tuesday and Wednesday you will then reconvene as a MET Committee next Thursday to review the draft report. Then, next Friday, you will reconvene as a Plenary to adopt the meeting report. It is of paramount importance therefore that you make optimum use of the limited time available over the next week-and-a-half. I am sure that the Chairman will be looking to help navigate you through non-turbulent but perhaps at times congested airspace over the coming days. It is important that you depart on time with your seatbelts safely secured, that you have a smooth flight, and that you arrive at your destination having given every item on the agenda sufficient consideration and that you reach consensus with every recommendation that you formulate.

I mentioned at the beginning of my remarks that the Air Navigation Commission has been closely following the developments leading up to this meeting. The same sentiment applies once your meeting has concluded. The ANC will undertake a review of the recommendations arising from the meeting in order for a report to then go forward to the Council. In parallel, the ANC will undertake a preliminary review of the proposed amendment to the SARPs ahead of consultation with States and relevant international organizations in early 2015.

For ICAO and WMO, conjoint MET Divisional Meetings happen infrequently. In fact, history shows that they occur typically just once every 8 or 12 years and this is only the eighth such conjoint meeting since the two organizations were established. So, it is important that you make efficient and effective use of your time, since it may be many years before you are all under the same roof again. This MET Divisional Meeting will be amongst the shortest, if not the shortest ever. The increased efficiency can be attributed, in part, to the use of electronic documentation preparation and distribution, but also to a kind request for a focussed approach by all delegates during the proceedings. So, with this in mind, I will conclude simply by wishing you a highly productive meeting and by saying that the ANC very much looks forward to reviewing the outcomes of this meeting in due course.

Thank you.

7.4 **President of the Commission for Aeronautical Meteorology of WMO, Mr. Chi-Ming Shun**

Mr. Victor Aguado, first vice president of the ICAO Council, Mr. Farid Zizi, president of the ICAO Air Navigation Commission, Mr. David Grimes, president of the WMO, distinguished delegates, ladies and gentlemen. It is a great honour for me to address you now as we start this most important meeting for aeronautical meteorology held once every decade or so.

Twelve years ago I had the privilege to attend this meeting, recalling that Dr. Neil Gordon, the then president of the CAeM, highlighted the history of the development of the World Area Forecast System (WAFS), created by us back in 1982 which had since evolved through the subsequent conjoint ICAO/WMO meetings in 1990 and 2002.

Today, after three decades, we have seen tremendous growth in international aviation transport as well as substantial advancements in meteorological science, services and enabling technologies. It is high time for us to re-think how aeronautical meteorology could better serve aviation in the coming decades. Indeed the Commission for Aeronautical Meteorology has, in the past several years, proactively engaged with ICAO and the aviation community to inform our users the evolving capabilities that the meteorological community could deliver to serve Air Traffic Management while at the same time the limits imposed by Mother Nature that we need to respect.

As pointed out by our distinguished colleagues from ICAO, WMO takes the lead in specifying the technical methods and practices to be used to fulfill the requirements established by ICAO for meteorological service for international air navigation. While this long-standing working arrangement between WMO and ICAO is not expected to change fundamentally, this important document, last updated in 1963, which by the way was the year when I was born, is proposed by this meeting to be reviewed so as to ensure that will continue to be current and relevant in the rapidly changing world.

As for the requirements, ICAO's latest Global Air Navigation Plan has laid down an ambitious plan to seek upgrades to the aviation systems in phases, driving significant changes to requirements for meteorological service for international air navigation in the next 15 years. These changes will inevitably lead to new models of service delivery that would allow a shift from product-centric to data-centric service provision, a more balanced approach in local, regional and global service provision and integration of meteorological information into the future system-wide information management environment.

The meteorological community has to respond by delivering new technical methods and practices to meet the new requirements, and by closing existing gaps over certain regions and aspects, like the provision of SIGMET information for assurance of flight safety en-route. We will not underestimate the challenges. But having implemented good governance tools like quality management systems and effective cost recovery mechanisms, fostering even closer partnership with the aviation users and actively bringing scientific research and new technologies to operational applications, I am confident that the meteorological service providers of our Member States would respond well to the challenges, stay competitive, and able to harness the opportunities to deliver better services to the aviation industry in the decades to come.

In the next one and a half weeks, we will need to consider together and agree on the change proposals, road maps and concepts of operations. We need to find the right balances, including the balance in the future roles of local, regional and global service providers, the balance in driving for efficiency while assuring safety, the balance in automated service provision versus human involvement, the balance in enabling effective data sharing while ensuring that the data is credible and fit for the intended purpose, and so on. In considering these issues, I would suggest that the underlying principles of equal opportunity and consensus in international cooperation, regional differences, the interests of the developing world, and the need to sustain the financial viability and basic infrastructures of the National Meteorological and Hydrological Services should be duly respected for the common good of the aviation and meteorological communities. These considerations have indeed been duly recognized and highlighted by the Executive Council of the WMO held just under two weeks ago in Geneva. Inevitably there are differing views and perspectives but I am sure that the wisdom of this community, as demonstrated in the past, will guide us to find the optimal path leading to a new era of aeronautical meteorology.

Together we will make history. Thank you very much.

LIST OF PARTICIPANTS

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ACD – Alternate Chief Delegate
D – Delegate
ALT – Alternate

ADV – Adviser
COBS – Chief Observer
OBS – Observer

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	MAPANAO MICHAEL	D
POLAND	CZAPROWSKI JERZY	CD
	TRABICKA MARZENA	D
PORTUGAL	BARAO MATEUS CARLOS MIGUEL	CD
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	PARK HYANG-GYU	D
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	DE SOUZA GLENDELL	D
	FLEMING PAUL	D
	GAIT NIGEL	D
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VENEZUELA (BOLIVARIAN REPUBLIC OF)	BLANCO DAVID	CD
	ZAMBRANO MÉNDEZ REIDY JOSE	CD
	DIAZ OSMA	D
ZAMBIA	NKOMOKI JACOB	CD
	SIKANA EMMANUEL	ACD
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CIVIL AIR NAVIGATION SERVICES ORGANISATION (CANSO)	BIRDSALL JENNIFER	COBS
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	LEITLANDE EVIJA	OBS
	OEZDEMIR TIMUR	OBS
	WILLIAMSON MIKE	OBS
EUROPEAN COMMUNITY (EU)	AMMELOOT JEAN LOUIS	D
	DE JONG MARINUS	COBS
	ROSS CHRISTOPHER	OBS
EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION (EUROCONTROL)	HART DENNIS (L.M.)	COBS
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INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)	COMBER MICHAEL	COBS
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	QUALLEY WARREN	OBS
	RENNIE GRAHAM	OBS
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INTERNATIONAL FEDERATION OF AIR LINE PILOTS' ASSOCIATIONS (IFALPA)	SIEVERS KLAUS	COBS
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	VUITTENEY-GELMAN BRIGITTE	OBS

DELEGATIONS		DELEGATES	
Member State Delegations	89	Member State Delegates	265
Observer Delegations	7	Observer Delegates	28
Total Delegations	96	Total Delegates	293

AGENDA OF THE MEETING

Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation

- 1.1: The Global Air Navigation Plan (GANP) — a framework for global planning
- 1.2: Realizing the "One Sky" concept through the GANP framework and Aviation System Block Upgrade (ASBU) methodology
- 1.3: The meteorological (MET) component of the ASBU methodology
- 1.4: The need for a restructuring of Annex 3/Technical Regulations [C3.1] and the development of a new PANS-MET to underpin the "One Sky" concept

Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision

- 2.1: Enhancement of existing meteorological service provision to support current strategic, pre-tactical and tactical operational decision-making (including ASBU Module B0-AMET)
- 2.2: Enhanced integrated meteorological information to support strategic, pre-tactical and tactical operational decision-making from 2018 (including ASBU Module B1-AMET)
- 2.3: Enhanced integrated meteorological information to support strategic, pre-tactical and tactical operational decision-making from 2028 (including ASBU Module B3-AMET)
- 2.4: Collaborative decision-making and common situational awareness – automation and human-factors considerations

Agenda Item 3: Integrating meteorological information exchange developments into the future system-wide information management environment

- 3.1: Meteorological information exchange developments in support of future international air navigation requirements
- 3.2: Integration of meteorological information in the future system-wide information management (SWIM) environment through the development of new forms of data representation

Agenda Item 4: Institutional issues

- 4.1: Review of the working arrangements between ICAO and WMO (Doc 7475)
- 4.2: Other institutional issues

Agenda Item 5: Standards, Recommended Practices and Procedures

- 5.1: Amendment 77 to Annex 3/Technical Regulations [C3.1]
- 5.2: Proposed *Procedures for Air Navigation Services — Meteorology* (PANS-MET, Doc xxxx), First Edition (not later than 2019)
- 5.3: Consequential amendments, if any, to other Annexes or PANS

GLOSSARY OF TERMS

AFS	aeronautical fixed service
AMHS	ATS message handling system
AMOFSG	Aerodrome Meteorological Observation and Forecast Study Group
AN-Conf/12	Twelfth Air Navigation Conference
ANSEP	air navigation services economics panel
ANSP	air navigation service provider
ASBU	aviation system block upgrade
ATC	air traffic control
ATM	air traffic management
ATMRPP	Air Traffic Management Requirements and Performance Panel
ATS	air traffic services
BIP-M	Basic instruction package – Meteorology [WMO]
BUFR	Binary universal form for the representation of meteorological data
CDM	collaborative decision making
CTA	controlled time of arrival
EDR	eddy dissipation rate
ET-M&M	Expert Team on Meteorological Services to ATM and Meteorological Information [WMO]
GANP	*Global Air Navigation Plan* (Doc 9750)
GASP	*Global Aviation Safety Plan* (Doc 10004)
IAVW	International airways volcano watch
IAVWOPSG	International airways volcano watch operations group
ICTSW	Inter-programme coordination team on space weather [WMO]
IROG	inter-regional OPMET gateways
ISO	International organization for standardization
IUGG	International union of geophysics and geodesy
IVATF	International volcanic ash task force
IWXXM	ICAO meteorological information exchange model
MARIE-PT	Meteorological aeronautical requirements and information exchange project team
MET	meteorological or meteorology
METWSG	Meteorological warnings study group
MET/02	Meteorology divisional meeting (2002)
MWO	meteorological watch office

PANS	Procedures for Air Navigation Services
PIRGs	planning and implementation regional groups
RHWAC	regional hazardous weather advisory centre
SADIS	satellite distribution system for information relating to air navigation
SADISOPSG	Satellite Distribution System Operations Group
SARPs	Standards and Recommended Practices
SIGWX	Significant weather
SWIM	system-wide information management
TBO	trajectory-based operations
TMA	terminal control area
VAAC	volcanic ash advisory centre
VASAG	volcanic ash scientific advisory group [WMO/IUGG]
WAFC	world area forecast centre
WAFS	world area forecast system
WAFSOPSG	World Area Forecast System Operations Group
WIFS	WAFS internet file service
XML/GML	extensible markup language/geography markup language

List of reference documents

Annex 1 — *Personnel Licensing*

Annex 3 — *Meteorological Service for International Air Navigation*

Annex 11 — *Air Traffic Services*

Annex 15 — *Aeronautical Information Services*

Doc xxxx, *Procedures for Air Navigation Services — Meteorology*

Doc 10007, *Report of the Twelfth Air Navigation Conference* (AN-Conf/12)

Doc 9974, *Flight Safety and Volcanic Ash*

Doc 9873, *Manual on the Quality Management System for the Provision of Meteorological Service to International Air Navigation*

Doc 9750, *Global Air Navigation Plan* (Fourth Edition)

Doc 9082*, ICAO's Policies on Charges for Airports and Air Navigation Services*

Doc 8896, *Manual of Aeronautical Meteorological Practice*

Doc 8400, *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC)

Doc 8143, *Directives to Divisional-type Air Navigation Meetings and Rules of Procedure for their Conduct*

Doc 7300, *Convention on International Civil Aviation* (Chicago, 1944)

Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM)

Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation

1.1: The Global Air Navigation Plan (GANP) — a framework for global planning

1.1.1 The meeting was apprised of a new (fourth) edition of ICAO's *Global Air Navigation Plan* (GANP) (Doc 9750) which represented a rolling fifteen-year strategy to guide complementary and sector-wide air transport improvements over the period 2013 to 2028. The meeting noted that the GANP, together with a companion new edition of ICAO's *Global Aviation Safety Plan* (GASP) (Doc 10004), had been approved by the ICAO Council and endorsed by the 38th Session of the ICAO Assembly in 2013.

1.1.2 The meeting noted that the GANP explored, inter alia, the need for more integrated aviation planning at both the regional and State level, and addressed required solutions by introducing a consensus-driven aviation system block upgrade (ASBU) methodology. The meeting further noted that the GANP identified issues to be addressed in the near term alongside financial aspects of aviation system modernization, and the increasing importance of collaboration and partnership as aviation recognizes and addresses the multi-disciplinary challenges that lay ahead.

Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation

1.2: Realizing the "One Sky" concept through the GANP framework and Aviation System Block Upgrade (ASBU) methodology

1.2.1 Acknowledging that the Organization had been directed by the 37th Session of the ICAO Assembly in 2010 to increase its efforts to meet the global need for airspace interoperability while maintaining its focus on safety, the meeting noted that, under the concept of "One Sky" for international air navigation, the Organization had initiated the referred ASBU methodology in order to develop a set of air traffic management (ATM) solutions or upgrades, take advantage of existing equipage, establish a transition plan, and enable global interoperability. The meeting noted that, in essence, the ASBUs provided a systems engineering modernization strategy for international air navigation, comprising a series of modules across four performance improvement areas[1] and four blocks[2]. The meeting was apprised that each block represented the target availability timeline for a group of operational improvements, both technological and procedural, intended to realize a fully harmonized global air navigation system.

1.2.2 The meeting recalled that ICAO's Twelfth Air Navigation Conference (AN-Conf/12) in 2012 had, through the formulation of Recommendation 4/7, invited the Meteorology Divisional Meeting (2014) to develop initial provisions in ICAO Annex 3 — *Meteorological Service for International Air Navigation*/WMO Technical Regulations [C.3.1] relating to the ASBU modules concerning meteorological information, to work on defining the meteorological information exchange model as an enabler for system wide information management (SWIM), and to develop a long-term strategy to support their further development and full implementation. The meeting appreciated that such aspects would be addressed through subsequent agenda items.

[1] Airport operations, globally interoperable systems and data, optimum capacity and flexible flights, and efficient flight paths.
[2] Block 0 (2013-2018), Block 1 (2018-2023), Block 2 (2023-2028) and Block 3 (2028 onward).

Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation

1.3: The meteorological (MET) component of the ASBU methodology

1.3.1 The meeting noted that aeronautical meteorology was a thread running through the ASBU performance improvement area titled "Globally Interoperable Systems and Data" and that, through future SWIM, aeronautical meteorology information would be a key enabler to the realization of a globally harmonized, interoperable air traffic management system.

1.3.2 The meeting was informed of the principle content of the three extant meteorology-specific ASBU modules within the current ASBU methodology, namely module B0-AMET in Block 0 ("Block zero") (2013-2018), module B1-AMET in Block 1 (2018-2023) and module B3-AMET in Block 3 (2028 onwards), as well as those non-meteorology-specific ASBU modules across all four performance improvement areas where meteorological service would be of relevance.

1.3.3 The meeting emphasized that there was a need to ensure that the meteorology-specific ASBU modules were understood in the context of their relationships and interdependencies with the other modules and including those related to SWIM which are shown in the appendix. This need had arisen in part due to the function of meteorology as an enabler to a number of operational improvement areas. The meeting formulated the following recommendation accordingly:

Recommendation 1/1 — Updating the GANP and ASBU methodology to reflect ASBU MET module dependencies with other modules

That ICAO be invited to:

a) improve the understanding and management of critical (inter-) dependencies between the operational performance improvement areas, the system-wide information management (SWIM)-related modules and the meteorology modules described in the *Global Air Navigation Plan* (GANP) (Doc 9750) and aviation system block upgrade (ASBU) methodology;

b) ensure that meteorology module-related activities be based on the identification of meteorology information requirements from non-meteorology-specific modules; and

c) reflect this core principle in the next update of the GANP and ASBU methodology on the basis of the initial dependencies provided in the appendix.

1.3.4 The meeting was cognizant that, at present, there was no meteorology-specific module in the Block 2 timeframe (i.e. B2-AMET in 2023-2028) since the implementation of B1-AMET (2018-2023), was expected to extend for a period beyond 2023. In this regard, the meeting noted that additional requirements could be expected in the meteorology domain for meteorological information and aspects of data collection and exchange. The meeting formulated the following recommendation accordingly:

Recommendation 1/2 — Inclusion of a MET-specific module related to Block 2 of the ASBU methodology

That ICAO:

a) identify the required meteorology capabilities to support Block 2 related operational improvements of the aviation system block upgrade (ASBU) methodology contained in the *Global Air Navigation Plan* (GANP) (Doc 9750), especially considering the introduction of airborne participation in collaborative air traffic management processes and the benefits of expanding meteorological observations by aircraft; and

b) consider including as part of the next update of the GANP and ASBU methodology the introduction of a meteorology-specific module related to Block 2.

Agenda Item 1: Supporting the "One Sky" concept through the enhancement of meteorological service for international air navigation

1.4: The need for a restructuring of Annex 3/Technical Regulations [C.3.1] and the development of a new PANS-MET to underpin the "One Sky" concept

1.4.1 The meeting was apprised that the 38th Session of the ICAO Assembly in 2013, through the formulation of Resolution A38-11, had recommended that the ICAO Council should, inter alia, promote the development and upkeep of broad system-level, functional and performance requirements, and should continue seeking the most appropriate means of development, translation, processing and dissemination of technical specifications.[*] With this in mind, the meeting noted that a number of Standards and Recommended Practices (SARPs) in Part I and a majority of SARPs in Part II of the current eighteenth edition (2013) of Annex 3/Technical Regulation [C.3.1] could, from a performance-based perspective, be considered as a technical means of fulfilling a functional need and its stated performance requirement. By recognizing that such SARPs were, essentially, a means of compliance, the meeting considered whether a suitable future placeholder for such provisions could be a (new) Procedures for Air Navigation Services — Meteorology (PANS-MET).

1.4.2 In this regard, the meeting concurred that since aeronautical meteorological service was an integral component of the "system of systems" that constituted the present and future civil aviation environment, there was a need to ensure that the evolution of the aeronautical meteorological service provisions contained in Annex 3/Technical Regulations [C.3.1], other Annexes to the Convention on International Civil Aviation, and procedures and guidance, were in the spirit of A38-11 and consistent with, inter alia, the rolling fifteen-year strategy contained in the GANP. The meeting formulated the following Recommendation accordingly:

Recommendation 1/3 — Evolution of aeronautical meteorological service provisions

That, as a means to foster the implementation of the "One Sky" concept for international air navigation, ICAO, in close coordination with WMO, ensure that the evolution of aeronautical meteorological service provisions (including the provision of meteorological information) is in the spirit of Resolution A38-11 of the 38th Session of the ICAO Assembly and consistent with, inter alia, the rolling fifteen-year strategy for complementary and sector-wide air transport improvements contained in the *Global Air Navigation Plan* (GANP) (Doc 9750).

The meeting noted that it would consider the potential scope of a restructured Annex 3/ Technical Regulations [C.3.1] and a new PANS-MET under Agenda Item 5.

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[*] Resolution A38-11 superseded Appendices A, D and E of Resolution A37-15 of the 37th Session of the ICAO Assembly in 2010.

APPENDIX

NON-MET SPECIFIC ASBU MODULES WHERE AERONAUTICAL MET SERVICE WILL BE OF RELEVANCE

Performance improvement area	*Module reference*	*Module scope*
Airport operations	B0-ACDM	Improved Airport Operations through Airport-CDM
	B0-APTA	Optimization of Approach Procedures including Vertical Guidance
	B0-WAKE	Increased Runway Throughput through Optimized Wake Turbulence Separation
	B1-WAKE	Increased Runway Throughput through Dynamic Wake Turbulence Separation
	B2-WAKE	Advanced Wake Turbulence Separation (Time-based)
Globally interoperable systems and data	B1-DATM	Service Improvement through Integration of all Digital ATM Information
	B1-FICE	Increased Interoperability, Efficiency and Capacity through Flight and Flow Information for a Collaborative Environment Step-1 (FF-ICE/1) application before Departure
	B1-SWIM	Performance Improvement through the Application of System-Wide Information Management (SWIM)
	B2-FICE	Improved Coordination through multi-centre Ground-Ground Integration (FF-ICE/1 and Flight Object, SWIM)
	B2-SWIM	Enabling Airborne Participation in collaborative ATM through SWIM
	B3-FICE	Improved Operational Performance through the introduction of Full FF-ICE
Optimum capacity and flexible flights — through global collaborative ATM	B0-FRTO	Improved Operations through Enhanced En-Route Trajectories
	B1-FRTO	Improved Operations through Optimized ATS Routing
	B1-NOPS	Enhanced Flow Performance through Network Operational Planning
	B3-NOPS	Traffic Complexity Management

Performance improvement area	*Module reference*	*Module scope*
Efficient flight path — through trajectory-based operations	B0-CDO	Improved Flexibility and Efficiency in Descent Profiles (CDO)
	B0-CCO	Improved Flexibility and Efficiency in Departure Profiles — Continuous Climb Operations (CCO)
	B1-CDO	Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV
	B1-TBO	Improved Traffic Synchronization and Initial Trajectory-Based Operation
	B2-CDO	Improved Flexibility and Efficiency in Descent Profiles (CDOs) using VNAV, required speed and time at arrival
	B3-TBO	Full 4D Trajectory-based Operations

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Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision

2.1: Enhancement of existing meteorological service provision to support current strategic, pre-tactical and tactical operational decision-making (including ASBU Module B0-AMET)

2.1.1 The meeting considered proposals relating to the enhancement of the existing world area forecast system (WAFS), aspects of the aeronautical fixed service (AFS) and progress made in other areas since the last Meteorology Divisional Meeting in 2002 (MET/02). In addition, the meeting noted nine information papers related to this sub-agenda item.

Aeronautical meteorological service at aerodromes and in the terminal area, including OPMET information

2.1.2 The meeting was pleased to note the significant progress made since MET/02, particularly relating to the automation of aerodrome observing and the introduction of aerodrome forecasts up to 30 hours at selected aerodromes.

The world area forecast system (WAFS), the aeronautical fixed service satellite distribution system and the Internet-based services

2.1.3 The meeting noted with appreciation that since MET/02 significant enhancements within the WAFS programme had included the increased temporal and spatial resolution of WAFS upper-air gridded global forecasts (including a transition from 6-hour output time steps to 3-hour output time steps, transition from a 1.25 degree thinned horizontal grid to a 1.25 degree regular (un-thinned) horizontal grid and increased vertical resolution particularly at cruise altitudes) and the development and operational implementation of WAFS gridded global forecasts for icing, turbulence and cumulonimbus clouds.

2.1.4 The meeting agreed that changes to the WAFS during the 2013 to 2018 timeframe should be focussed around improvements to the WAFS gridded global forecasts for icing and turbulence. In this regard, the meeting reviewed and agreed the principles to be used (in the form of deliverables) as the basis for future development of the WAFS in support of module B0-AMET of the aviation system block upgrade (ASBU) methodology contained in the GANP. The meeting formulated the following recommendation accordingly:

Recommendation 2/1 — Development of the WAFS in support of the ASBU methodology through to 2018

That ICAO, through an appropriate expert group, use the principles outlined by the deliverables included in Appendix A as a basis for the future development of the world area forecast system (WAFS) in support of module B0-AMET of the aviation system block upgrade (ASBU) methodology contained in the *Global Air Navigation Plan* (GANP) (Doc 9750).

2.1.5 With regard to the AFS satellite distribution system for information relating to air navigation (SADIS) used to disseminate or make available global OPMET information and WAFS forecasts to States and authorized users, the meeting noted the significant developments since MET/02 which had led to the SADIS second-generation satellite broadcast (SADIS 2G) and/or the Internet-based Secure SADIS FTP service used operationally by more than 180 authorized users in almost 110 States in the ICAO European (EUR), Middle East (MID), Africa-Indian Ocean (AFI) Regions and the western part of the Asia-Pacific (APAC) Region. The meeting agreed that, as a fully cost recoverable service, there

was a need to ensure that SADIS continued to operate in line with user expectations, and further developed in a manner consistent with the evolving GANP and the ASBU methodology contained therein. Furthermore, the meeting agreed that such development, as well as that of the WAFS internet file service (WIFS) serving the Americas and the eastern part of the APAC Region, should be aligned to the future system-wide information management (SWIM) environment and the work of other ICAO expert groups responsible for the development of SWIM. The meeting formulated the following recommendation accordingly:

Recommendation 2/2 — Operation and further development of the aeronautical fixed service satellite distribution system and the Internet-based services

That an appropriate ICAO expert group be tasked, as a matter of urgency, to ensure that the operation of the aeronautical fixed service (AFS) satellite distribution system for information relating to air navigation (SADIS), and the Secure SADIS FTP and WAFS Internet File Service (WIFS) Internet-based services, continue to meet user expectations and further develop in a manner consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750), including:

a) consideration of the role of SADIS and WIFS within the future system-wide information management (SWIM) environment underpinning the globally interoperable air traffic management system; and

b) alignment with future activities to be undertaken by ICAO in the information management domain.

2.1.6 With regard to the future of the SADIS 2G satellite broadcast beyond 2015, the meeting concurred with an expressed expert opinion of the Satellite Distribution System Operations Group (SADISOPSG) that SADIS 2G should be extended beyond 2015 but only until November 2019, and concluded that it would not be viable to invest in an enhancement of the system in the interim. The meeting formulated the following recommendation accordingly:

Recommendation 2/3 — Withdrawal of the SADIS 2G satellite broadcast and formal testing of the exchange of global OPMET information and WAFS forecasts on the AMHS

That ICAO, through an appropriate expert group, be tasked to:

a) undertake steps necessary to ensure that the SADIS 2G satellite broadcast be extended beyond 2015 but not beyond November 2019;

b) urge States/users concerned who have not already done so to migrate to operational use of the Secure SADIS FTP service in the intervening period described in a) above; and

c) undertake, as a matter of urgency, formal testing of the exchange of global OPMET information and world area forecast system (WAFS) forecasts on the ATS message handling system (AMHS) with a view to determining the capability and minimum specifications required to distribute such data to States/users in the future.

The international airways volcano watch (IAVW) and related matters concerning the release of radioactive material into the atmosphere and space weather

2.1.7 The meeting noted significant enhancements since MET/02 within the international airways volcano watch (IAVW) which included improvements in the real-time or near real-time observation, detection and reporting of volcanic eruptions and volcanic ash in the atmosphere, and in the forecasting of volcanic ash transport and dispersal therein. The meeting also noted that some of these advances had been prompted by, in particular, significant volcanic eruptions such as Eyjafjallajökull and Grimsvötn in Iceland in 2010 and 2011 respectively, and Puyehue-Cordón Caulle in Chile in 2011. The meeting noted that ICAO, in close collaboration with WMO, had established an International Volcanic Ash Task Force (IVATF) that worked in a complementary capacity between 2010 and 2012 to the extant International Airways Volcano Watch Operations Group (IAVWOPSG) to assist in expediting action on a number of the scientific, technical and operational issues that had been highlighted by these eruptions. In addition, the meeting was pleased to note that a World Meteorological Organization (WMO)/International Union of Geophysics and Geodesy (IUGG) Volcanic Ash Scientific Advisory Group (VASAG) had been established in March 2010 immediately prior to the Eyjafjallajökull eruption and that the VASAG had been instrumental in providing scientific inputs to the IVATF and IAVWOPSG.

2.1.8 The meeting noted that the IAVWOPSG had undertaken the development of a roadmap for the IAVW, as well as concepts of operation concerning information on the release of radioactive material into the atmosphere and space weather, all intended to aid the understanding of how service provision was expected to evolve over the coming years to support the emerging global air traffic management system.

Information on hazardous meteorological conditions, including en-route hazards

2.1.9 The meeting noted that the main task of the Meteorological Warnings Study Group (METWSG), established by ICAO in 2007, had been to review Annex 3/Technical Regulations [C.3.1] concerning the content and issuance of SIGMET information in order to meet the evolving needs of flight operations and in view of resolving long-standing SIGMET implementation difficulties encountered by many States. In this regard, the meeting was pleased to note that the METWSG had undertaken a trial in 2011 of the provision of SIGMET advisory information in the AFI Region and part of the APAC Region, with the significant contribution of China, France and South Africa that had served as SIGMET advisory centres during the trial. In view of the positive outcomes of the trial, the meeting noted a proposal for the establishment of a regional hazardous weather advisory system (addressed under Agenda Item 2.2).

2.1.10 In addition, the meeting noted other related developments arising from the METWSG, including a proposed amendment to Annex 3/Technical Regulations [C.3.1] intended to particularly improve the preparation of SIGMET and AIRMET information concerning hazardous meteorological conditions, including en-route hazards (addressed under Agenda Item 5.1).

Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision

2.2: Enhanced integrated meteorological information to support strategic, pre-tactical and tactical operational decision-making from 2018 (including ASBU Module B1-AMET)

2.2.1 In the context of enhancing aeronautical meteorological service from 2018, the meeting considered proposals relating to the enhancement of the WAFS and the IAVW as well as the provision of information on space weather, release of radioactive material and toxic chemicals and other hazardous meteorological phenomena. In addition, the meeting noted fourteen information papers related to this sub-agenda item.

General considerations for the development of future requirements for aeronautical meteorological information

2.2.2 The meeting supported, in principle, the evolution of the existing WAFS and IAVW, and the further development of provisions for space weather information, release of radioactive material and toxic chemicals and other hazardous meteorological phenomena. However, the meeting was of the view that additional consideration should be given to the overall evolution of aeronautical meteorological service provision in the context of a changing air transport environment and on the development of a provisions framework of local, sub-regional, regional, multi-regional and global service. Within such a framework, the meeting noted that the provisions could support the concept of having user communities at different levels, such as individual airspace users, airline operations and various air traffic services or functions, while at the same time ensuring the exchange of performance-based meteorological information that was cost-effective, proportional and agile to its operational use and to meet Block 1 of the ASBU methodology contained within the GANP and other associated objectives. The meeting agreed that it was imperative that the future management and governance of the aeronautical meteorology system serving international air navigation be assessed, with required changes clearly identified. It was further noted that while the development of technology was an integral component of expected future services, it would continue to be important for service delivery to remain collaborative and inclusive. The meeting formulated the following recommendation accordingly:

Recommendation 2/4 — Review of MET information service provision framework to reflect GANP objectives

That ICAO, through an appropriate expert group and in close coordination with WMO, in support of overarching safety and efficiency objectives, be urged to:

a) review the existing MET information service provision framework as laid down in Annex 3 — *Meteorological Service for International Air Navigation*/Technical Regulations [C.3.1], in consideration of the emerging needs from users, including air traffic services/air traffic management, for consistent, coherent, accurate, authoritative and fit-for-purpose MET information as specified in performance requirements in support of the overall objectives of the *Global Air Navigation Plan* (GANP) (Doc 9750);

b) ensure that the initial priorities of the review, which should be concluded by 2016, are a consolidated effort together with the:

i) future development of the world area forecast system (WAFS), the international airways volcano watch (IAVW), and provisions for information concerning space weather and the release of radioactive material into the atmosphere;

ii) development and implementation of a regional advisory system for select en-route hazardous meteorological conditions for States where there are SIGMET-related deficiencies;

iii) MET support for trajectory-based operations in general and collaborative decision making, including at the airport and network levels; and

iv) development of guidance for States concerning how their ICAO obligations may be met in the context of local, sub-regional, regional, multi-regional and global MET, including cost recovery and governance considerations;

c) ensure that outcomes of the referred review are considered when updating the GANP and relevant aviation system block upgrade (ASBU) modules; and

d) ensure that guiding principles respecting the mandates of both ICAO and WMO are developed for States to facilitate inclusive MET service provisions to be done locally, sub-regionally, regionally, multi-regionally and globally when required and local, sub-regional, regional, multi-regional and global user communities could use this information in their operations.

2.2.3 In addition to the foregoing, the meeting gave consideration to the needs of pilots, specifically in the context of the user needs during and upon the transition to the provision of aeronautical meteorological information in digital form, as envisioned by the GANP. In this regard, the meeting noted a number of issues, particularly related to the visualization of such information, which would be considered further in the context of automation and human factors considerations (addressed under agenda sub-item 2.4).

World area forecast system (WAFS)

2.2.4 The meeting noted the work that had been carried out in the development of a roadmap to facilitate the future requirements for the WAFS. In line with the future evolution of the GANP, the meeting noted that it was to be expected that the roadmap would evolve through the coming years to ensure that service levels fulfil current and future needs. The meeting therefore agreed that it was vital, as part of a holistic approach to future service provision, that the WAFS continue to evolve in line with the GANP in a cost-effective manner through appropriate governance. In addition, the meeting agreed that the information produced within the framework of the WAFS should be integrated into the future system-wide information management (SWIM) environment, including the interoperable data formats to be used based on the ICAO meteorological information exchange model (IWXXM).

2.2.5 The meeting agreed that changes to the WAFS during the 2018 to 2023 timeframe of Block 1, and additionally those in the 2023 to 2028 timeframe of Block 2, should be focussed around the principles provided in Appendix B. In this regard, the meeting reviewed and agreed the principles to be used as a basis for future WAFS developments. The meeting formulated the following recommendation accordingly:

Recommendation 2/5 — Further development of the WAFS in support of ASBU Blocks 1 and 2

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to:

a) further develop the requirements for the world area forecast system (WAFS) consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750), including the integration of the information produced by the WAFS into the future system-wide information management (SWIM) environment underpinning the globally interoperable air traffic management system; and

b) use the principles outlined by the deliverables included in Appendix B as a basis for the future development of the WAFS in the timeframes of Blocks 1 and 2 of the aviation system block upgrade (ASBU) methodology.

International airways volcano watch (IAVW)

2.2.6 The meeting noted the significant enhancements of the IAVW since the Meteorology Divisional Meeting in 2002 (MET/02) including the development of a roadmap to facilitate the future requirements for the IAVW. The meeting noted that, in line with the future evolution of the GANP, it was to be expected that the roadmap for the IAVW would evolve through the coming years to ensure that service levels fulfil current and future needs. The meeting therefore agreed that it was vital that the IAVW continue to evolve in line with the GANP and that the information produced within the framework of the IAVW should be integrated into the future SWIM environment. The meeting agreed that the roadmap provided in Appendix C should be used as a basis for the development of the future requirements of the IAVW. The meeting formulated the following recommendation accordingly:

Recommendation 2/6 — Further development of the international airways volcano watch (IAVW)

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to further develop the requirements for the international airways volcano watch (IAVW) consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750), including the integration of the information produced by the system into the future system-wide information management (SWIM) environment underpinning the future globally interoperable air traffic management system using, as a basis, the roadmap provided at Appendix C.

Space weather

2.2.7 The meeting noted the recent work carried out by the IAVWOPSG to develop draft initial provisions for inclusion in Annex 3/Technical Regulations [C.3.1] to meet the requirements for information concerning space weather, involving the establishment of space weather centres. Additionally, the meeting noted the complementary development of a concept of operations for space weather information services which, as a living document, would be expected to evolve in line with the GANP, which explicitly included space weather as agreed by ICAO's Twelfth Air Navigation Conference in 2012 (AN-Conf/12), and that space weather information should be integrated into the future SWIM environment.

2.2.8 Taking into account the advice of WMO, including the WMO Inter-Programme Coordination Team on Space Weather (ICTSW) and others concerned, the meeting was of the view that space weather information services which serve international air navigation should be organized through the establishment of an optimal number of global centres (for solar radiation storms and solar flares, as well as for geomagnetic storms and ionospheric disturbances at the predictive stage) augmented by an optimal number of regional centres (for geomagnetic storms and ionospheric disturbances at the observation stage). The meeting agreed that the roles, requirements and capabilities of the global and regional centres (together with the optimal number of centres) had not been fully elaborated. The meeting agreed therefore that further consideration should be given to the aforementioned, including the development of a process for the designation of global and regional centres, their governance (including cost recovery for provision of service and competency standards) and duration of mandate. Furthermore, the overall understanding of how space weather information would be used needed to be elaborated in detail and appropriately reflected in appropriate documentation for space weather.

2.2.9 In view of the foregoing, the meeting agreed to not include the draft initial provisions mentioned above in the draft Amendment 77 to Annex 3/Technical Regulations [C.3.1] (addressed under Agenda Item 5.1) in view of the need for the further development of service requirements and capabilities and any additional related guidance material. However, the meeting agreed that ICAO should work towards enabling space weather services for aviation by developing Annex 3 provisions for inclusion in 2018 (i.e. Block 1).The meeting formulated the following recommendation accordingly:

Recommendation 2/7 — Development of provisions for information concerning space weather

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to develop provisions for information on space weather to international air navigation consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750), including the integration of the information produced into the future system-wide information management (SWIM) environment underpinning the future globally interoperable air traffic management system, specifically addressing:

a) requirements for space weather information services consistent with the draft concept of operations for space weather information services;

b) selection criteria and associated capability for the designation of global and regional space weather centres, including the optimum number thereof;

c) appropriate governance and cost recovery arrangements for the provision of space weather information services on a global and regional basis; and

d) considerations on the use of space weather information and the various impacts space weather events could have on international air navigation.

Release of radioactive material

2.2.10 The meeting noted the significant developments since MET/02 to introduce provisions in Annex 3/Technical Regulations [C.3.1] regarding the dissemination of information on the release of radioactive material into the atmosphere and the development of a global database to assist the WMO regional specialized meteorological centre (RSMC) co-located with VAAC London (designated as focal point) in the direct notification to affected area control centres in the event of a release of radioactive material. Additionally, the meeting noted the development of a concept of operations for information concerning the release of radioactive material into the atmosphere which, as a living document, would be expected to evolve in line with the GANP and that such information should be integrated into the future SWIM environment. The meeting formulated the following recommendation accordingly:

Recommendation 2/8 — Further development of provisions for information on the release of radioactive material into the atmosphere

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to further develop provisions for information on the release of radioactive material into the atmosphere consistent with the evolving *Global Air Navigation Plan* (GANP) (Doc 9750), including integration of the information produced into the future system-wide information management (SWIM) environment underpinning the future globally interoperable air traffic management system.

Other hazardous meteorological phenomena

2.2.11 The meeting was pleased to note the significant progress made since MET/02, particularly by the METWSG, intended to resolve longstanding implementation issues in the provision of SIGMET information by some States, which was an impediment to continued safe and efficient flight operations. The meeting agreed that the implementation of a regional advisory system for select hazardous meteorological conditions, as proposed by the METWSG, should be actively pursued so as to provide a long-term solution to the difficulties encountered in this regard.

2.2.12 In addition to the technical challenges involved in the establishment of such a regionalized advisory system, the meeting emphasized that a number of non-technical issues would need to be addressed before any implementation could occur, including governance and equitable cost recovery arrangements. To these ends, the meeting reviewed a strategic assessment of the modalities for the implementation of a regional hazardous weather advisory system and an assessment of the associated governance and cost recovery arrangements as provided at Appendices D and E, respectively. Additionally, the meeting agreed that the development of such a regional hazardous weather advisory system should evolve in line with the GANP and that the information produced within the framework of the system should be integrated into the future SWIM environment.

2.2.13 The meeting noted that there had been long-standing SIGMET deficiencies in some States and expressed requirements from users for harmonized, phenomenon-based hazardous weather information. In this regard, there was an urgent need demonstrated by aviation users for the establishment of regional hazardous weather advisory centres (RHWACs) to assist meteorological watch offices (MWOs) with the provision of SIGMET information for select hazardous meteorological conditions that included, as a minimum, thunderstorms, icing, turbulence and mountain waves, but which excluded volcanic ash and tropical cyclones (given the existing volcanic ash and tropical cyclone advisory systems). The meeting agreed that an initial phase of issuing advisories to MWO would serve as a precursor to the next two phases of further regional hazardous weather advisory provision development as indicated in the referred Appendix D.

2.2.14 Taking into account such users' requirements, the meeting fully concurred that a regional hazardous weather framework should be implemented expeditiously, while considering the development of a governance and cost recovery framework.

2.2.15 The meeting agreed that the development of such a regional hazardous weather advisory system should be supported by appropriate guidance material for:

a) ICAO planning and implementation regional groups (PIRGs) providing technical background and capabilities of meteorological centres in States able to serve as RHWACs taking account of cost-effectiveness such as the utilization of existing capabilities; and

b) user States and service provider States on the processes for the preparation and dissemination of the advisory information, mutual cooperation and sustainability of the existing meteorological infrastructure and use of local expertize.

2.2.16 The meeting formulated the following recommendation accordingly:

Recommendation 2/9 — Implementation of a regional advisory system for select en-route hazardous meteorological conditions

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to:

a) expeditiously develop provisions supporting the implementation of a phenomenon-based regional advisory system for select en-route hazardous meteorological conditions consistent with the evolving *Global Air Navigation Plan* (GANP) (Doc 9750), in considering users' long-standing requirements, especially in those States where notable SIGMET-related deficiencies persist using, as appropriate, the strategic, governance and cost-recovery assessments provided in Appendices D and E;

b) integrate the information produced by the referred system into the future system-wide information management environment underpinning the future globally interoperable air traffic management system; and

c) develop appropriate guidance material to support the selection criteria of regional hazardous weather advisory centres taking account of cost-effectiveness, the processes for the preparation and dissemination of the advisory information, mutual cooperation, sustainability of the existing meteorological infrastructure and use of local expertise.

Note.— Select hazardous meteorological conditions in this context includes, as a minimum, thunderstorms, icing, turbulence and mountain waves, but excludes volcanic ash and tropical cyclones.

Meteorological service information for the terminal area

2.2.17 In a related issue, the meeting reviewed a proposal to include meteorological service for the terminal area in Block 1 of the ASBU methodology. The meeting also noted work undertaken in one State to develop ATM-tailored meteorological information that highlights potential weather-related impacts on air traffic flow and a need to develop guidance on verification methodology toward the continuous improvement of meteorological information for ATM. The meeting agreed that it would be important that specific mention be made of the meteorological requirements to support ATM in the terminal area in Block 1 modules, including B1-AMET of the ASBU methodology, noting that such an addition could only be made as part of a periodic review of the GANP as a whole. The meeting noted a potential study to be conducted by relevant WMO projects on the development of meteorological service for the terminal area which would include the impact of weather on different airports around the world. The meeting agreed that the experience gained from such work would indeed be valuable. In addition, the meeting noted that there were other studies underway to determine the needs of ATM service providers and operators for meteorological service information in the terminal area. Noting the discussion above, the meeting formulated the following recommendation:

Recommendation 2/10 —Development of meteorological service for the terminal area

That ICAO, in close coordination with WMO, be tasked to:

a) include meteorological service for the terminal area and other relevant operational requirements in Block 1 and subsequent blocks of the aviation system block upgrade (ASBU) methodology to highlight potential related impacts on air traffic flow in consideration of air traffic control and air traffic management (ATM);

b) develop ATM-tailored meteorological service for the terminal area to meet future ATM requirements identified by the *Global Air Navigation Plan* (GANP) (Doc 9750) and reflect the appropriate functional and performance requirements in the relevant provisions, noting outcomes from ICAO expert groups on meteorology, ATM and flight operations.;

c) develop guidance on verification methodology toward the continuous improvement of meteorological information to ATM; and

d) integrate the information concerning meteorological service for the terminal area into the future system-wide information management (SWIM) environment underpinning the future globally interoperable ATM system.

2.2.18 The meeting was pleased to note significant enhancements related to the establishment of an air traffic meteorology centre of the Japan Meteorological Agency to support ATM. In particular, the meeting noted the development of a new system to provide tailored weather information which could be used to indicate the likelihood of weather-related impacts on air traffic flow. The system has the potential to be used as a future index to measure the degree of weather-related impact on the ATM system.

2.2.19 Additionally, the meeting was apprised of a case study to illustrate how cumulonimbus clouds within the approach area of Tokyo International Airport significantly impacted ATC flow and how the air traffic meteorological centre helped the ATM centre to conduct efficient and effective ATM highlighting the importance of the information on meteorological conditions within approach control areas.

Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision

2.3: Enhanced integrated meteorological information to support strategic, pre-tactical and tactical operational decision making from 2028 (including ASBU Module B3-AMET)

2.3.1 Notwithstanding that module B3-AMET of the ASBU methodology contained in the GANP was due to be implemented from 2028, the meeting noted that the complexity of the technology involved, particularly flight management systems and data link communications, meant that potentially significant changes to existing and short-term systems and services needed to be planned well in advance of the expected implementation period envisaged by Block 3 (i.e. 2028 and beyond).

2.3.2 The meeting agreed therefore that consideration of the technological requirements and service capabilities contained in ASBU Block 3, in particular module B3-AMET and those other modules relating to SWIM, needed to be given many years in advance of the expected implementation date of 2028. The meeting formulated the following recommendation accordingly:

Recommendation 2/11 — Advanced planning relating to the aeronautical meteorological component of ASBU Block 3

That an appropriate ICAO expert group, in close coordination with WMO, be tasked to undertake advanced planning, in the 2015 to 2020 timeframe, of the technological requirements and aeronautical meteorological service capabilities needed to support the implementation by 2028 of module B3-AMET of the aviation system block upgrades (ASBU) methodology and the meteorological components of other ASBU modules related to system-wide information management contained in the *Global Air Navigation Plan* (GANP) (Doc 9750).

2.3.3 The meeting reviewed proposed changes to the world area forecast system (WAFS) in the Block 3 timescale, which were to be focussed around the principles provided in Appendix F. Having completed its review, and appreciating that it was particularly challenging to fully envisage the future state of the aviation system (and the WAFS component) in the 2028 timeframe, the meeting agreed to the principles to be used as a basis for future developments of the WAFS in support of module B3-AMET of the ASBU methodology. The meeting formulated the following recommendation accordingly:

Recommendation 2/12 — Development of the WAFS in support of the aviation system block upgrades (ASBUs) beyond 2028

That ICAO use the principles outlined by the deliverables for en-route operations included in Appendix F as a basis for the future development of the world area forecast system (WAFS) in support of module B3-AMET of the ASBU methodology.

Agenda Item 2: Improving the safety and efficiency of international air navigation through enhanced meteorological service provision

2.4: Collaborative decision making and common situational awareness — automation and human factors considerations

2.4.1 The meeting noted expected benefits that would arise from the application of collaborative decision making (CDM) in an information-rich operating environment. In this regard, CDM was considered a fundamental aspect of how the global air traffic management (ATM) system would mature, ensuring that decisions were informed, understood by all and based on a shared evaluation of the underlying information. It was also noted that since aeronautical meteorology was an integral component of the total available information from which operational decisions would be taken in a collaborative manner by the ATM community, it followed that aeronautical meteorology would be a key enabler to common situational awareness.

2.4.2 The meeting emphasized that in such a collaborative environment there was a strong need for governance, including quality management and data standardization for which there were prescribed data formats that were common across all information domains within the future SWIM environment of global ATM.

2.4.3 The meeting noted that the expected transition from product-oriented to information- or data-oriented service provision would inevitably mean less interaction with the aeronautical meteorological information (on the part of the providers and the users) due to increased automation. In addition, given such an automated operating environment and being cognizant of the uniqueness of users' operational decisions, the meeting agreed that it would be advisable to not be prescriptive in terms of visualization standards of the commonly available aeronautical meteorological information, since each user would have their own, often unique operational needs and capabilities.

2.4.4 The meeting noted that in the interest of maximizing interoperability and easing the implementation process, air navigation service providers (ANSPs), as a key ATM community member, would play an integral role in the aeronautical meteorology and ATM communities' transition to an information-oriented environment.

2.4.5 The meeting agreed that the transition to a more collaborate operating environment and increased automation would require changes to how aeronautical meteorological information was made available to and applied by users, and that governance was a prerequisite. In addition, there was a need to ensure that human factors considerations remain integral to aeronautical meteorological service provision during and upon such a transition. The meeting formulated the following recommendations accordingly:

Recommendation 2/13 — Development of provisions for aeronautical meteorological information services in the context of CDM and common situational awareness

That ICAO and WMO ensure the development of provisions for aeronautical meteorological information services that promote collaborative decision making (CDM) and common situational awareness among the air traffic management (ATM) community.

Recommendation 2/14 — Human factors considerations for the development of aeronautical meteorological service provisions

That ICAO and WMO ensure that human factors considerations are central to the development of aeronautical meteorological information services.

2.5 Statement by the Delegations of China and the Russian Federation

World Area Forecast System (WAFS)

2.5.1 The development of WAFS should be put in their proper historical perspective. It is understood that the establishment of WAFS in 1982 was based on the then situation that not all States had numerical weather prediction (NWP) and satellite dissemination capabilities. However, during the past three decades, the global situation has changed significantly in that many States now operate NWP models with high spatial and temporal scales out to a week or more. At the same time, satellite dissemination technologies are no longer cost-effective compared to the Internet. Therefore, apart from the WAFS model forecasts, there are many different global model forecasts which could be available for use, for en-route flight planning purpose, provided that they meet a required level of performance and internationally designated.

2.5.2 With tremendous air traffic growth around the world, in particular in the Asia-Pacific region, there is an increasing demand from the users for better forecasts and more timely amendments of the SIGWX information to respond to the rapid changes in weather such as significant convection which have not been forecast by the existing global centres. Furthermore, in future SWIM environment where there would be greater dependence on gridded forecasts to support ATM and TBO, it is not clear if the existing WAFS structure is meeting the future needs of users. To support inevitable growth in air traffic, the centres need to address the growing demands from users which might not be best served by the existing arrangement of having only two global centres. It is felt feasible to reconsider the place and role of WAFS in the new context of the GANP and ASBU methodology. As such, in considering the global centres, considerations in respect of performance, equity and sustainability including backup arrangements should be taken into consideration. Users should be given a choice as to the global model that best meets their operational needs.

2.5.3 Furthermore, Annex 3 and future PANS-MET should regulate on the provision of meteorological service, including WAFS forecasts, i.e. setting up the required performance standards each service should meet, not the agencies that provide such service.

2.6 Statement by the Delegations of Bahrain, Kuwait, Qatar and United Arab Emirates

To the Secretary General of ICAO and WMO

2.6.1 With reference to ICAO MET Divisional Meeting -14 supporting the "One Sky" concept as it relates to the Global Air Navigation Plan (GANP) and the meteorological component of the Aviation System Block Upgrade (ASBU) methodology. The Sub-regional representative presence at ICAO MET Divisional Meeting -14 are (Bahrain, Kuwait, Qatar, and United Arab Emirates) wish to put forward the following concerns for your consideration.

2.6.1.1 Reference to the Draft recommendation item 2.5.6, MET/14-WP/6|CAeM-15/Doc. 6, with regard to the Implementation of a regional advisory system for select en-route hazardous meteorological conditions and reference to Appendices B and C, we would like to bring to your attention that the implementation of a regional advisory system to serve SIGMET information would have impact on:

a) sub region role on providing SIGMET warning as service providers, and organizational viability of sub- region NMHSs:

b) the accurate manner as sub-region are fully compliance, and skilled since 1960 in providing SIGMET warning;

c) current and ongoing investment on human resources, and meteorological systems; and

d) annual fee collection reference to item 5.2.1.3, and 5.2.1.4 from MET/14-WP/6|CAeM-15/Doc. 6 Appendices C.

2.6.2 To conclude all above mentioned countries request both the ICAO and WMO to consider recommendations proposed above by the sub regional, as it will have effects on the governing role as single regionalized providers to international controlled system. All of the above mentioned member countries are providing valuable, quality and efficient meteorological services to aviation communities in terms of early weather warning for more than a decade. Our sub-region invested in meteorological systems in providing SIGMET service through their assigned FIRs with ongoing investment plans towards the contribution of composite RADAR Mosaic, high resolution NWP in both atmospheric &ocean domains, satellite data reception and sub-regional redistribution. After all these investments, we are in jeopardy of maintaining and sustaining these infrastructures in view of the new regionalized SWIM environment and forced to a position that we may lose our visible role among other members and also the support from the government.

2.6.3 In addition to the circumstances in our region, we request both ICAO and WMO to clarify clearly the regulations (with regards to bilateral agreements) and rules to be drawn up when, and before assigning the regional SIGMET service provision.

2.7 Statement by the Delegations of China and the Russian Federation

Global space weather centres

2.7.1 We both generally support the inclusion of space weather services under Annex 3 to support and satisfy the requirements of the international aviation, and to provide users with the accurate and effective space weather products and service which will increase the sustainability of the global system. However, we have some difficulty with the proposed framework of two global centres with mutual backup and augmented by regional centres. A three or more global centre framework with mutual backup will have more advantages considering geographical coverage of space-based observations augmented by ground-based observations and specific characteristics for data assimilation, model simulation and validation than that for the two global centre framework proposed by some States, and will have a higher chance of meeting the aviation user requirements for space weather.

2.7.2 We suggest that the standards and technical specifications of space weather products and service to international aviation should be developed and approved, and the selection criteria for global space weather centres should be defined.

2.7.3 We also suggest that the number of global space weather centres with mutual backup and augmented by regional centres to ensure smooth coordination between the global and regional levels should be quantified.

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APPENDIX A

WORLD AREA FORECAST SYSTEM DELIVERABLES IN SUPPORT OF ASBU BLOCK 0 (2013 to 2018)

- Implement improved turbulence algorithms including the replacement of turbulence potential with turbulence severity (i.e. eddy dissipation rate (EDR))

- Implement improved icing algorithms including the replacement of icing potential with icing severity

- Global and regional verification of WAFS forecasts by utilizing data provided by States and user organizations

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APPENDIX B

WORLD AREA FORECAST SYSTEM DELIVERABLES IN SUPPORT OF ASBU BLOCK 1 (2018 to 2023) AND BLOCK 2 (2023 TO 2028)

Changes intended during the time frame of Module B1-AMET — *Meteorological Information Supporting Enhanced Operational Efficiency and Safety* (2018-2028) are:

- 2018-2023:
    - Implement cumulonimbus cloud ensemble based prediction system
    - Implement turbulence type forecasts (e.g. convection, jet-stream shear, terrain) utilizing eddy dissipation rate (EDR)
    - Implement finer grid resolution for WAFS data
    - Implement calibrated probabilistic forecasts for icing, turbulence and cumulonimbus cloud
    - Provide partial dataset of meteorological information suitable for integration into flight planning, flight management and air traffic management (ATM) decision support systems for en-route weather
    - Implement significant weather forecasts (SIGWX) in XML/GML format as a replacement to SIGWX in BUFR format
    - Make available WAFS data via the System Wide Information Management (SWIM)
- 2023-2028:
    - Provide increased dataset of meteorological information suitable for integration of meteorological information into flight planning, flight management and ATM decision support systems for en-route weather

Improved algorithms

Improvements by the WAFCs include, but are not limited to:

- Cumulonimbus cloud:
    - Improvements linked to convection scheme and use of ensemble based forecasts
    - Change output parameters to provide more useful calibrated values

- Turbulence:
    - Characterization of turbulence type, e.g. convective, upper level wind shear or terrain induced
    - Calibrated probabilistic output utilizing EDR
- Icing:
    - Calibrated probabilistic output

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APPENDIX C

Roadmap

for

International Airways Volcano Watch (IAVW)

in

Support of International Air Navigation

21 November 2013

Version 1.0

Revision	Date	Description
0.1	29 July 2013	Initial draft. Based on draft ConOps for the IAVW in response to IAVWOPSG Conclusion 7/17. Aligns with *Meteorological Information Supporting Enhanced Operational Efficiency and Safety* from ICAO's Aviation System Block Upgrades (ASBU).
0.2	27 September 2013	Revised draft based on comments from IAVWOPSG ad hoc group.
0.3	24 October 2013	Revised draft based on comments on version 0.2 from the IAVWOPSG ad hoc group.
0.4	10 November 2013	Revised draft based on comments on version 0.3 from the IAVWOPSG ad hoc group
1.0	19 November 2013	Submitted to IAVWOPSG Secretariat
1.0 rev	21 November 2013	Revised to include additional comments from WMO

Contents

Preface

At the first meeting of the International Volcanic Ash Task Force (IVATF/1), held at ICAO Headquarters in Montréal from 27 to 30 July 2010, it was recognized that there was a need to further promote and improve the services provided by Volcanic Ash Advisory Centres (VAAC) and Meteorological Watch Offices (MWO). It was agreed that a global Concept of Operations (ConOps) for volcanic ash should be developed that would cut across all service fields from a perspective of the providers of information to the users/operators of that information in support of both tactical and strategic decision making. This resulted in IVATF Task TF-VAA10, *Development of a Concept of Operations for the International Airways Volcano Watch (IAVW)*.

A draft version, and follow-on revisions, of the ConOps for volcanic ash were presented to the IVATF at their subsequent meetings. At the IVATF's fourth meeting the IAVW Operations Group (IAVWOPSG) was tasked with developing a version 1.0 of the ConOps, and this was subsequently presented to the seventh meeting of the IAVWOPSG (Bangkok, Thailand, 18-22 March 2013). At that meeting the group recognized the inherent value of the ConOps document and agreed to use the material included in the ConOps for the development of an IAVW roadmap to be consistent with the outcomes of ICAO's 12th Air Navigation Conference (Montreal, Canada, November 2012) and formulated Conclusion 7/17 which states:

> **Conclusion 7/17— Development of an IAVW roadmap**
>
> That an ad-hoc group consisting of Canada, China, France, Germany, New Zealand, United Kingdom, United States (Rapporteur), IATA, ICCAIA, and WMO to be tasked to:
>
> a) develop an IAVW roadmap for the provision of information services in support of the aviation system block upgrade (ASBU) methodology to be included in ICAO's Global Air Navigation Plan, taking into consideration the draft concept of operations for the IAVW as presented in Appendix J to this report; and
>
> b) provide a draft of the roadmap called for by a) above by 29 November 2013 for onward consideration at the IAVWOPSG/8 meeting and the proposed ICAO MET Divisional Meeting in July 2014.

This roadmap replaces the ConOps as originally proposed and is a living document that will evolve as the science and technology improves, and as operational requirements evolves.

1.0 Introduction/Scope

The roadmap for the International Airways Volcano Watch (IAVW) is based on the draft Concept of Operations (ConOps) for the IAVW which was presented at the seventh meeting of the IAVW Operations Group (IAVWOPSG/7). This roadmap replaces the ConOps.

The roadmap is not intended to provide detailed descriptions on all the areas presented in the document, rather it presents a high-level overview for the user.

1.1 Purpose

This document is intended to provide international air navigation users and providers of information under the IAVW with a roadmap that defines improved services including the integration of volcanic meteorological information into decision support systems for trajectory based operations (TBO).

This document provides a plan for the development and implementation of volcanic meteorological information for modules B*1-AMET* and B*3-AMET*, time frames 2018 and 2028 respectively[4].

Module B*0-AMET*[5] of ICAO's Aviation System Block Upgrades (ASBU), titled *Meteorological Information Supporting Enhanced Operational Efficiency and Safety*, describes the baseline of meteorological information provided in Block 0 of the ASBU which is defined as beginning in 2013. The IAVW element is included in module B*0-AMET* and describes the information services provided by State Volcano Observatories (VO), Meteorological Watch Offices (MWO) and Volcanic Ash Advisory Centers (VAAC).

1.2 Background

The Eyjafjallajökull volcanic eruption of April and May 2010 highlighted issues relating to all aspects of volcanic ash service provision including underpinning science and observational capabilities. Eyjafjallajökull brought direct attention to the need for a better understanding of volcanic ash information and the use of that information in Air Traffic Management (ATM) and flight operations. In addition it was recognized that there were no measureable certificated tolerances for volcanic ash for safe and permissible aircraft operations.

While the provision of contemporary volcanic ash information has served the international community well for many years, especially in areas where the airspace is not congested and operators have greater flexibility in avoiding airspace identified with ash, the application of this operational procedure did not work well in congested airspace. This was evident from the Eyjafjallajökull volcanic ash episode in April and May of 2010. During this time period, volcanic ash of mostly unknown concentrations, were detected visually and/or by satellite imagery at times over parts of Western Europe and parts of the North Atlantic. This was due to the prevailing meteorological conditions and the prolonged period of eruption. The busy and

[4] Module B*1-AMET* encompasses the timeframes of Block 1 (2018) and Block 2 (2023).
[5] Advanced Meteorological Information (AMET).

congested air routes over Europe were significantly impacted and issues also arose with the many Air Navigation Service Providers (ANSP) and MWOs serving a multitude of Flight Information Regions (FIRs). At one time during the Eyjafjallajökull eruption, more than 40 volcanic ash SIGMET messages were in effect.

The limited ability to identify observed areas of volcanic ash as well as forecast areas of volcanic ash concentrations hazardous to aircraft was another significant factor in the resultant closing of airspace, especially during the first few days after the initial eruption.

Aviation users (i.e. ANSP, operators and pilots) need to know the location, size and vertical extent of a given volcanic cloud, and where it will be located in the future. Ideally, the precise location and future location of the volcanic ash cloud would be known with great accuracy and confidence and over time scales ranging from minutes to days. However, the current science for observing and forecasting volcanic ash cannot provide that precision or accuracy.

Currently there are no requirements to observe and forecast volcanic gases, such as sulphur dioxide (SO_2), thus these observation and forecasts do not exist. However, Grímsvötn (2011) highlighted shortfalls in our understanding of and service provision for possible SO_2 impacts.

Aviation users need to know how much volcanic ash is in the atmosphere and if those amounts pose a threat to the aircraft's engine(s) and system(s). However, there are no agreed values of ash which constitute a hazard to an aircraft.

In addition, many volcanoes are not monitored despite continued efforts from the International Union of Geodesy and Geophysics (IUGG), ICAO and WMO. The lack of this monitoring contributes to uncertainty in the model output in that the source data from the eruption is based on an estimate.

1.3 Problem Statement

Explosive volcanic eruptions eject pulverized rock (volcanic ash) and corrosive/hazardous gases high into the atmosphere. Depending on the energy and duration of an eruption, there is potential for an ash cloud to cover a wide area for timescales ranging from hours to days.

Volcanic eruptions represent a direct threat to the safety of aircraft in flight and present major operational difficulties at aerodromes and in airspaces located proximal to volcanoes. Currently there are no agreed values of ash loading metrics (amount and rate of ash ingestion) that represent quantified hazard to aircraft or gas turbine engines. The exposure time of aircraft or engines to the ash, type of ash and the thrust settings at the time of the encounter, both have a direct bearing on the threshold value of ash loading that may constitute a hazard. Hence, the current globally recommended procedure is to avoid any volcanic ash, regardless of the level of ash contamination. Many years of service have demonstrated this to ensure safe operation.

In order to improve efficiencies in air transportation during volcanic events, quality, timely and consistent volcanic ash information (observations and forecasts) are essential to mitigate the

safety risk of aircraft encountering volcanic ash. Education of all users (operators and ATM) is also needed to ensure proper use of volcanic ash information within the operator's risk assessment process.

If demonstrated to be beneficial and without compromising safety, it may be desirable to agree to standards on where and for how long aircraft can operate in specified concentrations. Until those standards are established, if indeed they can be, considerable effort is required to establish rigorous and well understood practices and products provided by the VAACs.

1.4 Identification

This roadmap is expected to provide the guidance on services tasked by the IVATF and the ICAO challenge team and identified in the ICAO's ASBUs. This document will be updated as required as procedures changes or as technology warrants a change to take advantage of new state of the art capabilities to detect, monitor, and forecast ash.

This document is intended to complement the ICAO *ATM Volcanic Ash Contingency Plan,* ICAO Doc 9974 *Flight Safety and Volcanic Ash*, ICAO Doc 9691 *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*, and ICAO Doc 9766 *Handbook on the International Airways Volcano Watch*.

2.0 Current Operations and Capabilities

During a volcanic event the coordination and flow of information regarding the location and forecast position of the volcanic cloud is the primary concern. It involves cooperation among all information providers in support of operational decision makers. Providers of information primarily include MWO, VAACs, and VOs. Users of information are ANSPs that include Aeronautical Information Services (AIS), Air Traffic Control (ATC) and Air Traffic Flow Management (AFTM) units, flight crews, and airline operations centers (AOC). The cooperation between operators and civil aviation authorities (CAA) using the information provided by the providers is essential for the purpose of supporting the pre-flight process, and the in-flight and post-flight decision-making process, as part of the risk mitigation in accordance with ICAO Doc 9974 *Flight Safety and Volcanic Ash*.

2.1 Description of Current Operations

Services in support of the provision of meteorological information for volcanic events can be categorized in four areas: (1) monitoring the threat, onset, cessation, dimensions and characteristics of an eruption, (2) monitoring the volcanic ash in the atmosphere, (3) forecasting the expected trajectory and location of the ash cloud, and (4) communicating the information to the users.

2.1.1 Monitoring the threat, onset, cessation, dimensions and characteristics of an eruption

The ability to provide an advanced warning of an imminent eruption and the onset of the eruption rests with the VOs which are loosely organized under the banner of the World Organization of Volcano Observatories (WOVO) of the International Union of Geodesy and

Geophysics (IUGG). These VOs provide guidance on the magnitude of the eruption, including dimensions and characteristics, which are then used in support of numerical dispersion and transport models.

Pre-eruptive activity may come from several sources, including, but not necessarily limited to: seismic monitors, physical observations of deformation, hydrologic activity, gaseous activity, steam explosions, or debris flow. The international aviation community has established a four-level color code chart for quick reference to indicate the general level of threat of an eruption for a given volcano. The color codes identify the state of the volcano (i.e. pre-eruptive vs. eruptive stage)[6] and not to ash in the atmosphere. While the international community has developed the color code chart, it should be noted that these codes are not assigned to all volcanoes for various reasons.

In 2008, the IAVWOPSG agreed to implement a message format to assist volcanologists in the provision of information on the state of a volcano in support of the issuance of volcanic ash advisories (VAA) by VAACs, and the issue of SIGMET information by MWOs, and the issuance of a Notice to Airmen (NOTAM) for volcanic ash by Air Traffic Services (ATS). The message, referred to as Volcano Observatory Notice for Aviation (VONA), was introduced into the ICAO *Handbook on the International Airways Volcano Watch*, Doc 9766. The VONA should be issued by an observatory when the aviation color code changes (up or down) or within a color code level when an ash producing event or other significant change in volcanic behavior occurs. The VONA allows the volcanologists to provide a succinct message on the state of volcano to MWO, VAAC, and ACC which as noted above assists in the issuance of SIGMET, VAA and NOTAM respectively.

For safety purposes, operators have stated the importance of having available pre-eruption activity for situational awareness. Some VOs and a VAAC[7] currently provide information the volcanic activity within their area of responsibility. This is expected to be extended so that all volcanic areas have improved activity reporting for aviation and is a task being looked at by the IAVWOPSG[8].

2.1.2 Volcanic ash-cloud monitoring

Depending on many variables, an ash cloud can be detected from the ground, air, or from satellite. A large number of different ground and air-based instruments are available to monitor volcanic ash clouds, including lidar, ceilometers, sun photometers, radar, imaging cameras and aerosol sondes. However, none of these are yet designed, networked or quality controlled for operational use and many are operated in ad-hoc research mode only[9]. Satellite-based sensors are used to locate ash cloud and aid in discerning the perimeter of ash clouds. Ash clouds can

[6] In the aviation volcano color code; Green denotes a non-eruptive state; Yellow denotes a state of elevated unrest; Orange denotes a state of heightened unrest with the likelihood of eruption, or minor eruption underway; and Red denotes a forecast of imminent major eruption, or that major ash-producing eruption is underway.

[7] The Darwin VAAC provides a daily volcanic activity summary on the volcanoes in their area of responsibility.

[8] IAVWOPSG Conclusion 7/13 refers.

[9] In 2012 WMO had established the GALION activity as a network (see also www.dwd.de/ceilomap) with a focus also on operational volcanic ash monitoring. This European network already now consists of several thousand systems, for which algorithms have been developed to get quantified volcanic ash information in a quality much better than (passive) satellite observation, although the location of systems is certainly restricted to continental (land-surface) stations.

be detected on visible satellite imagery, but only during the day. Single and multi-spectral infrared imagery and applied techniques can be used both day and night, and can provide a means of estimating the top of the ash cloud and in the case of the multi-spectral Meteosat SEVERI sensor ash cloud composition characteristics including mean particle size and ash mass loading estimates. Both visible and infrared imagery have limitations when meteorological clouds (e.g., cirrus, etc.) are present depending on the thickness and height of the meteorological cloud cover. Infrared measurements can only detect volcanic ash if the ash is the highest cloud layer, regardless of the level of ash contamination.

Until recently, what was detected by satellite was assumed or interpreted by many to be the "visible ash cloud." This term was also used to refer to ash clouds seen by pilots in the air and people on the ground. To avoid further confusion and misuse of terms, the IAVWOPSG formulated Conclusion 7/16 which defined "visible ash" and "discernible ash". According to Conclusion 7/16:

- visible ash be defined as "volcanic ash observed by the human eye" and not be defined quantitatively by the observer
- discernible ash be defined as "volcanic ash detected by defined impacts on/in aircraft or by agreed in-situ and/or remote-sensing techniques"

It is noted that there is no single quantitative threshold value for 'visible ash'. Discernible ash agreed in-situ and/or remote-sensing techniques are based on the findings and recommendations of the IUGG/WMO Volcanic Ash Scientific Advisory Group.

2.1.3 Volcanic ash forecasts

Today's volcanic ash forecasts are basic textual and graphical products derived and produced using the output from dispersion and transport models validated and amended against available volcanic ash observations. Most of the numerical models utilized by VAACs depend on meteorological input (e.g. wind speed and direction) as well as input regarding the eruptive parameters at the volcanic source (Eruption Source Parameters - ESP). ESPs include (1) plume height, (2) eruption duration or start/stop time, (3) mass eruption rate, (4) fraction of fine ash particles, and (5) the vertical distribution of mass with height above the vent. Uncertainty or inaccuracy in any of the various sources can result in large errors in the resultant volcanic ash forecasts.

Forecasters provide value added input to the model output as required before issuing a VAA and VAG. This work is dependent on real-time verification of the ash cloud model output against a range of observational resources, principally, remote sensing by satellite.

Today's two primary volcanic ash forecast products are the VAA and the SIGMET. The VAA is produced and issued by the VAAC, and the SIGMET is produced and issued by the MWO. The VAAC provides the VAA in a text and/or graphic-based format (the graphic version of the VAA is referred to as a VAG), that provides an analysis of the ash cloud and a 6, 12 and 18-hour forecast on the trajectory of the ash cloud and the associated flight levels that may be affected. The VAAs are produced and issued by nine VAACs across the world, each with a defined geographical area of responsibility, as shown in Figure 1. MWOs issue volcanic ash cloud SIGMETs based on the guidance provided by the associated VAAC. These SIGMETs are valid for

up to six hours and describe the location and expected location of the ash cloud within the FIR or area of responsibility of the MWO.

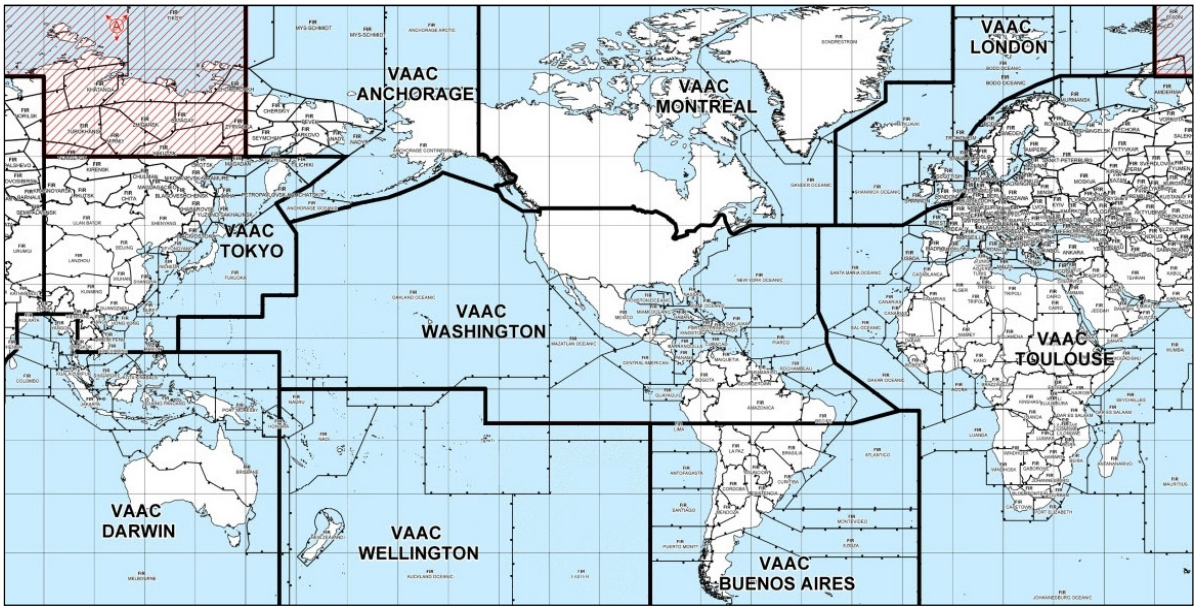


Figure 1. **Areas of responsibility for the nine VAACs.**

As a supplementary service, meteorological (MET) offices collocated with the EUR/NAT VAACs are required by regional documentation to issue forecast ash concentration charts. Such charts, depicting forecast ash concentration were first provided to users in April 2010 in response to the Eyjafjallajökull volcanic event. It is important to note that there are no globally agreed standards and procedures for the production and provision of such information. Despite lack of global requirement and large uncertainties the ICAO EUR/NAT Volcanic Ash Contingency Plan still includes the provision and use of such charts to underpin the current airlines volcanic ash safety risk assessments.

2.1.4 Communicate volcanic ash information to users

In the simplest terms, MET services are required to provide volcanic ash information to airline operators and ANSPs who then pass the information to aircraft and pilots. Figure 2 depicts an example of information flow following a volcanic eruption. The Figure identifies participants in the provision of contemporary volcanic ash cloud information. The lines between the providers in the diagram do not imply one-way communication, or communication relationships. The lines represent the distribution of information over aeronautical fixed services, with the exception of the VONA[10]. The box colors do not represent significance; rather they help distinguish the information products (e.g., observations and forecasts) (red) from the providers/users (shades of blue, purple and green).

The initial report of volcanic ash can result in many products being delivered to the end user. In most cases, information about a volcanic ash cloud will be provided to the pilot, either in-flight,

[10] VOs disseminate the VONA via facsimile or e-mail.

or during pre-flight planning, in the form of a SIGMET, NOTAM or ASHTAM[11], Special AIREP, or VAA. Each of these products is unique in format and content, but all provide information regarding the location of the volcanic ash. It is critically evident that all of these products must be consistent in their overall message.

[11] ASHTAM is a special series NOTAM for a volcanic eruption and/or volcanic ash cloud.

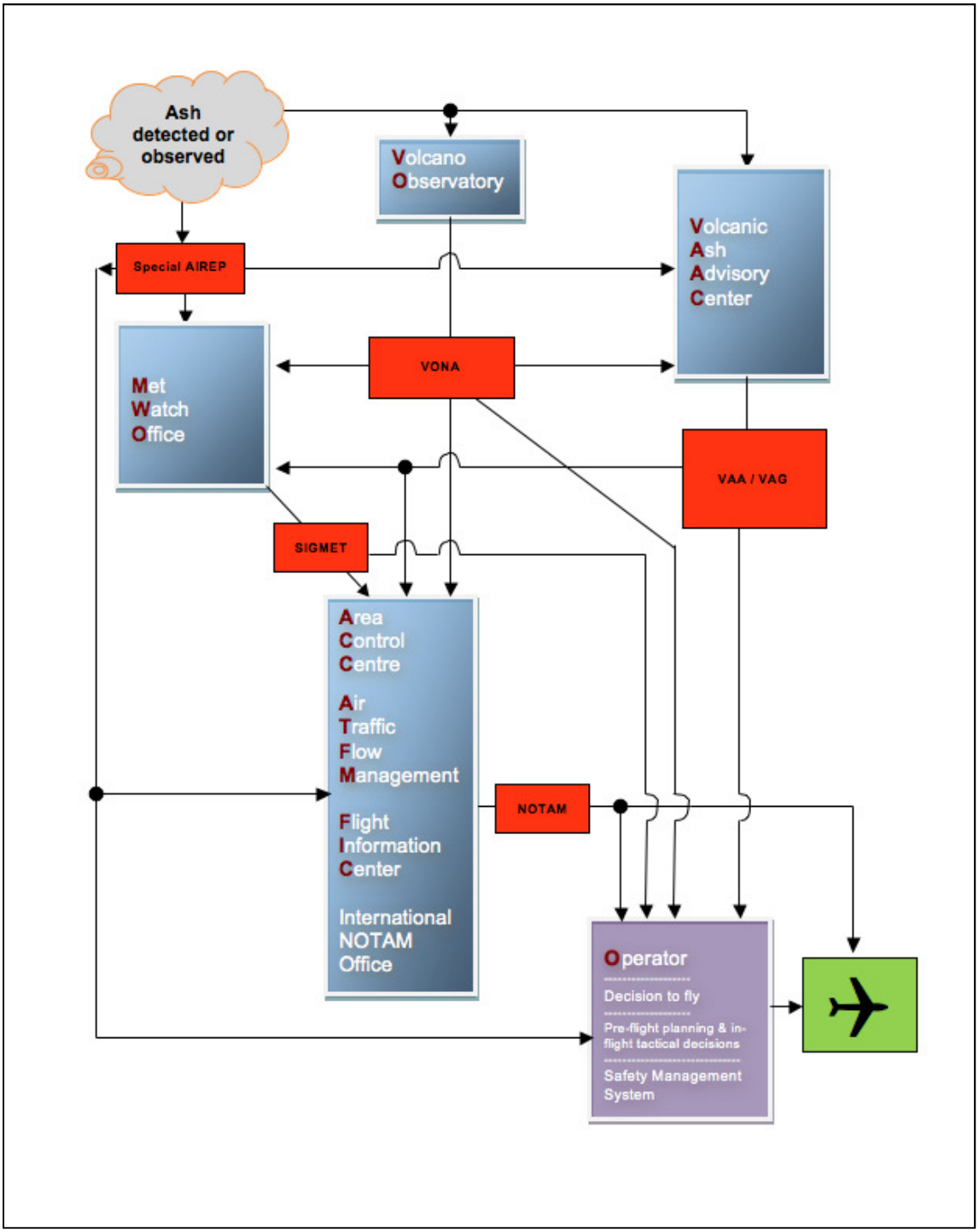


Figure 2. High-level information flow diagram between the users and providers of contemporary volcanic ash cloud information. The lines represent the distribution of information over aeronautical fixed services, with the exception of the VONA. The box colors do not represent significance; rather they help distinguish the information products (e.g., observations and forecasts) (red) from the providers/users (shades of blue, purple and green). It should be noted that there are other distribution networks and information sources that may be unique to different States which are not depicted in the diagram.

2.2 Current Supporting Infrastructure

Table 1 outlines service providers and their functions with respect to volcanic cloud information. The exact role of each provider depends on various circumstances that are not exhaustively described in the table.

Current Services and Providers		**Functions for:**			**Information**	
Service Provider		**Pre-Eruption**	**Eruption**[12]	**Volcanic Ash**[13]	**Information Received and Used**	**Information Provided (shared)**
Volcano Observatory (VO)		Monitor volcano, report changes in status. Pre-eruption activity for situational awareness	Monitor eruption, report changes in status.	Monitor and report	Data from ground-based, air-based and satellite-based observing networks.	VONA
MET Service Provider	Met Watch Office (MWO)		Provide location and notice of eruption	Provide location and dimension of volcanic ash	AIREP, VONA (report from VO), VAA/VAG, METAR/SPECI, NOTAM. Data from ground-based, air-based, satellite-based observing networks. Input from VAACs and other research institutes.	SIGMET
	Aerodrome Met Office and Stations	Report pre-eruption activity	Report	Report		METAR/SPECI. Aerodrome Warning
	Volcanic Ash Advisory Center (VAAC)	Pre-eruption activity for situational awareness.	Initial analysis including dispersion model initialization), forecast and coordination.	Determine and predict location and dimensions of airspace impacted by volcanic ash	VONA (report from VO). Data from ground-based, air-based, satellite-based observing networks. Input from other VAACs and other research institutes.	VAA and VAG
	Other State, Research, University, Commercial Services (including research modeling centers)	Coordinate with VO and VAACs	Initialize dispersion model. Operate aircraft and sondes for airborne sampling of ash. LIDAR etc for ground based sampling.	Produce model derived predictions of volcanic ash. Operate aircraft and sondes for airborne sampling of ash. LIDAR etc for ground based sampling.	Data from ground-based, air-based, satellite-based observing networks. ESP.	Deliver model derived predictions

[12] Known as the "Start of Eruption" cycle in Doc 9974 - ICAO Doc 9974 *Flight Safety and Volcanic Ash*.
[13] Same as the "Ongoing Eruption" cycle in Doc 9974 ICAO Doc 9974 *Flight Safety and Volcanic Ash*.

Current Services and Providers		Functions for:			Information	
Service Provider		Pre-Eruption	Eruption[12]	Volcanic Ash[13]	Information Received and Used	Information Provided (shared)
Air Navigation Service Provider (ANSP)	Air Traffic Control Units (Area, Approach, Aerodrome)	Identify appropriate areas[14] within airspace to outline hazard	Identify appropriate areas within airspace to outline hazard. Reroute traffic as necessary	Identify appropriate areas within airspace to outline hazard. Reroute traffic as necessary	SIGMET, NOTAM/ASHTAM, VAA/VAG, VONA or report from VO, VAR (Special AIREP)	IFR clearances. FIR's sector capacity. Affected aerodrome arrival and departure acceptance rate
	Air Traffic Management (ATM)	Maintain communications links and ATS monitoring systems	Implement contingency plans	Lead CDM process for adjusting traffic capacity and routes	SIGMET, NOTAM/ASHTAM, VAA/VAG, VONA (report from VO), VAR (Special AIREP, other[15]	FIR traffic capacity
	Flight Information Center (FIC)	Maintain communications links and ATS monitoring systems	Provide preflight and in-flight information about eruption	Provide preflight and in-flight information about volcanic cloud	SIGMET, NOTAM/ASHTAM, VAA/VAG, VONA (report from VO), Special AIREP	SIGMET, NOTAM/ASHTAM VAA/VAG, VONA (report from VO), Special AIREP
	International NOTAM Office (NOF)	Maintain communications links and ATS monitoring systems. Provide notice of pending hazard.	Provide notice of hazard	Provide notice of hazard	SIGMET, VONA (report from VO), Special AIREP	NOTAM/ASHTAM
Aerodrome		Maintain communications links and monitoring systems	Address ash contamination on runways, taxiways, ground equipment, planes	Address ash contamination on runways, taxiways, ground equipment, planes	Aerodrome Warning	Information for the NOTAM/ASHTAM
Operator	Airline Operations Center (AOC)	Maintain communications links and monitoring systems. Reroute aircraft around volcanoes identified in a pre-eruption state.	Reroute aircraft away from eruption.	Apply agreed SMS processes to adjust routes. Provide information to flight crew. Plan for reroute.	SIGMET, NOTAM/ASHTAM, VAA/VAG, VONA (report from VO), ash or SO2 report from flight crew, or ANSP (ATS, FIS, AIS).	Route/altitude selection, fuel, go/no-go decision, in-flight route/destination change.
	General Aviation Operators	Maintain communications links and monitoring systems	Appropriate decisions per SMS for operators of Large and Turbojet Aeroplanes.	Appropriate decisions per SMS for operators of Large and Turbojet Aeroplanes.	SIGMET, NOTAM/ASHTAM, VAR (Special AIREP), ash or SO2 report from ANSP (ATS, FIS, AIS)	Special AIREP, VAR
	Pilot / Flight crew (Commercial and General Aviation)	Maintain communications links and monitoring systems	Report eruption	Report volcanic ash, sulphur	SIGMET, NOTAM/ASHTAM, VAR (Special AIREP), ash or SO2 report from AOC or ANSP (ATS, FIS, AIS)	Special AIREP, VAR

[14] In accordance with the *ATM Volcanic Ash Contingency Plan*
[15] Ash concentration forecast (if provided)

Current Services and Providers	Functions for:			Information	
Service Provider	**Pre-Eruption**	**Eruption[12]**	**Volcanic Ash[13]**	**Information Received and Used**	**Information Provided (shared)**
Original Equipment Manufacturers (OEM) or Type Certificate Holder (TCH)	Guidance and information to operators	Advice and information to operators	Advice and information to operators	Engineering and operations reports from operator.	Technical information about aircraft operation in volcanic ash, future/ongoing maintenance information requirements, details of inspection requirements

Table 1. Current service providers and their functions with respect to volcanic cloud information.

3.0 Description of Changes

Future services center on a number of changes that are intended to match the time frames of the Blocks of the ASBUs.

Module B*0-AMET* of the ASBUs is the baseline services for Block 0. The following is taken from ASBU module B*0-AMET*:

> *VAACs within the framework of the International Airways Volcano Watch (IAVW) respond to a notification that a volcano has erupted, or is expected to erupt or volcanic ash is reported in its area of responsibility. The VAACs monitor relevant satellite data to detect the existence and extent of volcanic ash in the atmosphere in the area concerned, and activate their volcanic ash numerical trajectory/dispersion model in order to forecast the movement of any ash cloud that has been detected or reported. In support, the VAACs also use surface-based observations and pilot reports to assist in the detection of volcanic ash. The VAACs issue advisory information (in plain language textual form and graphical form) concerning the extent and forecast movement of the volcanic ash cloud[16], with fixed time validity T+0 to T+18 at 6-hour time-steps. The VAACs issue these forecasts at least every six hours until such time as the volcanic ash cloud is no longer identifiable from satellite data, no further reports of volcanic ash are received from the area, and no further eruptions of the volcano are reported. The VAACs maintain a 24-hour watch. Argentina, Australia, Canada, France, Japan, New Zealand, the United Kingdom and the United States are designated (by regional air navigation agreement) as the VAAC provider States. Accordingly, VAACs Buenos Aires, Darwin, Montreal, Toulouse, Tokyo, Wellington, London, Anchorage and Washington make available the aforementioned advisories on the ICAO AFS.*

This baseline describes the services as they are for the beginning of Block 0 with the timeframe of 2013. During Block 0, several improvements are proposed and they are described in subsequent sections of this roadmap.

[16] There is no requirement in Annex 3 – *Meteorological Service for International Air Navigation* to monitor, observe and forecast volcanic gases.

Module B*1-AMET - Enhanced Operational Decisions through Integrated Meteorological Information* enables the identification of solutions when forecast or observed meteorological conditions impact aerodromes or airspace. Full ATM-MET integration is needed to ensure that: MET information is included in decision making process and the impact of the MET conditions (e.g., volcanic ash) are automatically taken into account. Module B*1-AMET* improves upon current operations where ATM decision makers manually determine the change in capacity associated with an observed or forecast MET condition (e.g., volcanic ash), manually compare the resultant capacity with the actual or projected demand for the airspace or aerodrome, and then manually devise ATM solutions when the demand exceeds the MET-constrained capacity value. Module B*1-AMET also* improves in-flight avoidance of hazardous MET conditions by providing more precise information on the location, extent, duration and severity of the hazard(s) affecting specific flights.

The aim of Module B*3-AMET - Enhanced Operational Decisions through Integrated Meteorological Information* is to enhance global ATM decision making in the face of hazardous MET conditions in the context of decisions that should have an immediate effect. Key points are a) tactical avoidance of hazardous MET conditions especially in the 0-20 minute timeframe; b) greater use of aircraft based capabilities to detect MET parameters (e.g. volcanic ash); and c) display of MET information to enhance situational awareness.

3.1 Changes intended through 2018:

Changes intended within the timeframe of 2013-2018 (i.e., Block 0 timeframe) to support Module B*0-AMET (Meteorological Information Supporting Enhanced Operational Efficiency and Safety)* are:

- Incorporate collaborative decisions and information sharing into volcanic ash cloud analyses and forecasts
- Increase the use of the aviation color-code alert system and provision of VONA by State VOs
- Develop confidence levels to aid decision makers as part of their safety risk assessment
- Improve ground-based, air-based and space-based observing networks to determine ESP and existing ash loading in the atmosphere
- Scientific research in support of reducing risks from volcanic ash hazards including understanding the impact of ash on aircraft and engines and the provision of enhanced guidance to operators

3.1.1 Collaborative decision analysis, forecasting and information sharing

The term Collaborative Decision Making (CDM) is a process used in ATM that allows all members of the ATM community, especially airspace users, to participate in the ATM decisions affecting all members. CDM means arriving at an acceptable solution that takes into account the needs of those involved. CDM for ATM is described in ICAO Document 9854 -*Global Air Traffic Management Operational Concept,* and Document 9982 – *Manual on Air Traffic Management System Requirements.*

A similar process has been proposed[17] for volcanic ash and is called Collaborative Decision Analysis and Forecasting (CDAF). From a high level perspective and for an example, collaboration on the perimeter of the volcanic ash could be done, at a minimum, for events that affect high density traffic areas, or several FIRs and extend beyond the area of responsibility of one or more VAACs. This collaboration could be undertaken between predetermined partners, based on the event and extent. Table 2 lists some of the volcanic ash information needed by airspace users. As part of this process, information sharing between the partners is essential, so that all possible outcomes can be considered. Table 3 lists the partners for collaboration and information sharing as well as the expected role of the partners. The final decision (i.e., the location of horizontal/vertical airspace volcanic ash contamination boundaries) will depend on agreed upon guidelines that may vary depending on the size and scope of the volcanic event, but efforts should be made to ensure that the authority for the final decision concerning volcanic ash information resides with the designated Primary VAAC, otherwise the final output (e.g., forecast) may lead to inconsistency and hamper effective decision making by ATM and airlines. Once the decision is finalized it can be integrated into ATM decision tools for a CDM process by ATM decision makers and airspace users.

One of the challenges for the IAVWOPSG is to establish agreed procedures to support CDAF which have not been defined.

Need to know	Information Sharing	Output from a Collaborative Decision
Location of volcanic ash contamination boundaries.	Share data from ground, air, and space observing platforms	Current horizontal and vertical extent (perimeter) of volcanic ash contamination to be used in decision support systems and forecast products.
How the volcanic ash boundaries are changing and where will they be in the future.	Share various outputs of dispersion models	Forecast horizontal and vertical extent of the volcanic ash contamination and produce seamless products
If provided and available, multiple contours of ash contamination	Share various outputs of dispersion models	Forecast horizontal and vertical extent of multiple contours of ash contamination

Table 2. Collaborative decisions for volcanic ash cloud information

[17] IVATF Recommendation 4/18, IAVWOPSG Conclusion 7/21 refers.

Partners	Role
Primary VAAC	Produces preliminary forecast and shares with rest of partners. Considers input and suggested changes from participating partners. Has the final decision on the forecast after considering information and input from partners.
Other VAAC(s)	Shares new information with participating partners. Reviews preliminary forecast and provides suggested changes.
VO(s)	
MWO(s)	
State's NMHS	
University or Research Centers (dispersion modeling)	
Others (TBD), e.g., operators	Share information.

Table 3. Partners for the collaboration and information sharing and expected roles

3.1.2 Increase the use of the aviation color-code alert system and provision of VONA by State VOs

Not all State VOs issue a VONA, which provides a concise statement describing the activity at the volcano, as well as the specific time of the onset and duration of the eruptive activity. VONAs also contain a color code (see 2.1.1). As a form of "best practice", this roadmap recommends that all State VOs use the VONA and its aviation color-code alert system for the provision of volcano information.

3.1.3 Develop confidence levels to aid decision makers as part of their safety risk assessment

In February 2012, the IATA met with the VAACs and discussed their need for levels of confidence in the volcanic analyses and forecasts (i.e., VAA/VAG). These confidence levels would be used or translated into the risk assessment conducted by operators to best determine the aircraft flight route or track.

The VAAC practices for presentation of 'confidence' must be consistent and be a well understood process to ensure a harmonized regional interoperability within the operator's risk assessment process. Development of guidance material should be conducted in parallel with the development of the presentation of confidence.

Development of confidence levels are considered to be a key factor in improving the quality of information provided which will aid in the decision making process as part of an operators safety risk management plan.

3.1.4 Improve ground-based, air-based and space-based observing networks to determine ESP

Observation and forecasts information on volcanic ash will require continued improvement of observational capabilities globally, including volcano-monitoring networks, ground-based aerosol networks, satellite platforms and sensors, and airborne sampling.

3.1.5 Scientific research in support of reducing risks from volcanic ash hazards including understanding the impact of ash on aircraft and engines and the provision of enhanced guidance to operators

Scientific research in support of reducing risks from volcanic ash hazards should aim for tangible improvements in the detection and measurement of volcanic plumes and ash clouds during eruptions and in the accuracy of model forecasts of ash transport and dispersion. Research topics (both new and on-going) pertinent to these goals include the following:

- Characterizing volcanic plumes at/near the source
- Understand the evolution of volcanic ash and gas clouds in time and space
- Verification of the model forecasts

In addition,

- Develop an understanding of the impact of ash on aircraft and engines and provide enhanced guidance to operators
- Scientific research to support service delivery for volcanic ash hazard risk reduction

Since 2010 manufacturers have continued work on developing their understanding of the impact of volcanic ash. This will continue through a number of initiatives including involvement of the major manufacturers in the National Aeronautics and Space Administration (NASA) and United States Air Force (USAF) Vehicle Integrated Propulsion Research (VIPRIII) test programme and coordination between manufacturers through the International Coordinating Council of Aerospace Industries Associations (ICCAIA) Volcanic Ash working group. As this knowledge and understanding increases enhanced guidance to operators will be provided where possible.

Further description and discussion regarding research is detailed in Working Paper 14 from the fourth meeting of the IVATF.

3.2 Changes intended within 2018-2023:

Changes intended within the timeframe of 2018-2023 (i.e., Block 1 timeframe) to support Module B*1-AMET (Enhanced Operational Decisions through Integrated Meteorological Information)* are:

- Enhance the provision of SIGMETs in support of operational decisions
- Transition to all digital format for all volcanic ash information
- Further develop ATM for operations in or close to areas of volcanic ash
- Increase the VAA/VAG issuance frequency and time steps

- Provide additional information which reflects the forecast of volcanic ash beyond 18 hours
- Continued improvement in ground-based, air-based and space-based observing networks to determine ESP
- Continued scientific research in support of reducing risks from volcanic ash hazards

3.2.1 Enhance the provision of SIGMETs in support of operational decisions

A large volcanic ash cloud over congested, multi-States areas such as Europe could result in multiple SIGMET information messages, all being in effect at the same time. Each of these SIGMETs becomes a part of a jigsaw puzzle for the user to assimilate, in order to obtain a good understanding of the entire area of the volcanic cloud. As a result the International Air Transport Association (IATA) has stated that they have strong preference for the VAA vs. the SIGMET, i.e., that is one message covering a large region.

Since SIGMETs are, in most cases, based on the first portion of a VAA, that portion of the VAA/VAG could technically be elevated in status to serve as a SIGMET. Making the VAA/VAG's first six-hour portion (i.e., T+0 and T+6 hour) equivalent to the SIGMET would reduce the information overload experienced by users (pilots, operators, etc) who must currently track dozens of SIGMETs for their particular flight in congested areas.

Under today's operations each MWO is responsible for the provision of a SIGMET for their FIR in support of defining the location and forecast position of the ash cloud. However, many MWOs do not have the skill to provide this service and are dependent on the VAAC for this information via the VAA. Some MWOs have more advanced skill levels to provide value input. In those cases the MWO should coordinate with the VAAC and advise the VAAC that the information provided in the VAA is not necessarily reflective of conditions in their FIR. With the proposal to support CDAF this divergence of information should be minimized where the information provided in the VAA is consistent with the SIGMET or vice versa. If achievable this then begs the issue on whether there is a need to retain both products but rather provide a single high quality product to the operator and ANSP in support of integration of MET information into air traffic flow management (ATFM) systems for the routing of aircraft away from a hazard.

Proposed SIGMET enhancements are:

- The first six-hour portion of the VAA (i.e., T+0 and T+6 hour) is equivalent to the SIGMET for a volcanic ash cloud (with validity for one or more FIRs)
- MWOs should participate in the CDAF process and share information with the VAAC to ensure the VAA reflects the conditions in their FIR
- SIGMET *Information* messages should only be issued by a MWO for those cases where the VAA is not yet available or the VAA does not reflect the conditions in the FIR even after the CDAF process.

It is noted that IATA has formulated a set of requirements which were presented to the VAAC Best Practices Seminar of 12-13 June 2012 and expanded upon at IAVWOPSG/7. Those

requirements will be considered in this enhancement process taking into account the issues of sovereignty, cost recovery and collaborating procedures among related States.

3.2.2 Transition to all-digital format for all volcanic ash information

Today's volcanic cloud products are primarily text-based (e.g., SIGMET information message), with some supplementation of graphic-based products (e.g., VAG). Future volcanic cloud information must be provided in a digital format in order to better serve aviation users and decision makers. The visualization of volcanic information must be capable of being displayed on moving maps, cockpit displays, radar screens, etc.

The IAVWOPSG, recognizing the need for digital information, formulated Decision 7/25 which calls for the development of a digital format of the VAA/VAG in an XML/GML format for implementation with Amendment 77 to Annex 3 – *Meteorological Service for International Air Navigation.*

The transition from text and graphic-based products to all-digital formats will take time, as there will continue to be a need for legacy text-based products for several years, especially in certain regions of the world.

3.2.3 Further develop ATM for operations in or close to areas of volcanic ash

In an effort to increase information exchange between ATM and operators, make available to affected ANSP's the outcomes of the operators risk assessment for their consideration, especially where applicable to ATFM.

3.2.4 Increase VAA/VAG issuance frequency and time steps

Operators need frequent updates of volcanic ash information especially in congested airspace and around constrained airports. The current VAA/VAG with its 6-hourly issuance and 6-hour time steps does not meet those needs.

The VAA/VAG presenting levels of certainty should be developed to include three hourly time-step information. There is a need to have the capability to increase the frequency of VAA/VAG for pre-defined operational conditions. This would be when ash is present in congested airspace and around capacity constrained airports.

3.2.5 Provide additional information which reflects the forecast of volcanic ash beyond 18 hours

Operators at IAVWOPSG/7 expressed an interest in having volcanic ash information beyond the current practice of T+18 hours for long-haul flight planning and management of airline operations. While it is understood that today's numerical models provide information for various meteorological elements out to several days, providing volcanic ash information beyond T+18 hours introduces a number of uncertainties into the forecast as a result of unknown or uncertain source terms and meteorology as well as inaccuracies in the physics of the dispersion/transport models. With this understanding, the goal is to provide additional information which can realistically reflect the forecast of volcanic ash beyond 18 hours.

3.2.6 Continued improvements in ground-based, air-based and space-based observing networks to determine ESP

Improvements to volcano-monitoring networks, ground-based aerosol networks, satellite platforms and sensors, and airborne sampling will continue in Block 1, building on the accomplishments from Block 0.

3.2.7 Continued scientific research in support of reducing risks from volcanic ash hazards

Scientific research in support of reducing risks from volcanic ash hazards will need to continue in Block 1 and build upon the area and topics listed in section 3.1.5.

3.3 Changes intended within the time frame of 2023-2028

Changes intended within the time frame of 2023-2028 (i.e., Block 2 timeframe), which is an extension of ASBU Block 1, to support Module B*1-AMET (Enhanced Operational Decisions through Integrated Meteorological Information)* are:

- Develop volcanic ash nowcasts
- Develop volcanic ash forecasts that include the use of probability

3.3.1 Develop volcanic ash nowcasts

Users need to know the current location of the volcanic ash. The VAA/VAG and SIGMET provide information about the ash at T+0, but these products are issued every six hours, thus at two hours after T+0, users must do some kind of interpolation between T+0 and T+6 to obtain an estimate of where the ash contamination boundary lies. Providing VAA/VAG at three hour time-steps will help this issue, but more can be done with the transition to a digital information data base for meteorological information, as part of the ASBUs, including volcanic ash.

In the Block 2 timeframe, it is foreseen that a three-dimensional representation of the current or near-current volcanic ash contamination boundaries, known in this document as a “nowcast”, could be made available and extracted by the user. Nowcasts would be updated at a high frequency and provide a more realistic assessment of the location and extent of the ash cloud.

3.3.2 Develop probabilistic volcanic ash forecasts

Current volcanic ash forecasts, such as the VAA/VAG, are deterministic forecasts. They are a yes/no forecast, with respect to the depiction of the airspace impacted by volcanic ash contamination. These forecasts are based on the definition of “discernible ash” as a fundamental criterion.

Volcanic ash transport and dispersion models can produce an array of solutions (e.g., forecasts) by varying the model input. Changes in meteorological parameters and ESP will result in different forecast outputs that affect the 4-dimensional shape (3-dimensional shape and change of shape with time) of the cloud. The purpose of a probabilistic forecast is to provide decision makers with an assessment of all the likelihoods of a weather parameter’s risk of occurrence exceeding a defined magnitude. Probabilistic forecasts help multiple decision

makers use the same weather information, applying their own operational constraints to determine risk to their operation. Section 5.2 identifies those functions that could be provided in deterministic and probabilistic terms.

From a high-level perspective, probability forecasts may be based on an ensemble approach. An ensemble is one way to account for some degree of uncertainty. For instance, the model can be run many times, each time with a realistic variant of one of the uncertain parameters (e.g. ash amount, ash column height, eruption start time and duration, input meteorology dataset, with and without wet deposition, etc.). Taken as a whole, the variability of the ensemble members' output gives an indication of the uncertainty associated with that particular ash forecast.

The application of probabilistic forecasts will best benefit high-density (congested) traffic areas, where decision makers can benefit from more than just a deterministic forecast. Also, decision support systems can use the probabilistic information to provide route and altitude selections based on user's acceptance thresholds.

For operators to effectively use 'probabilities' for specific time and space within the initial and ongoing risk assessments, a thorough understanding of the output from the VAAC is needed by operators and flight crew.

3.4 Changes intended by 2028 and beyond

Changes intended by 2028 (i.e., Block 3 timeframe) in support of Module B*3-AMET* (*Enhanced Operational Decisions through Integrated Meteorological Information)* are:

- Develop other volcanic derived contaminant forecasts, specifically SO_2
- Integrate volcanic ash forecasts into decision support systems for trajectory based operations
- Develop understanding of the impact of ash on aircraft and engines and provide enhanced guidance to operators
- Incorporate processes and procedures for the use of airborne detection equipment

3.4.1 Develop other volcanic derived contaminant forecasts, specifically sulphur dioxide

While the document has focused on volcanic ash there is strong evidence that there is a need to expand the services to other toxic elements that are typically associated with volcanic eruptions.

During volcanic eruptions, a number of toxic gases may be emitted in addition to ash; these include SO_2, hydrogen fluoride, and hydrogen sulphide amongst many others. Each of these gases has different atmospheric dispersion properties, and so gas clouds may be found coincident or separate from ash clouds. Of these gases, SO_2 is of particular importance as it may be emitted in large quantities and potentially has significant health effects. The documented experience to date of in-flight encounters with sulphurous gases suggests that SO_2 has never been a significant immediate safety hazard to an aircraft or health hazard to its occupants.

Through the work of the IVATF and IAVWOPSG[18], it was determined that ICAO, through an appropriate expert group or groups, should determine a clear meteorological/atmospheric chemistry requirement (such as a critical level of SO_2 in the atmosphere that would be observed or forecast) that, after passing through the aircrafts ventilation system, could pose a health risk to the aircraft's occupants.

3.4.2 Integrate volcanic ash forecasts into decision support systems for trajectory based operations

One of the key elements in Module B*3-AMET* of the ASBUs is the integration of meteorological information into decision support systems. Future ATM decision support systems need to directly incorporate volcanic ash nowcasts and forecasts, allowing decision makers to determine the best response to the potential operational effects and minimize the level of traffic restrictions. This integration of volcanic ash nowcasts and forecasts, combined with the use of probabilistic forecasts to address uncertainty, reduces the effects of volcanic ash on air traffic operations.

3.4.3 Development of index levels for ash tolerances

Different aircraft and engine designs may be affected differently by volcanic ash. For example, modern turbofan engines ingest large volumes of air and their turbines run hotter than the melting point for volcanic ash constituents. They typically utilize exotic turbine component coatings that can be affected by volcanic aerosols such as sulfates and chlorides. They also use turbine nozzle cooling and blade cooling with passages that are vulnerable to ash blockage. Older turboprop or turbofan engines typically do not have these same features and have different vulnerabilities. These design and operational differences can significantly affect the engine's susceptibility to volcanic ash.

In the longer term the development of a volcanic ash index for ash tolerances of various types of engine/aircraft combinations may allow operators and ATM to take advantage of quantitative volcanic ash forecasts. It should be recognized that this may not be feasible due to the extensive testing and evaluation required to adequately cover the range of aircraft and engines in service.

3.4.4 Develop processes associated with airborne detection equipment

To allow operators to take advantage of tactical on-board volcanic ash detection equipment, ATM processes and procedures will need to be developed and incorporated into ATM Contingency Plans.

4.0 Proposed Roadmap

The proposed way forward will involve all the changes described in Section 3 above. Specifically:

Through 2018:

[18] IAVWOPSG Conclusion 7/34 and Decision 7/35 refers.

- Incorporate collaborative decisions and information sharing into volcanic ash cloud analyses and forecasts
- Increase the use of the aviation color-code alert system and provision of VONA by State VOs
- Develop confidence levels to aid decision makers as part of their safety risk assessment
- Improve ground-based, air-based and space-based observing networks to determine ESP
- Scientific research in support of reducing risks from volcanic ash hazards including understanding the impact of ash on aircraft and engines and the provision of enhanced guidance to operators

2018-2023:

- Enhance the provision of SIGMETs in support of operational decisions
- Transition to all digital format for all volcanic ash information
- Further development of ATM for operations in or close to areas of volcanic ash
- Increase the VAA/VAG issuance frequency and time steps
- Provide additional information which reflects the forecast of volcanic ash beyond 18 hours
- Continued improvements in ground-based, air-based and space-based observing networks to determine ESP
- Continued scientific research in support of reducing risks from volcanic ash hazards

2023-2028:

- Develop volcanic ash forecasts that include the use of probability
- Develop volcanic ash nowcasts

2028 and beyond:

- Develop other volcanic derived contaminant forecasts, specifically SO_2
- Integrate volcanic ash forecasts into decision support systems for trajectory based operations
- Development of index levels for ash tolerances
- Incorporate processes and procedures for the use of airborne detection equipment

4.1 Assumptions and Constraints

The proposed concept is based on the following assumptions:

- IAVW retains global legal mandate for volcanic ash service delivery
- The first six-hour forecast from the VAA (i.e., T+0 and T+6 hour) can be used equivalent to a SIGMET
- Probabilistic forecasts can be utilized by aviation decision makers
- Probabilistic forecasts are best suited for users in congested airspace, but can also beneficial for users in uncongested airspace

- Before a probability can be derived from an ensemble, there Is a need to “calibrate” the ensemble, as the number of elements in a “cluster” is not necessarily a reliable measure of probability if the variations of the initial states and ESP’s are not driven by a scientifically sound selection principle
- Index levels for volcanic ash tolerances can be developed
- Continuing user demand for phenomena based information rather than FIR based information

The following constraints may impede the implementation of the proposed concept:

- The development of certifiable volcanic ash tolerances may take many years, or may not be feasible or beneficial to operators (if by 2028 the development is not possible then further work will be done to improve the avoidance of ash)
- Some States may not accept the VAA as equivalent to the SIGMET due to legal and political issues

4.2 Operational Environment

By 2028, volcanic cloud information will reside on a common information sharing platform and be part of the System Wide Information Management (SWIM) concept in support of global ATM.

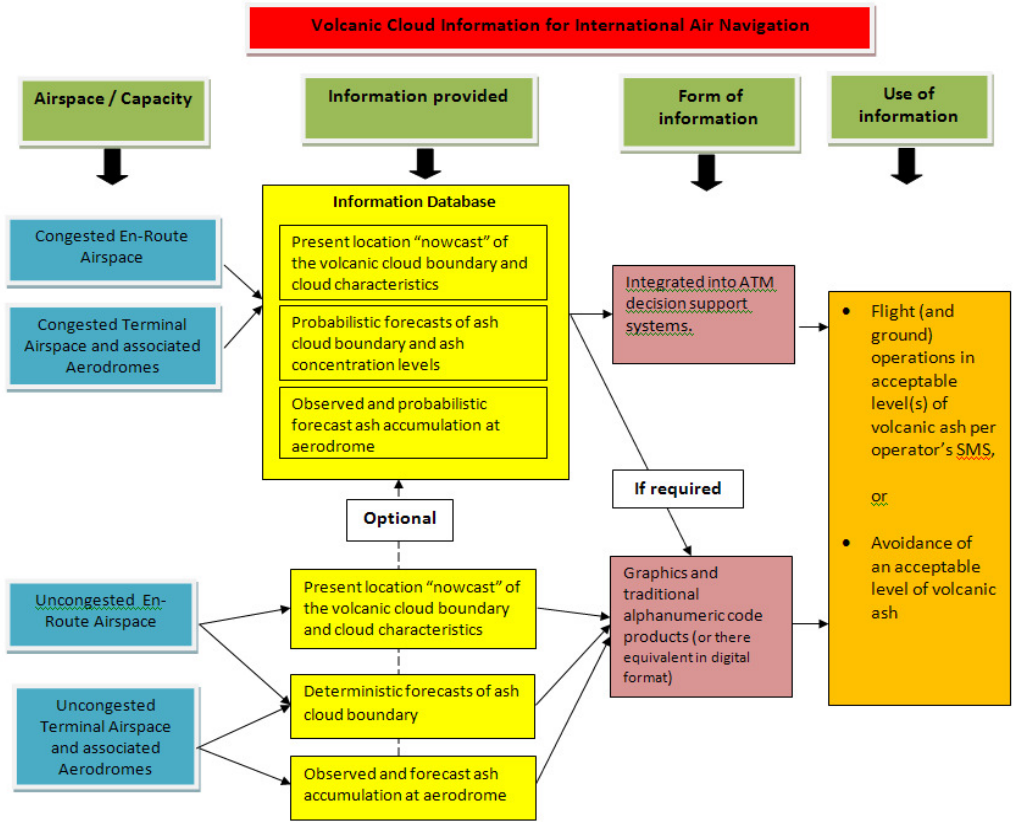
4.3 Operations

Operations during a volcanic event depend on the information available as well as a function of classification of airspace that being high density (congested) airspace versus low density (uncongested) airspace.

Nowcasts and deterministic forecasts may adequately serve the users of airspace that is not congested, and offers ample options for volcanic ash avoidance without great fuel penalties for the operator. But for congested airspace, the provision and use of probabilistic forecasts of the volcanic ash could be beneficial in order to achieve maximum efficiency of the air traffic system.

Figure **3** provides a high level schematic of meteorological service per airspace capacity. It should be noted that the provision and use of probabilistic forecasts is not restricted or limited to congested airspace, rather the “optional’ block in Figure 3 denotes that operators in uncongested airspace, e.g., oceanic User Preferred Routes (UPR), can take full advantage of these forecasts.

Figure 3. Operations concept using volcanic cloud information per airspace capacity. Note that the "optional" box indicates that the Information Database and its probabilistic forecasts are available for users of uncongested airspace.



4.4 Supporting Infrastructure

In Blocks 0 through 2, the information on volcanic ash will continue to be product centric and be produced by humans in traditional alphanumeric text along with a graphical image. Production of these products will inevitably migrate from the MWOs to the VAACs.

In the Block 3, all relevant information on the volcanic clouds will reside on a common information sharing platform.

4.5 Benefits to be realized

The proposals for volcanic cloud information to be developed and implemented as noted in sections 3.1, 3.2, and 3.3 will provide users with volcanic ash information that has greater confidence and usability. Moving from a product centric environment to an information centric environment will meet the future operational needs of aviation decision-makers. Also, decision support systems can use the probabilistic information to provide route and altitude selections based on user's acceptance thresholds. The integration of volcanic cloud forecasts, combined with the use of probabilistic forecasts to address uncertainty, will lead to more effective and informed decision making and planning for air traffic operations. Finally, if feasible, the

development of a volcanic ash index for ash tolerances for various types of engine/aircraft combinations may allow operators and ATM to take advantage of volcanic ash concentration forecasts.

5.0 Needs and Goals

5.1 Operational Needs

The following is a set of high-level operational needs[19] of aviation users for trajectory based operations in support of international air navigation:

- Determine the onset of a volcanic event (i.e., eruption)
- Determine if an eruption and any associated volcanic ash are a hazard to international air navigation based on any agreed threshold values of mass concentration
- Determine what aerodromes and airspace are affected by the eruption and associated cloud
- Determine when the eruption has ended
- Determine when the volcanic ash has dispersed below agreed threshold values
- Determine when the aerodrome/airspace affected by the eruption and/or cloud is safe to operate in or through
- Determine the cost of the event and stakeholder satisfaction

5.2 Functional Goals

Table 4 lists a set of functional goals for volcano eruption and volcanic cloud information based on different types of airspace and aerodrome densities (i.e., capacity or congestion). An “X” in the table’s cell indicates that this function is needed for this airspace and aerodrome. A “P” or “D” indicates whether the forecast function is Probabilistic or Deterministic. A “D, P” indicates that both are provided.

[19] As determined by the author based on information from users at ICAO’s IVATF.

Future Functional Goals for Volcano Eruption and Volcanic Cloud Information							
		Route operations		Terminal control area (TMA) operations		Aerodrome	
		Congested (high density)	Un-congested (low density)	Congested (high density)	Un-congested (low density)	High density	Low density
Volcano Eruption							
Detect an Eruption in all kinds of meteorological and day/night conditions (i.e., including tropical regions where convective activity is common)		X	X	X	X	X	X
Determine the height of the eruption plume		X	X	X	X	X	X
Determine the duration of the eruption		X	X	X	X	X	X
Detect, determine and report the heightened volcanic activity (pre-eruption)		X	X	X	X		
Volcanic Cloud							
Determine the perimeter, top and base of the volcanic cloud in all kinds of meteorological and day/night conditions		X	X	X	X		
Determine when the "volcanic cloud" is a hazard due to:	Ash	X	X	X	X	X	X
	SO2	X	X	X	X	X	X
	Electro-magnetic risks to avionics	X	X	X	X	X	X
	Other (TBD)						
Determine the perimeter of the lowest acceptable ash contamination level (ash cloud)		X	X	X	X	X	X
Determine the perimeter of the gaseous cloud		X	X	X	X	X	X
Determine the eruption source parameters		X	X	X	X	X	X
Forecast the perimeter of the lowest acceptable ash contamination level (ash cloud)		D, P	D, P	D, P	D	P	D
Forecast the top and base height of the lowest acceptable ash contamination level (ash cloud)		D, P	D, P	D, P	D	P	D
Forecast the movement of the lowest acceptable ash contamination level		D	D	D	D		
Forecast the growth and		D, P	D, P	D, P	D		

Future Functional Goals for Volcano Eruption and Volcanic Cloud Information						
	Route operations		Terminal control area (TMA) operations		Aerodrome	
	Congested (high density)	Un-congested (low density)	Congested (high density)	Un-congested (low density)	High density	Low density
decay of the lowest acceptable ash contamination level (ash cloud)						
Forecast the location of the gaseous cloud	D, P	D, P	D, P	D	P	D
Forecast the top and base height of the gaseous cloud	D, P	D, P	D, P	D	P	D
Forecast the movement of the gaseous cloud	D, P	D, P	D, P	D		
Forecast the growth and decay of the gaseous cloud	P	D, P	P	D		
Determine when the volcanic cloud is no longer a hazard	X	X	X	X		
Determine when the volcanic cloud is hidden or mixed with clouds, especially cumulonimbus clouds and cirrus clouds	X	X	X	X		
Forecast when the volcanic cloud is hidden or mixed with meteorological clouds	P	D, P	P	D		
Volcanic Ash Accumulation						
Determine the ash accumulation at the aerodrome					X	X
Forecast the ash accumulation at the aerodrome					D, P	D

Table 4. Future functional goals for volcano eruption and volcanic cloud information

6.0 Operational Scenarios

Two kinds of operational scenarios are envisioned, avoidance of the volcanic cloud, and planned flight into a cloud. The information for both scenarios is in the form of nowcasts and forecasts that are integrated into decision support systems.

Nowcasts

The three-dimensional representation of the current or near-current volcanic ash cloud, including depiction of the perimeter of the lowest acceptable level of ash contamination, in a common exchange format that provides integration into decision making tools as well as offers a graphical depiction of the information. In the avoidance scenario, the nowcast provides users with the location of discernible volcanic ash. As the volcanic ash moves or changes, the nowcast is updated at a temporal frequency that meets user needs and service provider capabilities. For

flight into acceptable levels of ash, volcano ESP, *in situ* measurements of the airborne volcanic ash (from ground-based, space-based, or airborne-based observing platforms) are required to provide a nowcast that has a high level of confidence of the ash concentration levels inside the cloud.

Forecasts

The four-dimensional representation of volcanic ash, including depiction of the perimeter of the lowest acceptable level of ash contamination, ash concentration levels and indices, in both deterministic and probabilistic terms, in a common exchange format that provides integration into decision making tools as well as offers a graphical depiction of the information. For both scenarios, the forecasts would be valid “X” hours and up to “Y” days, but would contain finer temporal resolution in the near time frame. Forecasts would also be provided in terms of uncertainty (use of probability). For flight into acceptable levels of ash contamination, volcano ESP, quantitative measurements of the airborne volcanic ash (from ground-based, space-based or airborne-based observing platforms), would be needed to enable accurate validation of ash contamination to support airline decision making.

The Collaboration Process

Aligned with the above forecast process is the collaborative decision and information sharing process. In this scenario, collaboration on the nowcasts and forecasts will occur on a regular basis such that all users are afforded the opportunity to contribute information. Information will be shared and could be made available on an information database or web portal that is jointly run by the VAACs.

Civil aviation operators will then apply these new nowcasts and forecasts to their operations specifications per their Safety Management System (SMS) and any specific Safety Risk Assessments (SRA) for any operations other in areas of a volcanic ash cloud.

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APPENDIX D

STRATEGY FOR THE FUTURE PROVISION OF INFORMATION ON HAZARDOUS METEOROLOGICAL CONDITIONS

Overall Objective

To develop a high-level strategic statement relating to the provision of information on hazardous meteorological conditions for international civil aviation, covering the period 2014 to 2025.

This strategic statement is expected to support recommended actions concerning aeronautical meteorological service provision arising from ICAO's 12th Air Navigation Conference (AN-Conf/12 held 19 to 30 November 2012), while recognizing that there is a need for shorter term action in some areas to rectify existing deficiencies in the provision of information on hazardous meteorological conditions to international civil aviation.

This strategic statement is intended to support and align with the programme and timing of the aviation system block upgrades (ASBUs)[20] methodology contained in the Fourth Edition (2013) of ICAO's Global Air Navigation Plan (GANP) (Doc 9750-AN/963). The ASBUs provide target availability timelines for a series of operational improvements – technological and procedural – that will eventually realize a fully-harmonized global air navigation system.

Refer: Agreed Action 5/1, Meteorological Warnings Study Group (METWSG), 5th Meeting, Montréal, 20 to 21 June 2013.

Problem Definition

There is a significant and long standing issue regarding deficiencies in some ICAO Regions concerning the provision of SIGMET information and harmonization of such information within the current State meteorological watch office (MWO) flight information region (FIR)-based system[21].

Deficiencies in SIGMET provision is a major concern, particularly given the programmed migration to performance-based air traffic management principles set out in the GANP. The need to provide better meteorological support for the safety and efficiency of international civil aviation is particularly important.

IATA and its member airlines continue to express concern over the safety and efficiency of operations in areas where SIGMETs are rarely, if ever, issued by MWOs.

Some States have a chronic lack of capacity[22] to fully meet their Annex 3 – *Meteorological Service for International Air Navigation* responsibilities. In particular, some smaller developing States have difficulty with SIGMET provision. Some developed States also have significant problems in this area[23]. These difficulties result in particular MWOs not being able to issue SIGMETs in a timely, reliable, or accurate manner.

[20] Refer Working document for the Aviation System Block Upgrades, 28 March 2013.

[21] Where a State has accepted the responsibility of providing air traffic services within an FIR (or control area), SIGMET information is to be issued by an MWO concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations. Such phenomena include severe turbulence, severe icing and others.

[22] Capacity includes people, expertise and underpinning infrastructure.

[23] The acute lack of capacity of some States to meet many Annex 3 responsibilities regarding SIGMET issuance was emphasised during a SIGMET trial conducted by the METWSG in April to July 2011. This trial was aimed at testing the feasibility of regional SIGMET advisory centres (RSAC) assisting MWOs to issue SIGMETs by providing them with SIGMET advisory information.

The problem is not unique to any one State or any one ICAO Region. The issues range from State non-compliance in actually issuing SIGMET, non-functional or non-supportive MWO, through to providing SIGMET in incorrect formats. The problem is compounded with the current FIR-based system of SIGMET provision also presenting co-ordination challenges, particularly over areas with small and irregular FIR boundaries, as well as in those ICAO Regions with many small FIRs.

Furthermore, IATA has noted that inconsistent cessation or change of hazardous meteorological conditions information at FIR boundaries, due to differences in methods and working practices between MWOs, creates significant and expensive flight management issues.

Any remedial developments must therefore align meteorological inputs to the evolving technical capacity of modern airline and aircraft operations and the increasing globalization of the civil aviation industry.

Statement of Strategic Intent

Reflecting its strategic objectives, and in an increasingly competitive business and technically advancing environment, ICAO recognizes:

(a) the increasing demand from international civil aviation users for efficient and effective phenomena-based hazardous meteorological condition information, seamlessly covering the globe in a co-ordinated and harmonized way; and

(b) the limitations, inconsistencies and gaps in the current production of hazardous meteorological conditions information (in the form of SIGMET) required to be produced by each MWO for its associated FIR.

To meet international civil aviation user demands, and make best use of resources (including technology), this strategy proposes to transfer the issue of defined[24] regional hazardous meteorological condition information to appropriately resourced regional centres, supported by respective meteorological watch offices (MWOs) as may be determined, in a three phased approach and in support of the Aviation System Block Upgrades (ASBUs) methodology of ICAO's Global Air Navigation Plan (GANP), as follows:

1.1 **Phase One (2014-2017):** The first phase is the establishment of regional hazardous weather advisory centres (RHWACs) to assist MWOs with the existing provision of SIGMET information in those ICAO Regions in need of such support.

Explanatory note: *Formal planning and development will begin with a mandate from the ICAO Meteorology Divisional Meeting in July 2014. All planning and arrangements will be in place with formal ratification of the scheme expected in Amendment **77** to Annex 3 (with intended applicability in November 2016), and parallel documentation in Regional Air Navigation Plans. The allocated RHWACs will commence operations at a date to be agreed but no later than December 2017.*

1.2 **Phase Two (2016-2020):** The second phase (including the transition of the RHWACs) will cover the centralization of SIGMET-related responsibilities of MWOs to regional hazardous weather centres (RHWCs) supporting multiple FIRs. This may include the amalgamation of existing volcanic ash advisory centres (VAACs) and tropical cyclone advisory centres (TCACs)[25] into these RHWCs, and will include close liaison with users and detailed definition of all products to be supplied by the new centres.

Explanatory note: *Formal planning and development will begin in 2016 with the completion of planning for Phase 1.*

[24] Part of the first phase would be the identification of exactly what constitutes hazardous meteorological conditions, excluding the contemporary work of VAACs, TCACs and pending the expected future work of space weather centres.

[25] VAACs and TCACs have been operating successfully in a regional capacity for the past several decades.

*All planning and arrangements will be in place with formal ratification of the scheme expected in Amendment **78** to Annex 3 (with intended applicability in November 2019), and parallel documentation in Regional Air Navigation Plans. Planning will include the development of suitable RHWC performance metrics to support Phase 3. The allocated RHWCs will commence operations at a date to be agreed but no later than December 2020.*

1.3 **Phase Three (2020-2024):** This phase primarily covers the review of the performance of the regional hazardous weather centres, making any appropriate recommendations in this regard. The review will also include, inter alia, an evaluation of the efficacy, or otherwise[26], of consolidating, in a further phase (potentially a Phase Four), hazardous meteorological condition information issued from a few centres conjointly covering the globe[27], in or after 2025.

Explanatory note: *The review will be undertaken in 2023 using performance data compiled for the years 2020 – 2022 inclusive. The review will include evaluation of operations, modelling, logistics, communications and science capability. A final report and recommendations will be provided by the end of 2023. If recommended, a reduced number of regional centres, or a few centres conjointly covering the globe, could be operating in 2025 if mandated in Amendment **80** to Annex 3 (with intended applicability in November 2025). It is noted, however, that any highly significant recommendations from this review process may need to go an ICAO Meteorology Divisional meeting around 2025/2026 for ratification, delaying implementation of any significant changes until after about 2026.*

1.4 **Note**

Notwithstanding the strategic approach outlined above, and in accordance with Annex 3, Chapter 2, States can enter into bilateral arrangements at any time to obtain the support they may need to fulfil their MWO obligations with regard to SIGMET provision. As an interim arrangement, while Phase One of the strategy is implemented, such action is encouraged.

Supporting Considerations

This section references the areas of consideration taken into account in the derivation of the statement of strategic intent for the future provision of information on hazardous meteorological conditions.

1.5 ICAO Strategic Objectives

ICAO has established three strategic objectives for years 2011, 2012 and 2013:

(a) Safety: Enhance global civil aviation safety.

(b) Security: Enhance global civil aviation security.

(c) Environmental Protection and Sustainable Development of Air Transport: Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment.

In years 2014, 2015 and 2016 the number of strategic objectives of ICAO will increase to five. Ten key air navigation policy principles[28] are contained in the GANP, intended to guide global, regional and State air navigation planning consistent with ICAO's strategic objectives.

1.6 General Considerations

Those aspects contributing to the derivation of this document, not covered elsewhere, are:

(a) Identification of hazardous meteorological conditions best managed in a consolidated manner;

[26] It is accepted that the review may recommend slowing, delay, or postponement of further consolidation.

[27] There is a high level expectation of IATA for a better global hazardous weather scheme than exists today, consisting of only a few regional centres conjointly covering the globe, to be fully assessed and implemented in the mid-term.

[28] Refer Doc 9750-AN/963 — 2013-2028 Global Air Navigation Plan.

(b) Utilization of information within the envisaged data-centric environment[29] as part of the system wide information management (SWIM) concepts.

(c) Need for evaluation of cost recovery schemes to support regional centres.

(d) Need for evaluation of relevant airspace sovereignty, liability, and obligations of States - noting the range of political perceptions of regional and global change.

(e) Need to ensure robust implementation of quality management system (QMS) and safety management system (SMS) principles and requirements in any new system.

1.7 **Discussion**

Article 28 of the ICAO Convention on International Civil Aviation (Doc 7300) and Annex 3 to that Convention defines meteorological services in support of international air navigation. Over the past six decades, amendments of Annex 3 have been largely centred on meteorological observations and forecasts rather than the nature of the underlying global systems structures.

In the 1980s the international community recognized technological advances and user demand changes (for example, increasing long-haul flights) with the establishment of the world area forecast system (WAFS). The WAFS initially provided global wind and temperature data with planning for significant weather forecasts (as currently provided). In the final phase of WAFS implementation, the WAFS replaced regional area forecast centres (RAFC) which had provided regional forecasts within their defined area of responsibility, operating within the limits of technology and communication networks of the times. The development of the WAFS hinged on global modelling capabilities, the advent of satellite remote sensing techniques, and satellite broadcast of WAFS products to States/users across the globe.

Other changes reflected this on-going development of international civil aviation. An example is the removal of the two-hour rule that restricted dissemination of METAR/TAF reports within a two-hour flying distance from the aerodrome. Just as it was recognized that this two-hour rule was obsolete then, the international civil aviation community recognizes now that future systems and the nature of meteorological information will need to meet new and different requirements within new and different contexts.

Reflecting this perspective, the future vision for aeronautical meteorological service practices was covered at the AN-Conf/12.

The international civil aviation community understands that meteorological conditions are not restricted to the boundaries of a flight information region (FIR) and that there is a need to provide a harmonized assessment of meteorological conditions irrespective of FIR boundaries. This perspective became most apparent in recent years with the provision of volcanic ash information; where there was a lack of information on the location of the hazard in some areas compounded by occasional inconsistency of information from different providers, covering adjacent areas. Within the international airways volcano watch (IAVW) these deficiencies have been well documented, with a wide array of remedial system changes implemented or being implemented. However, the international community has not yet implemented the necessary system and product changes needed for other hazardous meteorological conditions.

[29] Including inter-alia the achievement of a robust global network based on the principles of Service Oriented Architecture (SOA).

If States are to respond to user demands for the provision of better aeronautical meteorological services, there is a need to change how these services are provided in support of the vision provided at the AN-Conf/12. For example, if States fail to recognize these changes, operators may look to other sources to obtain the necessary information to support their performance based operations. While it is recognized that fundamental services must continue to be provided by States, there is a need to identify which services belong to the State to support operations within their FIR, and which services are required for situations where meteorological conditions are transparent to FIR boundaries

1.8 **Working Relationships**

To ensure the success of the strategic plan there is a need to develop a co-ordinated working relationship with various organizations, service providers and users of services that includes but not necessarily defines all the stakeholders, including:

- WMO — World Meteorological Organization.
- IATA — International Air Transport Association.
- CANSO — Civil Air Navigation Services Organisation.
- IFALPA — International Federation of Airline Pilots' Associations.
- IFATCA — International Federation of Air Traffic Controllers' Associations.
- ISO — International Organization for Standardization.
- States in general (States in need of assistance, States able to host RHWACs, States likely to be able to provide other assistance, VAAC and TCAC host States)
- ICAO Regional offices.
- Particular States with capability and capacity to serve as a regional centre.

Discussion on Implementation

Consideration will be needed as to the assignment of an expert group to manage the process. This group may need to have overall management responsibilities for the system, reporting on a regular basis to the Secretariat or to the Air Navigation Commission (ANC). Its work will need to include the implementation of appropriate funding systems.

It is recognized that States will continue to have an important role in support of the operation of the intended regional hazardous weather centre concept. States will need to:

(a) ensure that they provide, through their respective MWOs and requisite communications systems and protocols , local information[30] including special air-reports to the regional hazardous weather advisory centres, and eventually the regional hazardous weather centres, in a timely fashion;

(b) continue to provide so-called flight following services through their respective MWOs, including the relay as appropriate of hazardous meteorological conditions information, monitoring of the regional hazardous weather advisory centres and eventually the regional hazardous weather centre products with formal routine and special feedback to the centres[31];

[30] Local information includes data and information from any remote sensing and satellite reception capabilities not directly accessible by the Regional Centres.

[31] Routine feedback to the Regional Centre would include the routine provision of validation and complementary real-time information. Special feedback would include real-time quantitative and qualitative advice on specific quality matters with regard to the Regional Centre products.

(c) where possible, provide routine evaluation of the hazardous weather information provided by the regional centres; and

(d) continue to undertake the specified tasks required in the volcanic ash advisory and tropical cyclone advisory schemes.

MWOs would continue with all other specified requirements as currently set out in Annex 3.

In implementing the strategy care needs to be taken to ensure the voice of all States is represented on the referred expert group. In this regard, it is suggested that there be particular representation from a State or several States in each ICAO Region, and service provider and user representative bodies to supplement the expertise required (including WMO experts). The experience and capabilities of States involved in the development and operation of TCAC, WAFC and VAAC responsibilities should also be represented on the expert group either through membership and/or defined relationships.

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APPENDIX E

PLAN FOR THE COST RECOVERY AND GOVERNANCE SUPPORTING REGIONAL HAZARDOUS WEATHER ADVISORY CENTRES

Overall Objective

To develop a plan for the future governance and equitable cost recovery of a regional SIGMET advisory system for hazardous meteorological conditions for international civil aviation.

This plan and associated discussion is expected to support recommended actions concerning aeronautical meteorological service provision arising from ICAO's 12th Air Navigation Conference (AN-Conf/12 held 19 to 30 November 2012), and, importantly, the strategic statement relating to the provision of information on hazardous meteorological conditions to international civil aviation from regional advisory centres.

This paper details some of the issues relating to the future governance and cost recovery arrangements of the regional hazardous weather advisory centres (RHWAC) and provides an initial plan for development to assist discussion at the forthcoming Meteorology (MET) Divisional Meeting in July 2014.

The plan is intended to support and align with the programme and timing of the aviation system block upgrades (ASBUs)[32].

Refer: Agreed Action 5/3, Meteorological Warnings Study Group (METWSG), 5th Meeting, Montréal, 20 to 21 June 2013.

Problem Definition

Strategy Linkage

The concurrent strategic paper on the Future Provision of Information on Hazardous Meteorological Conditions (deriving from the Agreed Action 5/1, METWSG, 5th Meeting) sets out that there is a significant and long standing issue regarding deficiencies in some ICAO Regions concerning SIGMET provision and harmonisation within the current State Meteorological Watch Office (MWO) flight information region (FIR)-based system.

Some States have a chronic lack of capacity[33] to fully meet their Annex 3 – *Meteorological Service for International Air Navigation* responsibilities. In particular, some smaller developing States have difficulty with SIGMET provision. Some developed States also have significant problems in this area[34]. These difficulties result in particular MWOs not being able to issue SIGMETs in a timely, reliable, or accurate manner.

A three phased remedial strategy is proposed in response to long voiced concerns from users (IATA and others) regarding the safety and efficiency of operations in areas where SIGMETs are rarely, if ever, issued for hazardous meteorological conditions.

Key Issue

[32] ASBUs methodology contained in the Fourth Edition (2013) of ICAO's Global Air Navigation Plan (GANP) (Doc 9750-AN/963). The ASBUs provide target availability timelines for a series of operational improvements – technological and procedural – that will eventually realize a fully-harmonized global air navigation system.

[33] Capacity includes people, funding, expertise and underpinning infrastructure.

[34] The acute lack of capacity of some States to meet many Annex 3 responsibilities regarding SIGMET issuance was emphasised during a SIGMET trial conducted by the METWSG in April to July 2011. This trial was aimed at testing the feasibility of regional SIGMET advisory centres (RSAC) assisting MWOs to issue SIGMETs by providing them with SIGMET advisory information.

There is currently no specific guidance or systems available through ICAO and WMO to assist in the funding or governance of regional centres providing advisory services on hazardous meteorological conditions.

The Plan

In direct relation to the *Statement of Strategic Intent* in the concurrent paper, *Future Provision of Information on Hazardous Meteorological Conditions*:

Assign an ICAO Expert Group by September 2014

The first objective will be to assign an ICAO expert group to have overall management responsibilities for developing the RHWAC scheme. The expert group would report on a regular basis to the Secretariat or directly to the Air Navigation Commission (ANC). Its work will need to include:

(a) the development and implementation of permanent governance arrangements by mid-2015; and

(b) the development and implementation of appropriate funding systems by mid- 2015.

The voice of key States should be represented on the expert group. In this regard, it is suggested that there be particular representation from a State or several States in each ICAO Region, and service provider and user representative bodies to supplement the expertise required (including WMO experts). The experience and capabilities of States involved in the development and operation of tropical cyclone advisory centre (TCAC), world area forecast centre (WAFC) and volcanic ash advisory centre (VAAC) responsibilities should also be represented on the expert group either through membership and/or defined relationships. The ICAO Secretariat will need to ensure that relevant ICAO financial and economic expertise is available (such as from within the Air Transport Bureau).

Develop and Implement Governance Arrangements by mid-2015

In developing robust governance arrangements, the expert group will need to consider, taking into account those matters considered in this paper:

(a) all technical management issues in establishing the RHWACs;
(b) establishment of formal governance processes within the ICAO framework, documentation and reporting;
(c) product validation/verification processes and routine assessment and reporting; and
(d) financial management relationships, accounting and reporting procedures.

Develop and Implement of Appropriate Funding Systems by mid-2015

In developing robust funding systems, the expert group will need to consider taking into account those matters considered in this paper:

(a) all possible alternatives, including those set out in this paper;
(b) current cost recovery systems and guidance from both ANSPs and NMHSs that cover FIRs outside respective State territories;
(c) extensive consultation and discussion with key stakeholders and possible third party assistance (for example, World Bank, Regional Development Banks);
(d) the most expeditious method for accounting, reviewing and reporting on revenue and allocation to the RHWACs; and
(e) the most expeditious method for RHWACs to report financial estimates, budgets and financial performance.

Complete all arrangements by the end of 2015

The target for ensuring good governance and funding systems are in place is the end of June 2015. It is

expected that this will enable the first RHWACs to be established on a firm foundation within the time-scale set out in the *Statement of Strategic Intent* for regional centres – i.e. by the end of 2015.

As other regional centres are progressively developed they will have an already operating governance and financial system to engage, making the process straight forward and largely of a technical nature.

Background Considerations

This section sets out background information taken into account in the derivation of the plan for funding and governance of the future provision of advisory information on hazardous meteorological conditions.

ICAO Strategic Objectives

ICAO has established three Strategic Objectives for years 2011, 2012 and 2013:

(a) Safety: Enhance global civil aviation safety;
(b) Security: Enhance global civil aviation security; and
(c) Environmental Protection and Sustainable Development of Air Transport: Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment.

In years 2014, 2015 and 2016 the number of strategic objectives of ICAO will increase to five. Ten key air navigation policy principles[35] are contained in the GANP, intended to guide global, regional and State air navigation planning consistent with ICAO's strategic objectives.

Existing International Guidance

Extensive ICAO guidance on cost recovery is provided in *the Manual on Air Navigation Services Economics* (Doc 9161). This detailed manual sets out the ICAO policy on cost recovery and provides a robust array of perspectives that need to be taken into account in designing cost recovery systems. Appendix 3 of Doc 9161 details the guidance for determining the costs of aeronautical meteorological services. Additionally, ICAO's *Policies on Charges for Airports and Air Navigation Services* (Doc 9082) provides guidance on cost recovery.

WMO provides a *Guide to Aeronautical Meteorological Services Cost Recovery: Principles and Guidance* (WMO Publication No. 904). This publication contains additional information on the principles of cost allocations for National Meteorological Services and other providers of meteorological services to aviation, but currently does not provide guidance on multi-State/multi-FIR based cost recovery mechanisms.

Existing Regional Schemes

At present, within the ICAO framework there are:

(a) nine volcanic ash advisory centres (VAACs) (namely Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington and Wellington) as part of the international airways volcano watch (IAVW)
(b) seven tropical cyclone advisory centres (TCACs) (namely Darwin, Honolulu, La Réunion, Miami, Nadi, New Delhi and Tokyo), and
(c) two world area forecast centres (WAFCs) (namely London and Washington) as part of the world area forecast system (WAFS)

In addition, there is the ICAO Satellite Distribution System (SADIS) that provides OPMET information and WAFS forecasts to States/users in the ICAO EUR, AFI, MID and western part of the ASIA/PAC Regions.

[35] Refer Doc 9750-AN/963 — 2013-2028 Global Air Navigation Plan.

With the exception of the SADIS, which has a governance and cost recovery arrangement in place, there are no regional cost recovery arrangements in place for any of the other regional or global centres referred to above.

Currently the IAVW, WAFS and SADIS all have a governance structure in place by way of ICAO operations groups – namely the IAVWOPSG, WAFSOPSG and SADISOPSG – which report to the Air Navigation Commission and/or Planning and Implementation Regional Groups (PIRGs) of ICAO on a routine basis. These operations groups consist of, inter alia, the provider States, States who make use of the services provided, airline users represented by IATA, and flight crew users represented by IFALPA. ICAO provides the Secretariat support for these operations groups.

These operations groups currently meet on a 12- or 18-month cycle and each has a similar agenda that includes:

(a) review of associated regional and/or global ICAO provisions;
(b) operation of the centres or systems;
(c) development of the centres or systems; and
(d) long term development and implementation issues.

WMO arranges for the governance for the TCACs. A technical co-ordination meeting involving all of the TCAC provider States currently takes place once every three years, however a number of regional committees (within the construct of the WMO Regional Associations) take place during the intersession period. There are no airline or flight crew user representatives on these particular WMO groups, however the ICAO Secretariat attends where resources allow.

Known Issues

Each State is responsible for the provision or facilitation, and funding of its meteorological service. Some States contract out the work and rely on those contractors to recover costs through third party mechanisms. Others meanwhile fund service directly from taxes or through air traffic services (ATS) and airspace levies and charges. In many cases, airlines and operators have little input into how the State delivers the service and how it is funded, leading to a general lack of transparency.

Currently States that provide regional and global meteorological centres (such as the TCACs, WAFCs and VAACs alluded to above) have taken responsibility for funding and resourcing. Where cost-recovery takes place, airspace users receiving en-route air navigation services (ANS) within the particular State's FIR(s) may be charged directly by the ATS provider or indirectly through other charging mechanisms bearing on airline operations. There is no international or regionally common scheme for the collection of revenue to support regional and global meteorological centres.

The demands on providing more accurate regional or global forecasts require constant improvements to the provider State's capability. This includes increasingly expensive computing capability for numerical weather prediction (NWP), data post-processing, as well as more sophisticated production software development. In this regard, States providing regional and global meteorological centre operations have generally noted that that there is increasing scrutiny being applied to these costs by operators.

The additional costs of providing such services for aviation can no longer be considered marginal or just a bi-product of the routine activities. Staff resources and infrastructure costs to provide these often complex and demanding services are needed; in addition, they also have to be tested and exercised on a regular basis.

An important aspect for any regional centre is the need to share information with neighbouring States and other centres[36]. Operationally meeting this requirement, let alone the cost, may well be above and beyond what the provider State would be normally be required to undertake if it was not a regional centre.

Generally speaking, airlines/operators overflying the regional centres area of operation but not the provider State FIRs currently do not contribute to the cost of the provision of the particular service. In a regionalised scheme, this highlights that current cost State/FIR-based recovery methodologies would be materially inequitable.

Discussion

Management and Governance

It is considered that similar arrangements of governance to the existing regional and global centres alluded to above could be utilised for the RHWACs - a global group of experts advising ICAO on the operation of the service and its effectiveness in meeting user requirements.

Careful consideration is needed as to the makeup of the ICAO expert group(s) that would oversee the work of the RHWACs, noting the need for a variety of expertise not just in meteorology but airline operations, air traffic management (ATM) and cost recovery. The expert group would need to ensure best practices are developed and shared between the RHWACs.

More local discussions relating to the day-to-day operation of the RHWACs should take place at the ICAO regional MET sub-group meetings (or equivalent) of the PIRGs, since these meetings would also allow States and users within the ICAO Region to have the opportunity to influence the development of the service and to propose changes to the requirements to particular or all RHWACs.

Governance structures must be in place to manage the establishment of the RHWACs. These governance structures (expert group(s)) would need to;

- detail the specific regional requirements (based on global ICAO provisions);
- arrange appropriate user consultation, produce guidance and usability guides for the products being provided;
- set out the performance indicators as agreed with the users;
- detail the meteorological information required from States (for example, observations);
- ensure there is a transparent costing, budgeting and long term investment plan in place;
- assist in the running (or development) of a cost recovery scheme; and
- review of performance, based on the performance indicators.

During implementation, governance could reside with a more local group (for example, a PIRG) that assists the State providing the RHWAC by providing guidance on policy and strategy during its initial operation. However, recognising the need for harmonized practices it is suggested that during the implementation phase a number of best practices workshops are held for the RHWACs.

The alternative is for a global expert group to oversee the establishment of the RHWACs as currently defined and as may be requested by the PIRGs.

It is noted that users have expressed a need for consistency between RHWACs, one aspect of the governance expert groups is to ensure that the advisory products are provided uniformly and in a similar manner and that change management principles are applied. Also critical to the work of the RHWACs will be the development and subsequent agreement of a common set of key performance indicators (KPIs) to ensure that the RHWACs meet the quality standards required by users.

[36] Including, for example, pilot reports, satellite information and other observations.

It is considered that there are no additional liability issues for a State since all the information provided by the RHWAC is provided as guidance material only.

Funding

While in theory it can be relatively easy to determine what type of cost recovery system should be in place, practically this is not the case. There are complicated political considerations and administration arrangements that would need to be put in place and any such scheme also needs to be fair and enforceable.

The following excerpt from ICAO's *Policies on Charges for Airports and Air Navigation Services* (Doc 9082) provides details for the charges for air navigation services used by aircraft when not over the provider State. A similar policy could be developed for provision of meteorological services.

> "53. The Council observes that the providers of air navigation services for international use may require all users to pay their share of the cost of providing them regardless of whether or not the utilization takes place over the territory of the provider State. Accordingly, wherever a State has accepted the responsibility for providing route air navigation services over another State, over the high seas, or in an airspace of undetermined sovereignty (in accordance with the provisions of ICAO Annex 11 — *Air Traffic Services* to the *Convention on International Civil Aviation* and Regional Air Navigation Agreements approved by the Council), the State concerned may levy charges on all users for the services provided. A State may delegate to another State or to an organization the authority to levy such charges on its behalf.
>
> 54. The Council also notes that the collection of air navigation services charges in cases where the aircraft does not fly over the provider State poses difficult and complex problems. It is for the States to find the appropriate kind of machinery on a bilateral or regional basis for meetings between provider States and those of the users, aiming to reach as much agreement as possible concerning the facilities and services provided, the charges to be levied, and the methods of collecting these charges."

Whilst the direct costs of provision will be relatively straightforward to identify, the allocation of additional core costs (i.e. infrastructure and underpinning services) will be more difficult. It is likely that additional guidance on the subject would need to be provided to assist States in order that a standardised allocation of costs is undertaken by the RHWAC provider States. This guidance would need to ensure States undertaking the operation of an RHWAC understand the need for transparency in determining the associated core costs.

Conversely, it is recognised that if an RHWAC were to have multiple functions, for instance if they were responsible for tropical cyclone, volcanic ash and other hazardous phenomena, this would reduce costs for training/competencies, administration for recovering costs, staff costs, data transfer, etc.

5.2.1 Cost Recovery Options

Creating a cost recovery arrangement for the RHWACs will provide an opportunity for users to influence the development work and have knowledge of the quality of information being provided. This will also allow users to compare the output from the RHWACs and see which provide quality services in a cost effective manner whilst recognising that the costs of providing the RHWAC service will vary due to the cost of living and other factors.

While the prospect of no cost recovery mechanisms is not ideal, this does not mean that a State hosting (providing) an RHWAC must cost recover. An RHWAC provider State could elect to meet costs from its own internal budgetary process.

5.2.1.1 No Regional Cost Recovery

In the past, when the provision of regional based advisory services were considered part-and-parcel of the National Meteorological Service (NMS) it could be argued that the costs of provision were relatively low and therefore the costs were "*de minimis*" (i.e. the effort to collect the charges does not justify the means since its effect on the en-route rate was low). However, as noted above, the costs of provision of regional and global meteorological services are increasing. The other possible concern to consider is that while it

might be perfectly feasible for a large or well-developed State to bear this cost, this might not be the case for smaller or developing States. This could result in discouraging important investment in capability.

5.2.1.2 Airspace Users / States contract directly with the State providing the regional service

Airline operators that conduct flights through a region being supplied with SIGMET advisories from a RHWAC would contract directly with the State providing the RHWAC service. In addition, there would be a facility for States within the region to make contractual arrangements with the RHWAC provider State in order that the NMS and other agencies (e.g. the ANSP) could receive the information.

This option is complex in that the role of contract Law between the RHWAC provider State and the airlines / users could be quite fraught, and expensive to administer. There is also the likelihood that either non-State based operators are denied access to the services or that a number of users do not pay but receive the information from other sources.

5.2.1.3 Regional Cost Recovery Scheme

The SADIS cost recovery scheme alluded to above is a good example of a regional cost recovery scheme, whereby each year the provider State establishes the costs of providing the service; this cost is then shared by the States that make use of the service according to usage information provided by ICAO. Such a model could be used for regional cost recovery of RHWAC. It is noted that countries designated by the United Nations as a Least Developed Country are not required to pay any share of the costs. A similar model is used in Europe for the central collection of en-route charges for regional institutions (i.e. Eurocontrol).

This option requires the support of all States in a given ICAO Region and would be open to argument as to the acceptance and/or proportionality of charges levied on each State.

5.2.1.4 Fee Collection

In the contemporary systems, the administration, record keeping and fee collection arrangements form a critical element for the success of such a scheme. In addition, any user - be it State or operator - that refuses to pay would almost certainly be able to receive the information from other sources. If substantial numbers of users do not pay then it is likely that the services provided from the RHWAC would be of lower quality since the resources and investment to maintain the service delivery at sustainable levels would not take place.

5.2.1.5 Third Party Alternative

From the discussion in this section it is clear that any State-based scheme to fund the RHWACs will be difficult to implement and manage due to complexity of relationships and State Law. An alternative to that approach is to use a method of third party funding. ICAO successfully administers the contributions from States (recovered from airlines) to fund the provision of certain international services through its joint financing program;

- Air Navigation Services in Greenland and Iceland (DEN/ICE),
- North Atlantic Height Monitoring System (HMS)

5.2.2 Summary

Any future cost recovery mechanism should ensure that there is:

- clear description of objectives and benefits;
- identification of facilities and services to be jointly financed;
- definition of the responsibilities of the different partners;
- simplicity and flexibility of the arrangements; and
- equitable recovery of costs through charges consistent with ICAO’s policies on charges

- alignment with the principles of *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082)

5.3 Working Relationships

To ensure the success of the strategic plan there is a need to develop a co-ordinated working relationship with various organizations, service providers and users of services that includes but not necessarily defines all the stakeholders, including:

- WMO — World Meteorological Organization.
- IATA — International Air Transport Association.
- CANSO — Civil Air Navigation Services Organisation.
- IFALPA — International Federation of Airline Pilots' Associations.
- IFATCA — International Federation of Air Traffic Controllers' Associations.
- ISO — International Organization for Standardization.
- States in general (States in need of assistance, States able to provide RHWACs, States likely to be able to provide other assistance, VAAC and TCAC provider States)
- ICAO Regional Offices.
- Particular States with capability and capacity to serve as a regional centre.

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APPENDIX F

WORLD AREA FORECAST SYSTEM DELIVERABLES IN SUPPORT OF ASBU BLOCK 3 (2028 AND BEYOND)

- Fully integrated multi-member ensemble hazard forecasts
    - Implementation of the WAFS-database, populated with meteorological information from appropriate models to produce ensemble forecasts of global meteorological information
- Implementation of high spatial and temporal resolution models resulting in improved representations of meteorological information
- Provide full dataset of meteorological information covering en-route weather suitable for integration into flight planning for en-route operations, flight management and air traffic management (ATM) decision support systems
- Fully automated gridded and significant weather forecast (SIGWX) output
- Full implementation of system wide information management (SWIM) for access to WAFS data
- Retirement of legacy WAFS products and dissemination systems

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Agenda Item 3: Integrating meteorological information exchange developments into the future system wide information management environment

3.1: Meteorological information exchange developments in support of future international air navigation requirements

3.1.1 The meeting noted the efforts made by the Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE-PT), in coordination with the Air Traffic Management Requirements and Performance Panel (ATMRPP) and the WMO CAeM Expert Team on Meteorological Services to ATM and Meteorological Information (ET-M&M) in considering the future need to understand and define the requirements for aeronautical information to support trajectory-based operations (TBO). The meeting noted that the notion of TBO was intended to be an all-encompassing operational improvement covering the air traffic management (ATM) requirements through all phases of flight. As a result the meeting noted a draft concept of operations and roadmap and agreed that the document, once finalized, should be used to facilitate the development of the future ATM requirements for aeronautical meteorological information.

3.1.2 The meeting agreed on the importance of the continued identification of requirements and development of capabilities, forming a significant and necessary component of a system meeting the ATM community's goals concerning TBO. The meeting formulated the following recommendation accordingly:

Recommendation 3/1 — Aeronautical meteorological information to support trajectory-based operations

That an appropriate ICAO expert group (or groups), in close coordination with WMO, be tasked to:

a) finalize a draft concept of operations and roadmap concerning aeronautical meteorological information integration for trajectory-based operations (TBO); and

b) using the result of a) above, establish further air traffic management requirements and aeronautical meteorological service capabilities to support TBO consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750).

3.1.3 The meeting noted some concerns expressed relating to the implementation of the expected draft provisions for the use of extensible markup language (XML)/geography markup language (GML) for the exchange of meteorological information, namely METAR/SPECI, TAF and SIGMET. These provisions were introduced as a part of Amendment 76 to Annex 3 — *Meteorological Service for International Air Navigation/*Technical Regulations [C.3.1] for States in a position to do so which became applicable in November 2013 and it was noted that these provisions were proposed for inclusion as a Recommended Practice for all States as a part of draft Amendment 77 to Annex 3 which would become applicable in November 2016, if adopted. A survey was proposed to assess the level of preparedness of States for the implementation of these provisions, which was noted to be the first major step of the migration to the use of digital aeronautical meteorological information. However, the meeting was of the opinion that a survey relating to States' intentions in this regard would be premature at this stage. It was noted that attention should be paid to the levels of implementation over time to facilitate a smooth transition for those States, with air navigation service providers (ANSPs) and aeronautical meteorological service providers actively and collaboratively engaged in the migration.

Agenda Item 3: Integrating meteorological information exchange developments into the future system wide information management environment

3.2: Integration of meteorological information in the future system-wide information management (SWIM) environment through the development of new forms of data representation

3.2.1 The meeting noted an expectation that existing information exchange systems could constrain the implementation of operational improvements to the ATM system. The limitations of the systems include the lack of harmonization of information (including aeronautical information, meteorological information and flight information) proprietary interfaces and data formats, message-size limitations and a non-scalable approach to information exchange within the present infrastructure.

3.2.2 The meeting agreed that a careful migration of meteorological information into a SWIM environment was required in order to allow the ATM system to develop along with the expectations of the GANP. It was also noted that such a migration would need to consider various significant issues including the potential separation between the service provider and the user due to increased levels of automation; the quality of service which would necessitate an increased use of metadata to enable a user assessment of the data usability; the integration of the "human in the loop" in an automated or semi-automated environment; the move from a product-centric to a data-centric environment; an information interoperability framework; information exchange services and models; determination of authoritative sources; local information integration; and governance. Due to the complexity of this undertaking, the meeting agreed to a set of tasks (as provided in Appendix A) to be used as a basis for the development of requirements to integrate meteorological information into the SWIM environment.

3.2.3 The meeting noted the need to coordinate the work done in this area with other related information domains contributing to SWIM and to consider the principles of transparent governance and risk mitigation during the development of aeronautical meteorological information requirements and services. The meeting formulated the following recommendation accordingly:

Recommendation 3/2 — Inclusion of aeronautical meteorological information in the future SWIM-enabled environment

That ICAO through an appropriate expert group, in close coordination with WMO, develop provisions to enable the inclusion of aeronautical meteorological information in the future system-wide information management (SWIM) environment consistent with the *Global Air Navigation Plan* (GANP) (Doc 9750), by adhering to the following principles:

a) the outline provided in Appendix A forms the initial basis for foreseen implementation milestones, and where this outline and associated milestones are reviewed on a regular basis (every 12 months) to reflect changes in the alignment between, and the priorities of, the SWIM related aviation system block upgrade (ASBU) modules and operational improvement areas;

b) ongoing coordination with (an) appropriate ICAO expert group(s) tasked with developing the SWIM concept to ensure that the meteorological elements of SWIM meet the GANP objectives;

c) any duly justified meteorological consideration on the future development of the physical infrastructure layer (network connectivity), the messaging infrastructure, the information exchange models and the information exchange services should be made based on the core architectural principle of service orientation and in coordination with the SWIM and GANP objectives alongside other information exchange models; and

d) the evolution towards an information management environment should be guided by a roadmap including a transparent system of governance and risk mitigation actions and the foreseen role of existing ICAO information exchange functions for aeronautical meteorology such as regional OPMET databanks (RODB), inter-regional OPMET gateways (IROG) and internet based services.

3.2.4 Noting the needs of users for consistent, coherent, accurate, authoritative and fit-for-purpose meteorological information, the meeting discussed and noted that a number of governance and technical issues, listed in Appendix B, would need to be addressed by an ICAO expert group responsible for the implementation of SWIM to ensure that the meteorology-related developments were fully aligned with the guiding principles respecting the mandates of both ICAO and WMO. In this regard the meeting formulated the following recommendation accordingly:

Recommendation 3/3 — Further development of the SWIM concept relating to meteorology

That ICAO through an appropriate expert group, in close coordination with WMO, ensure that the issues in Appendix B are addressed in relation to the meteorological component of system-wide information management (SWIM).

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APPENDIX A

METEOROLOGICAL INFORMATION INTEGRATION FOR TRAJECTORY-BASED OPERATIONS TASKS

(Note.— This is based on the assumption of a three-year amendment cycle.)

1. TRANSITION

The main principles and considerations for the evolution of MET information exchange provisions are expressed in a foreseen end-state of this evolution by 2025. Intermediate steps are defined in line with the regular amendment cycle of Annex 3 to support the transition towards this full migration by 2025. [*]

1) Amendment 77 to Annex 3/Technical Regulations [C.3.1] (with intended applicability in November 2016)

- Introduction of an updated IWXXM (logical level) to reflect additional aeronautical meteorological information elements currently contained in the defined Annex 3/Technical Regulations [C.3.1] products or templates (evolution of IWXXM version 2013)

- Introduction of recommended practice for XML/GML-based exchange format for METAR, SPECI, TREND, TAF and SIGMET (upgrade of IWXXM version 2013)

2) Amendment 78 to Annex 3/Technical Regulations [C.3.1] (with intended applicability in November 2019)

- Introduction of an updated IWXXM (logical level) to reflect all aeronautical meteorological information elements contained in the products, templates and services that Annex 3/Technical Regulations [C.3.1] supports

- Introduction of a separate chapter on information exchange services including:

  - the general principles and in some cases recommended practices to provide all gridded data products currently part of Annex 3/Technical Regulations [C.3.1] as an information exchange service in a recommended exchange format;

  - recommended practices to provide all gridded data products as an information exchange service in a recommended exchange format; and

  - introduce newly defined and agreed services.

[*] It should be recognized that at the time of writing, the SWIM concept and globally applicable AIRM is under development. The content of the paper is based on the concepts, notions and principles discussed by the 12th Air Navigation Conference, reflected in the GANP and ASBUs, endorsed by the 38th Assembly. The details of implementing the defined intermediate steps can therefore slightly change in content or time.

3) Amendment 79 to Annex 3/Technical Regulations [C.3.1] (with intended applicability in November 2022)

- Restructuring to reflect that Annex 3/Technical Regulations [C.3.1] described core aeronautical meteorological information elements and aeronautical meteorological information exchange services at the logical level to support international air navigation, including:

  - an updated IWXXM (logical level) to reflect all meteorological information elements and services contained in Annex 3/Technical Regulations [C.3.1]; and

  - recommended practices for the physical exchange formats of these services

4) Amendment 80 to Annex 3/Technical Regulations [C.3.1] (with intended applicability in November 2025)

- Modifications required by emerging service needs; and

- Removal of product requirements.

2. EXPERT GROUP TO SUPPORT DEVELOPMENT

2.1 Considering the complexity and multidisciplinary aspects of the proposed transition, it is proposed to set up an expert group to support, in close coordination with ICAO groups involved in the development of SWIM, the specific development of provisions for aeronautical meteorological information exchange as integral component of SWIM.

2.2 This expert group should:

a) identify aeronautical meteorological information services to include in subsequent versions of IWXXM;

b) support the development of subsequent versions of the IWXXM logical data model;

c) support the development of the physical data models and exchange formats to support the information services defined in the IWXXM logical data model;

d) identify implementation considerations for States for implementing aeronautical meteorological information services, for providers and users, and

e) identify potential training needs for making available aeronautical meteorological information services by SWIM-enabled applications.

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APPENDIX B

GUIDING PRINCIPLES AND ISSUES RELATING TO THE METEOROLOGICAL COMPONENT OF SYSTEM WIDE INFORMATION MANAGEMENT (SWIM)

ICAO should consider:

a) whether meteorological information exchange services could be identified as from an authoritative source and who that authoritative source is;

b) whether the intended use of the meteorological information exchange services could be identified;

c) whether meteorological information exchange service could be identified for its originating data source and all the processing steps until it is made available to the user;

d) whether meteorological information exchange services could be event driven;

e) that meteorological information exchange services should be traceable to enable post-operations and accident/incident investigation;

f) that appropriate coordination is established between the ICAO expert groups concerned with meteorology and SWIM respectively;

g) that aircraft-derived data related to meteorology be included in the SWIM environment; and

h) that guidance material be developed to support States in regulating SWIM-enabled applications.

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Agenda Item 4: Institutional issues

4.1: Review of the working arrangements between ICAO and WMO (Doc 7475)

4.1.1 The meeting recalled that the *Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization* (ICAO Doc 7475/WMO Publication No. 60, Chapter II.3), hereunder referred to as the "Working Arrangements", provided the necessary foundation upon which respective spheres of activity of the two organization in the field of aeronautical meteorology were delineated and the mechanism for collaboration was defined. In particular, it served as a fundamental framework for the collaboration and partnership between ICAO and WMO in aeronautical meteorological matters, identifying and validating both the aeronautical requirements for meteorological service and the capability specifications to fulfil the requirements.

4.1.2 Over the past several decades there had been an appreciable acceleration in scientific and technological advances that could have not been foreseen in the 1950s and 1960s when the Working Arrangements were instituted and last updated. As a consequence, the meeting agreed that there was a need for a thorough review of the Working Arrangements in order to ensure that they appropriately reflect the respective mandates, governance structures and modes of operation of the two organizations. This review would be expected to include consideration of the data management policies of both organizations which would be of paramount importance in the future SWIM environment.

4.1.3 The meeting considered a proposal to establish an "inter-agency" group to manage the future Working Arrangements, whereby the work of the respective expert groups would be coordinated on a formal basis. However, the meeting agreed that given the commitment to review the Working Arrangements, which concerned the responsibilities of the corresponding Secretariats, it would not be feasible to operate under the supervision of such an inter-agency group. Furthermore, it was noted that it would be difficult to establish the authority under which such a group would operate and to whom it would be accountable. In this regard, the relationship and involvement of the Air Navigation Commission (ANC) in the ICAO framework, as the body responsible for the supervision of the States voluntary work force was highlighted. The meeting agreed that while strategic coordination was important this did not justify the establishment of a new group at a level similar to the ANC, or indeed the WMO Commission for Aeronautical Meteorology.

4.1.4 The meeting indicated that both ICAO and WMO should ensure that appropriate resources be allocated to undertake the work associated with the review of the Working Arrangements and related activities.

4.1.5 Noting ongoing work to update the ICAO standardization policies and arrangements between ICAO and other international standards-making bodies, the meeting agreed that it would be useful to consider the outcome of that work when reviewing the Working Arrangements. The meeting recognized the importance of the participation of all the stakeholders in this process but expressed concerns in giving a third party such a role in a bilateral agreement. Therefore, the meeting proposed that the review of the Working Arrangements should in principle be carried out by the Secretariats of the two organizations who could seek assistance, as necessary. In view of the foregoing the meeting formulated the following recommendation accordingly:

Recommendation 4/1 — Review of the working arrangements between ICAO and WMO

That ICAO and WMO:

a) undertake a review to be completed not later than November 2016 of the *Working Arrangements between the International Civil Aviation Organization and the World Meteorological Organization* (ICAO Doc 7475/WMO-No. 60, Chapter II.3) to ensure that the respective roles and responsibilities as well as the commitments of both organizations are appropriately aligned with the mandates of both organizations taking into consideration evolving technological capabilities and aeronautical requirements; and

b) upon completion of a) and as necessary, develop a proposed amendment to Doc 7475/WMO-No. 60, Chapter II.3 for the consideration and approval of the ICAO and WMO governing bodies.

Note.— As a minimum, the review is to address the means of establishing aeronautical requirements for meteorological service for international air navigation and the technical methods and practices and governance structures recommended for use in providing the required service. This review should also ensure that there is no duplication of effort or documentation between the two organizations.

Agenda Item 4: Institutional issues
4.2: Other institutional issues

Designated meteorological authority

4.2.1 The meeting was aware that ICAO Annex 3 — *Meteorological Service for International Air Navigation*/WMO Technical Regulations [C.3.1], Chapter 2, 2.1.4 required States/Members to designate a meteorological authority to provide meteorological service for international air navigation or to arrange for the provision on its behalf. In this regard, while the operational responsibility for aeronautical meteorological service resided with the designated meteorological authority, the ultimate responsibility for fulfilling the ICAO requirements in respect of the *Convention on International Civil Aviation* (Doc 7300) resided with the State.

4.2.2 In this regard, the meeting took note of the practice of some States/Members to delegate the provision of meteorological service for international air navigation to a commercial entity. The meeting noted that such delegation, whilst fully in line with Annex 3/Technical Regulations [C.3.1], did not relieve the designated meteorological authority of the responsibility for safety oversight of the meteorological service provision through the maintenance of and adherence to performance standards, including quality assurance and quality control, and that the State/Member continues to bear the full responsibility for the meteorological service provided to international air navigation by that State/Member.

4.2.3 To this end the meeting noted that some confusion remained regarding the use of the terms "Contracting State" and "meteorological authority" in certain provisions of Annex 3/Technical Regulations [C.3.1] and in related guidance material. It was agreed, therefore, that a review should be undertaken to provide clarification where possible in this regard. This review was not to change the intent of such provisions, particularly regarding the definition of the meteorological authority or the prerogative of the State to designate the meteorological authority. The meeting formulated the following recommendation accordingly:

Recommendation 4/2 — Definition of meteorological authority

That ICAO, in coordination with WMO, further clarify the notion of meteorological authority, through appropriate amendments to ICAO provisions and supporting guidance material.

Oversight of aeronautical meteorological service provision

4.2.4 The meeting was aware that as part of the Universal Safety Oversight Audit Programme (USOAP) Continuous Monitoring Approach (CMA), ICAO conducted mandatory audits of all States with a view to improving global aviation safety through the correction of deficiencies identified by the audits. Moreover, new Annex 19 — *Safety Management*, applicable since 14 November 2013, required States to establish and implement a safety oversight system. The meeting was apprised that Annex 19 recommended that the State should use a methodology to determine its staffing requirements for personnel performing safety oversight functions, taking into account the size and complexity of the aviation activities in that State. Furthermore, Annex 19 required each State to establish minimum qualification requirements for the technical personnel performing safety oversight functions and provide for appropriate initial and recurrent training to maintain and enhance their competence at the desired level.

4.2.5 In an Annex 3 context, the meeting noted that while the provisions extensively refer to the responsibilities of the State-designated meteorological authority, the provisions did not extend to

describing the responsibilities of a meteorological inspectorate, where meteorological inspectors could be a subset of the personnel performing safety oversight functions.

4.2.6 In view of the foregoing, the meeting agreed that there was a need for a State to ensure that the personnel performing safety oversight functions of the aeronautical meteorological service were adequately qualified as required by Annex 19 — *Safety Management*. The meeting formulated the following recommendation accordingly:

Recommendation 4/3 — Oversight of aeronautical meteorological service provision

That ICAO:

a) urge States to ensure that the personnel performing safety oversight functions of the aeronautical meteorological service are adequately qualified and competent meeting the requirements of Annex 19 — *Safety Management*; and

b) develop appropriate guidance material to assist States in establishing oversight of aeronautical meteorological service provision.

Multi-regional, regional and sub-regional provision of service and associated cost recovery

4.2.7 The meeting was aware that in accordance with Article 15 to the Chicago Convention, States/Members were entitled to recover from international civil aviation the costs for providing the required meteorological service for international air navigation. The meeting noted that the legal basis for cost recovery provided by Article 15 was elaborated upon in *ICAO's Policies on Charges for Airports and Air Navigation Services* (Doc 9082), and that, in addition, ICAO's *Manual on Air Navigation Service Economics* (Doc 9161) provided internationally-agreed guidelines, developed by the Air Navigation Services Economics Panel (ANSEP), for the practical application of the recovery of costs for aeronautical meteorological service provision. The meeting noted that WMO had a related publication titled the *Guide on Aeronautical Meteorological Service Cost Recovery — Principles and Guidance* (WMO Publication No. 904).

4.2.8 The meeting noted that the existing ICAO and WMO guidance/guidelines predominantly concentrated on the provision and cost recovery of aeronautical meteorological service, including the provision of meteorological data, on an individual State/national level. The meeting appreciated that a cost recovery mechanism may be warranted for the case of States wishing to entrust service provision to a commonly operated entity under sub-regional, regional or multi-regional agreement. The meeting noted the need to consider strengthening guidance on national cost recovery, particularly in those States with complex airspace arrangements. The meeting formulated the following recommendation accordingly:

Recommendation 4/4 — Guidance/guidelines on the recovery of costs of aeronautical meteorological service provision

That ICAO and WMO undertake a review and, as necessary, update of the ICAO *Manual on Air Navigation Service Economics* (Doc 9161) and WMO *Guide on Aeronautical*

Meteorological Service Cost Recovery (WMO Publication No. 904) so as to ensure that they appropriately reflect agreed and equitable cost recovery practices in those instances where aeronautical meteorological service provision is fulfilled on a multi-regional, regional or sub-regional (multi-State) basis.

Quality management

4.2.9 The meeting recalled that Amendment 72 to Annex 3/Technical Regulations [C.3.1], applicable on 1 November 2001, introduced provisions concerning the quality management of meteorological service provided to users, including quality assurance and quality control aspects. The meeting further recalled that as part of Amendment 75, applicable on 15 November 2012, the requirement that the State establish and implement a properly organized quality system comprising procedures, processes and resources had been upgraded from a Recommended Practice to a Standard.

4.2.10 The meeting was pleased to note that since the Meteorology Divisional Meeting in 2002 (MET/02), both ICAO and WMO had undertaken concerted and often joint efforts to provide technical assistance to States/Members with respect to the implementation of a quality management system for aeronautical meteorological services. Such efforts had included the development of guidance material (notably the *Manual on the Quality Management System for the provision of Meteorological Service for International Air Navigation* (ICAO Doc 9873, WMO Publication No. 1001) and amendments thereto), the conducting of regional seminars and workshops, and the conducting of technical assistance missions to individual States. These efforts had been complemented by many State/Member collaborative initiatives, such as bilateral/twinning assistance between those States/Members that had already fully implemented a quality management system and those States/Members yet to fully implement. It was noted by the meeting that there would be a need to re-examine the existing ICAO and WMO guidance material on quality management in due course owing to the pending publication of the next version of the ISO 9001 Standard which was expected during 2015.

Aeronautical meteorological personnel competency

4.2.11 The meeting was aware that Annex 3/Technical Regulations [C.3.1] requires States/Members to ensure that the designated meteorological authority complies with the requirements of the WMO in respect of the qualifications and training of meteorological personnel providing service for international air navigation. Moreover, the requirements concerning the qualifications and training of meteorological personnel in aeronautical meteorology were given in WMO Publication No. 49, *Technical Regulations*, Volume I — *General Meteorological Standards and Recommended Practices*. The meeting was apprised that on 1 December 2013 WMO had introduced competency Standards with respect to aeronautical meteorological observers and aeronautical meteorological forecasters and that on 1 December 2016 WMO would further require that aeronautical meteorological forecasters successfully complete those elements of the Basic Instruction Package – Meteorology (BIP-M) necessary to support the competency requirements for their assigned area and airspace of responsibility. Commensurate with these new and upcoming competency Standards, the meeting noted that WMO had undertaken a revision to its technical regulations, such that top-level Standards were contained in WMO-No. 49 and supplementary guidance material was available on a WMO CAeM training website[1].

4.2.12 The meeting acknowledged that the realization of the “One Sky” concept for international air navigation (discussed under Agenda Item 4) would inevitably result in changes to the way in which aeronautical meteorological information, products and other related services were prepared and provided

[1] http://www.caem.wmo.int/moodle/ (under ‘Regulatory and reference material’, log-in as a ‘guest’).

to users. There would likely be an increased reliance on automated production and delivery processes aligned with advances in technology and a more prominent role to be played by aeronautical meteorological personnel in the collaborative decision-making (CDM) process of aviation stakeholders (providers and users of services), ensuring human-in-the-loop interactions for the foreseeable future. Accordingly, the meeting noted that the specific functions of aeronautical meteorological personnel would likely evolve, and there would be a need to ensure that the competency and underpinning training of the personnel was sufficient to adapt to new working practices. The meeting formulated the following recommendation accordingly:

Recommendation 4/5 — Evolving competency of aeronautical meteorological personnel

That WMO in coordination with ICAO undertake steps to ensure that aeronautical meteorological personnel can, through the implementation of a competency framework based on quality management system principles and supported by relevant training material, adapt to new working practices arising from the realization of the "One Sky" concept for international air navigation.

Note.— Such new working practices may include a transition to automated production and delivery processes aligned with advances in technology (including digital information exchange) and a more prominent role in collaborative decision-making among aviation stakeholders (service providers and users).

English language proficiency

4.2.13 The meeting was aware that Annex 3/Technical Regulations [C.3.1], Chapter 9, requires meteorological information to be supplied to operators and flight crew members for the principle purposes of pre-flight planning and in-flight re-planning. Moreover, briefing and/or consultation is required to be provided, on request, to flight crew members and/or other flight operations personnel. The purpose of such briefings/consultations was to ensure that the recipients were supplied with the latest available information on existing and expected meteorological conditions along the route to be flown, at the aerodrome of intended landing, alternate aerodromes and other aerodromes as relevant. Furthermore, coordination activities were required between aeronautical meteorological personnel across national borders for example, between neighbouring meteorological watch offices, volcanic ash and tropical cyclone advisory centres (VAACs and TCACs) and world area forecast centres (WAFCs).

4.2.14 The meeting was also aware that Annex 3/Technical Regulations [C.3.1] does not establish requirements with respect to the language to be used by, or the language proficiency of aeronautical meteorological personnel where such coordination is involved.

4.2.15 The meeting noted that Annex 1 — *Personnel Licensing* makes clear that the requirement for training and qualifications for all aeronautical meteorological personnel is the responsibility of WMO (Chapter 4, 4.8 refers), and that this was in keeping with Annex 3 provisions (Chapter 2, 2.1.5) as well as the Working Arrangements. However, the meeting noted that while WMO has responsibility for the training of personnel on the fields of meteorology, hydrology and climatology, such a mandate for training in basic educational subjects such as languages did not fall within the scope of WMO responsibilities, since such educational requirements were the responsibility of secondary and tertiary education systems of States/Members. The meeting was apprised that top-level competency requirements of aeronautical meteorological forecasters included the need for such personnel to be able to "communicate effectively" with users in their area of responsibility. For personnel providing the required

oral briefing to flight crew members and coordination between meteorological offices in different States, it was considered that knowledge of English would be essential so as to mitigate the risk of critical misunderstandings caused by language problems that may, downstream, have flight safety implications.

4.2.16 Taking into account the language proficiency requirements/ratings that exist for those personnel engaged in radiotelephony communications in Annex 1, the existing competency requirements established by WMO for aeronautical meteorological personnel (WMO No 49, Vol. 1, Part 2), and appreciating that as collaborative decision making (CDM) among aviation stakeholders plays a more prominent role in how air navigation service providers (including meteorology) and users interact, the meeting agreed that there was a need to consider the development of provisions concerning English language proficiency for those aeronautical meteorological personnel providing briefings and/or consultations to flight crew members as well as coordination between meteorological offices in different States. The meeting also noted that, since this would involve a relatively small number of personnel and that in many States face-to-face briefing would tend to be replaced by more automated methods, any requirements for language proficiency should be at the discretion of the State concerned. The meeting formulated the following recommendation accordingly:

Recommendation 4/6 — English language proficiency of aeronautical meteorological personnel

That ICAO, in close coordination with WMO, consider the development of provisions concerning the required level of English language proficiency of aeronautical meteorological personnel to be applied at the discretion of the State.

Note.— The development of such provisions would be intended to mitigate the risk of misunderstandings between the aeronautical meteorological service provider and the user that may impact the level of weather-related situational awareness and flight safety, as well as promote inter-State coordination, as needed.

The provision and use of aeronautical meteorological information for aeronautical purposes only

4.2.17 The meeting was aware that the ICAO *Manual of Aeronautical Meteorological Practice* (Doc 8896), Appendix 10, provides guidelines for access to aeronautical meteorological information[2] and that, in this regard, the telecommunications facilities to be used for the international exchange of OPMET information should be the ICAO aeronautical fixed service (AFS), in accordance with Annex 3/Technical Regulations [C.3.1] and Parts IV and VI of the ICAO regional air navigation plans. The meeting noted that, through the use of the AFS to exchange OPMET information, States/Members meet their obligation under Article 28 of the Convention on International Civil Aviation (Chicago, 1944) (Doc 7300) regarding the supply to users of aeronautical meteorological information for the provision of meteorological service for international air navigation. In addition, the recovery of the associated costs by States/Members through charges on international civil aviation should be based on the principles contained in Article 15 of the Chicago Convention and in Doc 9082.

4.2.18 The meeting was further aware that the Twelfth World Meteorological Congress (Cg XII) of WMO formulated Resolution 40 — *WMO policy and practice for the exchange of meteorological and*

[2] Aeronautical meteorological information in this context consists of OPMET information (including tropical cyclone advisories, volcanic ash advisories, METAR, SPECI, special air-reports, TAF, GAMET area forecasts, and SIGMET and AIRMET information) and WAFS forecasts.

related data and products including guidelines on relationships in commercial meteorological activities[3] and that, in this regard, Annex IV to Resolution 40 makes clear in the context of meteorological and related data and products that "aeronautical information generated specifically to serve the needs of aviation and controlled under the Convention on International Civil Aviation (Chicago, 1944) is *not included* in the application of the practice". The meeting affirmed therefore that aeronautical information, of which aeronautical meteorological information prescribed by Annex 3/Technical Regulations [C.3.1] is a component[4,] cannot be considered as basic meteorological data nor used for non-aeronautical purposes.

4.2.19 Taking the referred ICAO provisions and WMO resolution into account, and appreciating that the cost for the provision of aeronautical meteorological service was entirely recoverable from aviation (through air navigation charges), the meeting agreed that there was a need to remind States/Members of their obligations in respect of the provision and use of aeronautical meteorological information. The meeting formulated the following recommendation accordingly:

Recommendation 4/7 — Provision and use of aeronautical meteorological information for aeronautical purposes only

That ICAO and WMO remind States and Members respectively of their obligations in respect of the provision and use of aeronautical meteorological information for aeronautical purposes only.

Note.— Aeronautical meteorological information in this context consists of OPMET information and WAFS forecasts.

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[3] http://www.wmo.int/pages/about/Resolution40_en.html

[4] Excluding air-reports received at world area forecast centres (WAFCs) which shall be further disseminated as basic meteorological data in accordance with Annex 3/Technical Regulations [C.3.1], Appendix 4, 3.2.

Agenda Item 5: Standards, Recommended Practices and Procedures
5.1: Amendment 77 to Annex 3/Technical Regulations [C.3.1]

5.1.1 The meeting undertook a review of a consolidated proposal for amendment of Annex 3— *Meteorological Service for International Air Navigation*/Technical Regulations [C.3.1]. The meeting noted that the sources of the proposed amendments had been the International Airways Volcano Watch Operations Group (IAVWOPSG), the World Area Forecast System Operations Group (WAFSOPSG), the Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG), the Meteorological Warnings Study Group (METWSG), the Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE-PT) and the Secretariat.

5.1.2 The meeting recalled discussions under Agenda Item 2.2 concerning space weather, for which it was noted that the roles, requirements and capabilities of global and regional centres had not been fully elaborated. The meeting had therefore agreed to *not include* draft initial provisions for space weather in the draft Amendment 77 to Annex 3/Technical Regulations [C.3.1].

5.1.3 In respect of the provision of world area forecast system (WAFS) upper-air gridded forecasts and, more specifically, the grid point forecasts prepared by a world area forecast centres (WAFCs), the meeting agreed to a request made by the International Air Transport Association (IATA) to include a requirement for humidity data for flight level 80 (750 hPa) in the draft Amendment 77 to Annex 3/Technical Regulations [C.3.1].

5.1.4 The meeting was informed of a potential cost impact, with no operational benefits, of the switch to the "00" midnight notation in TAF. A view was expressed to wait for the implementation of IWXXM which uses this notation from the outset. It was noted that the switch from "24" notation to "00" notation had been proposed in order to ensure that Annex 3/Technical Regulations [C.3.1] provisions were consistent with provisions in Annex 5 — *Units of Measurement to be Used in Air and Ground Operations,* Attachment E.

5.1.5 Having completed its review, including taking into account the foregoing, the meeting agreed that the proposed amendment to Annex 3/Technical Regulations [C.3.1] should serve as the basis for Amendment 77. The meeting noted the need for consequential amendments to Annex 11 — *Air Traffic Services*, the *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400) and the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444).The meeting formulated the following recommendation;

RSPP

Recommendation 5/1 — Amendment 77 to Annex 3/Technical Regulations [C.3.1] and consequential amendments to Annex 11, PANS-ABC and PANS-ATM

That:

a) the proposal given in Appendix A be included as part of draft Amendment 77 to Annex 3 — *Meteorological Service for International Air Navigation*/Technical Regulations [C.3.1]; and

b) the consequential amendments to Annex 11, the PANS-ABC and the PANS-ATM, given in Appendices B, C and D respectively, be consolidated with other proposals for amendment of these documents.

Agenda Item 5: Standards, Recommended Practices and Procedures

5.2: Proposed *Procedures for Air Navigation Services — Meteorology* (PANS-MET, Doc xxxx), First Edition (not later than 2019)

5.2.1 The meeting recalled that under Agenda Item 1 it had initialized consideration of the need for a restructuring of Annex 3/Technical Regulations [C.3.1] and the development of a new *Procedures for Air Navigation Services — Meteorology* (PANS-MET) in the spirit of Resolution A38-11 of the 38th Session of the ICAO Assembly. The meeting agreed that Annex 3/Technical Regulations [C.3.1] and a PANS-MET should clearly identify the following:

a) State obligations;

b) service provider obligations; and

c) technical requirements for the service.

And, moreover, that Annex 3/Technical Regulations [C.3.1] should specify service requirements whilst PANS-MET should specify the means of complying with the service requirements.

5.2.2 When considering a restructuring of Annex 3/Technical Regulations [C.3.1] and the development of a new PANS-MET, the meeting recognized that every functional and performance requirement and technical specification contained in Annex 3/Technical Regulations [C.3.1] would need to be assessed in order to determine whether a particular provision was retained or instead transferred to a PANS-MET. In addition, the meeting agreed that a roadmap should be developed by ICAO to support such provisions developments. The meeting was also cognizant of the need to ensure that the developments respect the rights and obligations of States contained in the *Convention on International Civil Aviation* (Doc 7300).

5.2.3 The meeting noted that the PANS did not have the same status as the Standards and Recommended Practices contained in the Annexes. While the latter were adopted by Council in pursuance of Article 37 of the Chicago Convention, subject to the full procedure of Article 90, the PANS were approved by the Council and recommended to Contracting States for worldwide application. The PANS therefore did not come within the obligation imposed by Article 38 of the Convention to notify differences in the event of non-implementation. Nevertheless, the attention of the meeting was drawn to the provision of Annex 15 — *Aeronautical Information Services* related to the publication in their Aeronautical Information Publications (State AIPs) of lists of significant differences between their procedures and the related ICAO procedures. The meeting further noted that, as with Annexes and Regional Air Navigation Plans, those aeronautical meteorological services which serve to meet the aeronautical requirements stated in a PANS are subject to cost recovery through air navigation charges.

5.2.4 In view of the significant work that would be required to restructure Annex 3/Technical Regulations [C.3.1] and concurrently develop a first edition of a PANS-MET, the meeting considered it prudent to undertake such work as part of Amendment 78 to Annex 3/Technical Regulations [C.3.1], the adoption (or applicability) of which should respect Block 1 of the aviation system block upgrades (ASBU) methodology contained in the *Global Air Navigation Plan* (GANP) (Doc 9750). This would allow Amendment 77 to Annex 3/Technical Regulations [C.3.1], as discussed at 5.1 above, to proceed in the meantime.

5.2.5 Noting the expressed need for functional and performance requirements elaborated by technical specifications (i.e. means of compliance) in the restructured Annex 3/Technical Regulations [C.3.1] and new PANS-MET, the meeting agreed that it was advisable to not be prescriptive at this stage insofar as the exact content and structure of the provisions were concerned. Recalling earlier discussions

under Agenda Item 2, the meeting noted that meteorological service for the terminal area and arrangements for the regional hazardous weather advisory centres would be important aspects that would need to be included in the restructured Annex 3/Technical Regulations [C.3.1] and new PANS-MET. In addition, the meeting noted a need to ensure the proper positioning (in the Annex and/or the PANS) of requirements addressing the accuracy and quality of aeronautical meteorological observations.

5.2.6 In view of the foregoing, the meeting formulated the following recommendation accordingly:

Recommendation 5/2 — Reorganization of provisions relating to aeronautical meteorology

That ICAO in close coordination with WMO undertake:

a) a restructuring of Annex 3/Technical Regulations [C.3.1] as part of Amendment 78; and

b) the development of *a Procedures for Air Navigation Services — Meteorology* (PANS-MET, Doc xxxx) so that a first edition be available concurrent with Amendment 78 referenced in a) above

based on a roadmap (to be developed and published by ICAO) and the principles contained in Appendix E.

Agenda Item 5: Standards, Recommended Practices and Procedures
5.3: Consequential amendments, if any, to other Annexes or PANS

5.3.1 The meeting noted that consequential amendments to other Annexes and PANS arising from the proposed amendment (Amendment 77) to Annex 3/Technical Regulations [C.3.1] had been addressed at 5.1.5 above and the associated Recommendation 5/1.

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NOTES ON THE PRESENTATION OF THE PROPOSED AMENDMENTS

1. The text of the proposed amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading as shown below:

~~text to be deleted is shown with a line through it~~	text to be deleted
new text to be inserted is highlighted with grey shading	new text to be inserted
~~text to be deleted is shown with a line through it~~ followed by the new text which is highlighted with grey shading	new text to replace existing text

2. The sources of the proposed amendments have been indicated as follows:

Source	Annotation
International Airways Volcano Watch Operations Group (IAVWOPSG)	IAVWOPSG
World Area Forecast System Operations Group (WAFSOPSG)	WAFSOPSG
Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG)	AMOFSG
Meteorological Warnings Study Group (METWSG)	METWSG
Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE-PT)	MARIE-PT
Meteorology Divisional Meeting (2014)	MET/14
Secretariat	Secretariat

APPENDIX A

PROPOSED AMENDMENT TO

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

METEOROLOGICAL SERVICE FOR INTERNATIONAL AIR NAVIGATION

ANNEX 3 TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

EIGHTEENTH EDITION — JULY 2013

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CHAPTER 1. DEFINITIONS

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1.1 Definitions

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METWSG

~~***Automatic dependent surveillance (ADS).*** A surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position and additional data as appropriate.~~

Automatic dependent surveillance — contract (ADS-C). A means by which the terms of an ADS-C agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under what conditions ADS-C reports would be initiated, and what data would be contained in the reports.

Note.— The abbreviated term "ADS contract" is commonly used to refer to ADS event contract, ADS demand contract, ADS periodic contract or an emergency mode.

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AMOFSG

Meteorological watch office. An office designated to provide information concerning the occurrence or expected occurrence of specified en-route weather and other phenomena in the atmosphere that may affect the safety of aircraft operations within its specified area of responsibility.

. . .

SIGMET information. Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather ~~phenomena which~~ and other phenomena in the atmosphere that may affect the safety of aircraft operations.

. . .

Secretariat

State volcano observatory. A volcano observatory, designated by regional air navigation agreement, to monitor active or potentially active volcanoes within their State and to provide information on volcanic activity to their associated area control centre/flight information centre, meteorological watch office and volcanic ash advisory centre.

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WAFSOPSG

World area forecast centre (WAFC). A meteorological centre designated to prepare and issue significant weather forecasts and upper-air forecasts in digital form on a global basis direct to States ~~by appropriate means as part of~~ using the aeronautical fixed service satellite distribution system and the Internet-based services.

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CHAPTER 2. GENERAL PROVISIONS

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2.1 Objective, determination and provision of meteorological service

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AMOFSG

2.1.3 Each Contracting State shall determine the meteorological service which it will provide to meet the needs of international air navigation. This determination shall be made in accordance with the provisions of this Annex and ~~with due regard to~~ in accordance with regional air navigation agreements; it shall include the determination of the meteorological service to be provided for international air navigation over international waters and other areas which lie outside the territory of the State concerned.

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METWSG

2.2 Supply, use, ~~and~~ quality management and interpretation of meteorological information

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AMOFSG

~~2.2.6 **Recommendation.** — *Demonstration of compliance of the quality system applied should be by audit. If non- conformity of the system is identified, action should be initiated to determine and correct the cause. All audit observations should be evidenced and properly documented.*~~

2.2.6 Demonstration of compliance of the quality system applied shall be by audit. If non-conformity of the system is identified, action shall be initiated to determine and correct the cause. All audit observations shall be evidenced and properly documented.

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METWSG

Editorial Note.— Insert the following new text.

2.2.7 Owing to the variability of meteorological elements in space and time, to limitations of observing techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a report shall be understood by the recipient to be the best approximation to the actual conditions at the time of observation.

Note.— Guidance on the operationally desirable accuracy of measurement or observation is given in Attachment A.

2.2.8 Owing to the variability of meteorological elements in space and time, to limitations of forecasting techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a forecast shall be understood by the recipient to be the most probable value which the element is likely to assume during the period of the forecast. Similarly, when the time of occurrence or change of an element is given in a forecast, this time shall be understood to be the most probable time.

Note.— Guidance on the operationally desirable accuracy of forecasts is given in Attachment B.

End of new text.

2.2.~~7~~9 The meteorological information supplied to the users listed in 2.1.2 shall be consistent with Human Factors principles and shall be in forms which require a minimum of interpretation by these users, as specified in the following chapters.

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2.3 Notifications required from operators

AMOFSG

2.3.1 An operator requiring meteorological service or changes in existing meteorological service shall notify, sufficiently in advance, the meteorological authority or the aerodrome meteorological office concerned. The minimum amount of advance notice required shall be as agreed between the meteorological authority or aerodrome meteorological office and the operator concerned.

. . .

2.3.4 **Recommendation.—** *The notification to the aerodrome meteorological office of individual flights should contain the following information except that, in the case of scheduled flights, the requirement for some or all of this information may be waived ~~by agreement~~ as agreed between the aerodrome meteorological office and the operator concerned.*

. . .

CHAPTER 3. WORLD AREA FORECAST SYSTEM AND METEOROLOGICAL OFFICES

. . .

3.4 Meteorological watch offices

3.4.1 A Contracting State, having accepted the responsibility for providing air traffic services within a flight information region or a control area, shall establish, ~~on the basis of~~ in accordance with regional air navigation agreement, one or more meteorological watch offices, or arrange for another Contracting State to do so.

. . .

Secretariat

3.4.2 A meteorological watch office shall:

. . .

Note.— The information is provided by WMO regional specialized meteorological centres (RSMC) for the provision of transport model products for radiological environmental emergency response, at the request of the delegated authority of the State in which the radioactive material was released into the atmosphere, or the International Atomic Energy Agency (IAEA). The information is sent by the RSMC to a single contact point of the national meteorological service in each State. This contact point has the responsibility of redistributing the RSMC products within the State concerned. Furthermore, the information is provided by IAEA to RSMC co-located with VAAC London (designated as the focal point) which in turn notifies the ACCs/FICs concerned about the release.

. . .

3.5 Volcanic ash advisory centres

AMOFSG

3.5.1 A Contracting State, having accepted~~, by regional air navigation agreement,~~ the responsibility for providing a VAAC within the framework of the international airways volcano watch and as designated by regional air navigation agreement, shall arrange for that centre to respond to a notification that a volcano has erupted, or is expected to erupt or volcanic ash is reported in its area of responsibility, by arranging for that centre to:

IAVWOPSG

a) monitor relevant geostationary and polar-orbiting satellite data and, where available, relevant ground-based and airborne data, to detect the existence and extent of volcanic ash in the atmosphere in the area concerned;

Note.— Relevant ground-based and airborne data includes data derived from Doppler weather radar, ceilometers, lidar and passive infrared sensors.

. . .

WAFSOPSG

c) issue advisory information regarding the extent and forecast movement of the volcanic ash "cloud" to:

. . .

3) world area forecast centres, international OPMET databanks, international NOTAM offices, and centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services; and

. . .

IAVWOPSG

d) issue updated advisory information to the meteorological watch offices, area control centres, flight information centres and VAACs referred to in c), as necessary, but at least every six hours until such time as the volcanic ash "cloud" is no longer identifiable from satellite data and, where available, ground-based and airborne data, no further reports of volcanic ash are received from the area, and no further eruptions of the volcano are reported.

. . .

3.6 State volcano observatories

Contracting States with active or potentially active volcanoes shall arrange that selected State volcano observatories, as designated by regional air navigation agreement, monitor these volcanoes and when observing:

. . .

shall send this information as quickly as practicable to their associated ACC/FIC, MWO and VAAC.

. . .

3.7 Tropical cyclone advisory centres

AMOFSG

A Contracting State having accepted~~, by regional air navigation agreement,~~ the responsibility for providing a TCAC and as designated by regional air navigation agreement shall arrange for that centre to:

. . .

WAFSOPSG

b) issue advisory information concerning the position of the cyclone centre, its direction and speed of movement, central pressure and maximum surface wind near the centre, in abbreviated plain language to:

. . .

3) world area forecast centres, international OPMET databanks, and centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services; and

. . .

_____

CHAPTER 4. METEOROLOGICAL OBSERVATIONS AND REPORTS

Note.— Technical specifications and detailed criteria related to this chapter are given in Appendix 3.

4.1 Aeronautical meteorological stations and observations

. . .

METWSG

~~4.1.9 Owing to the variability of meteorological elements in space and time, to limitations of observing techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a report shall be understood by the recipient to be the best approximation to the actual conditions at the time of observation.~~

~~*Note.— Guidance on the operationally desirable accuracy of measurement or observation is given in Attachment A.*~~

. . .

4.3 Routine observations and reports

AMOFSG

4.3.1 At aerodromes, routine observations shall be made throughout the 24 hours each day, ~~except as~~ unless otherwise agreed between the meteorological authority, the appropriate ATS authority and the operator concerned. Such observations shall be made at intervals of one hour or, if so determined by regional air navigation agreement, at intervals of one half-hour. At other aeronautical meteorological stations, such observations shall be made as determined by the meteorological authority taking into account the requirements of air traffic services units and aircraft operations.

. . .

CHAPTER 5. AIRCRAFT OBSERVATIONS AND REPORTS

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5.3 Routine aircraft observations — designation

METWSG

5.3.1 **Recommendation.**— *When air-ground data link is used and automatic dependent surveillance — contract (ADS-C) or secondary surveillance radar (SSR) Mode S is being applied, automated routine observations should be made every 15 minutes during the en-route phase and every 30 seconds during the climb-out phase for the first 10 minutes of the flight.*

. . .

AMOFSG

5.3.3 In the case of air routes with high-density air traffic (e.g. organized tracks), an aircraft from among the aircraft operating at each flight level shall be designated, at approximately hourly intervals, to make routine observations in accordance with 5.3.1. The designation procedures shall be ~~subject to~~ in accordance with regional air navigation agreement.

. . .

5.8 Relay of air-reports by air traffic services units

The meteorological authority concerned shall make arrangements with the appropriate ATS authority to ensure that, on receipt by the air traffic services units of:

. . .

METWSG

b) routine and special air-reports by data link communications, the air traffic services units relay them without delay to their associated meteorological watch office ~~and~~, the WAFCs, and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution system and the Internet-based services.

. . .

CHAPTER 6. FORECASTS

Note.— Technical specifications and detailed criteria related to this chapter are given in Appendix 5.

6.1 ~~Interpretation and u~~Use of forecasts

~~6.1.1 Owing to the variability of meteorological elements in space and time, to limitations of forecasting techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a forecast shall be understood by the recipient to be the most probable value which the element is likely to assume during the period of the forecast. Similarly, when the time of occurrence or change of an element is given in a forecast, this time shall be understood to be the most probable time.~~

~~*Note.— Guidance on the operationally desirable accuracy of forecasts is given in Attachment B.*~~

~~6.1.2~~ The issue of a new forecast by an aerodrome meteorological office, such as a routine aerodrome forecast, shall be understood to cancel automatically any forecast of the same type previously issued for the same place and for the same period of validity or part thereof.

6.2 Aerodrome forecasts

AMOFSG

6.2.1 An aerodrome forecast shall be prepared, ~~on the basis of~~ in accordance with regional air navigation agreement, by the aerodrome meteorological office designated by the meteorological authority concerned.

. . .

6.4 Forecasts for take-off

6.4.1 A forecast for take-off shall be prepared by the aerodrome meteorological office designated by the meteorological authority concerned ~~if required by agreement~~ as agreed between the meteorological authority and operators concerned.

. . .

6.5 Area forecasts for low-level flights

. . .

6.5.2 When the density of traffic operating below flight level 100 warrants the issuance of AIRMET information in accordance with 7.2.1, area forecasts for such operations shall be prepared in a format as agreed ~~upon~~ between the meteorological authorities concerned. When abbreviated plain language is used, the forecast shall be prepared as a GAMET area forecast, employing approved ICAO abbreviations and numerical values; when chart form is used, the forecast shall be prepared as a combination of forecasts of upper wind and upper-air temperature, and of SIGWX phenomena. The area forecasts shall be issued to cover the layer between the ground and flight level 100 (or up to flight level 150 in mountainous areas, or higher, where necessary) and shall contain information on en-route weather phenomena hazardous to low-level flights, in support of the issuance of AIRMET information, and additional information required by low-level flights.

. . .

CHAPTER 7. SIGMET AND AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS AND ALERTS

Note.— Technical specifications and detailed criteria related to this chapter are given in Appendix 6.

7.1 SIGMET information

AMOFSG

7.1.1 SIGMET information shall be issued by a meteorological watch office and shall give a concise description in abbreviated plain language concerning the occurrence and/or expected occurrence of specified en-route weather ~~phenomena, which~~ and other phenomena in the atmosphere that may affect the safety of aircraft operations, and of the development of those phenomena in time and space.

. . .

CHAPTER 8. AERONAUTICAL CLIMATOLOGICAL INFORMATION

Note.— Technical specifications and detailed criteria related to this chapter are given in Appendix 7.

8.1 General provisions

Note.— In cases where it is impracticable to meet the requirements for aeronautical climatological information on a national basis, the collection, processing and storage of observational data may be effected through computer facilities available for international use, and the responsibility for the preparation of the required aeronautical climatological information may be delegated ~~by agreement~~ as agreed between the meteorological authorities concerned.

8.1.1 Aeronautical climatological information required for the planning of flight operations shall be prepared in the form of aerodrome climatological tables and aerodrome climatological summaries. Such information shall be supplied to aeronautical users as agreed between the meteorological authority and ~~those~~ the users concerned.

. . .

8.2 Aerodrome climatological tables

Recommendation.— *Each Contracting State should make arrangements for collecting and retaining the necessary observational data and have the capability:*

. . .

b) to make available such climatological tables to an aeronautical user within a time period as agreed between the meteorological authority and ~~that~~ the user concerned.

. . .

CHAPTER 9. SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

Note.— Technical specifications and detailed criteria related to this chapter are given in Appendix 8.

9.1 General provisions

. . .

9.1.3 Meteorological information supplied to operators and flight crew members shall be up to date and include the following information, as ~~established by~~ agreed between the meteorological authority ~~in consultation with~~ and the operators concerned:

. . .

g) ~~subject to~~ as determined by regional air navigation agreement, GAMET area forecast and/or area forecasts for low-level flights in chart form prepared in support of the issuance of AIRMET information, and AIRMET information for low-level flights relevant to the whole route;

. . .

9.1.10 Meteorological information shall be supplied to operators and flight crew members at the location to be determined by the meteorological authority, after consultation with the operators and at the time ~~to be~~ agreed ~~upon~~ between the aerodrome meteorological office and the operator concerned. The service for pre-flight planning shall be confined to flights originating within the territory of the State concerned. At an aerodrome without an aerodrome meteorological office at the aerodrome, arrangements for the supply of meteorological information shall be as agreed ~~upon~~ between the meteorological authority and the operator concerned.

. . .

9.2 Briefing, consultation and display

Note.— The requirements for the use of automated pre-flight information systems in providing briefing, consultation and display are given in 9.4.

9.2.1 Briefing and/or consultation shall be provided, on request, to flight crew members and/or other flight operations personnel. Its purpose shall be to supply the latest available information on existing and expected meteorological conditions along the route to be flown, at the aerodrome of intended landing, alternate aerodromes and other aerodromes as relevant, either to explain and amplify the information contained in the flight documentation or, ~~if so~~ as agreed between the meteorological authority and the operator, in lieu of flight documentation.

. . .

9.2.4 The required briefing, consultation, display and/or flight documentation shall normally be provided by the aerodrome meteorological office associated with the aerodrome of departure. At an aerodrome where these services are not available, arrangements to meet the requirements of flight crew members shall be as agreed ~~upon~~ between the meteorological authority and the operator concerned. In exceptional circumstances, such as an undue delay, the aerodrome meteorological office associated with

the aerodrome shall provide or, if that is not practicable, arrange for the provision of a new briefing, consultation and/or flight documentation as necessary.

9.2.5 **Recommendation.—** *The flight crew member or other flight operations personnel for whom briefing, consultation and/or flight documentation has been requested should visit the aerodrome meteorological office at the time agreed ~~upon~~ between the aerodrome meteorological office and the operator concerned. Where local circumstances at an aerodrome make personal briefing or consultation impracticable, the aerodrome meteorological office should provide those services by telephone or other suitable telecommunications facilities.*

9.3 Flight documentation

Note.— The requirements for the use of automated pre-flight information systems in providing flight documentation are given in 9.4.

AMOFSG & IAVWOPSG

9.3.1 Flight documentation to be made available shall comprise information listed under 9.1.3 a) 1) and 6), b), c), e), f) and, if appropriate, g). However, ~~when agreed between the meteorological authority and operator concerned,~~ flight documentation for flights of two hours' duration or less, after a short stop or turnaround, shall be limited to the information operationally needed, as agreed between the meteorological authority and operator concerned, but in all cases the flight documentation shall at least comprise information on 9.1.3 b), c), e), f) and, if appropriate, g).

. . .

9.4 Automated pre-flight information systems for briefing, consultation, flight planning and flight documentation

. . .

AMOFSG

9.4.2 **Recommendation.—** *Automated pre-flight information systems providing for a harmonized, common point of access to meteorological information and aeronautical information services information by operators, flight crew members and other aeronautical personnel concerned should be ~~established by an agreement~~ as agreed between the meteorological authority and the ~~relevant~~ appropriate civil aviation authority or the agency to which the authority to provide service has been delegated in accordance with Annex 15, 2.1.1 c).*

. . .

———————

CHAPTER 11. REQUIREMENTS FOR AND USE OF COMMUNICATIONS

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11.1 Requirements for communications

11.1.7 **Recommendation.—** *As agreed between the meteorological authority and the operators concerned, provision should be made to enable operators to establish suitable telecommunications facilities for obtaining meteorological information from aerodrome meteorological offices or other appropriate sources.*

. . .

11.1.9 **Recommendation.—** *The telecommunications facilities used for the exchange of operational meteorological information should be the aeronautical fixed service or, for the exchange of non-time critical operational meteorological information, the public Internet, subject to availability, satisfactory operation and bilateral/multilateral and/or regional air navigation agreements.*

WAFSOPSG

Note 1.— ~~Three~~ One aeronautical fixed service satellite distribution ~~systems~~ system and two Internet-based services providing for global coverage are used to support the global exchanges of operational meteorological information. Provisions relating to the satellite distribution ~~systems~~ system are given in Annex 10, Volume III, Part 1, 10.1 and 10.2.

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PART II

APPENDICES AND ATTACHMENTS

. . .

APPENDIX 2. TECHNICAL SPECIFICATIONS RELATED TO WORLD AREA FORECAST SYSTEM AND METEOROLOGICAL OFFICES

(See Chapter 3 of this Annex.)

1. WORLD AREA FORECAST SYSTEM

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1.2 Upper-air gridded forecasts

WAFSOPSG

1.2.2 The grid point forecasts prepared by a WAFC shall comprise:

a) wind and temperature data for flight levels 50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 210 (450 hPa), 240 (400 hPa), 270 (350 hPa), 300 (300 hPa), 320 (275 hPa), 340 (250 hPa), 360 (225 hPa), 390 (200 hPa), 410 (175 hPa), 450 (150 hPa), 480 (125 hPa) and 530 (100 hPa);

. . .

MET/14

d) humidity data for flight levels 50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa) and 180 (500 hPa);

. . .

WAFSOPSG

i) geopotential altitude data for flight levels 50 (850 hPa), 80 (750 hPa), 100 (700 hPa), 140 (600 hPa), 180 (500 hPa), 210 (450 hPa), 240 (400 hPa), 270 (350 hPa), 300 (300 hPa), 320 (275 hPa), 340 (250 hPa), 360 (225 hPa), 390 (200 hPa), 410 (175 hPa), 450 (150 hPa), 480 (125 hPa) and 530 (100 hPa).

. . .

3. VOLCANIC ASH ADVISORY CENTRES (VAAC)

3.1 Volcanic ash advisory information

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IAVWOPSG

~~3.1.2 The volcanic ash advisory information listed in Table A2-1, when prepared in graphical format, shall be as specified in Appendix 1 and issued using:~~

~~a) the portable network graphics (PNG) format; or~~

~~b) the BUFR code form, when exchanged in binary format.~~

~~*Note.— The BUFR code form is contained in WMO Publication No. 306,* Manual on Codes*, Volume I.2, Part B — Binary Codes.*~~

IAVWOPSG &
MARIE-PT

Editorial note.— Insert the following new text.

3.1.2 **Recommendation.—** *Volcanic ash advisory centres should issue volcanic ash advisory information in digital form in addition the issuance of this advisory information in abbreviated plain language in accordance with 3.1.1.*

3.1.3 Volcanic ash advisory information, if disseminated in digital form shall be formatted in accordance with a globally interoperable information exchange model and shall use extensible markup language (XML)/geography markup language (GML).

3.1.4 Volcanic ash advisory information if disseminated in digital form shall be accompanied by the appropriate metadata.

Note.— Guidance on the information exchange model, XML/GML and the metadata profile is provided in the Manual on the Digital Exchange of Aeronautical Meteorological Information *(Doc 10003).*

3.1.5 The volcanic ash advisory information listed in Table A2-1, when prepared in graphical format, shall be as specified in Appendix 1 and issued using the portable network graphics (PNG) format.

End of new text.

4. STATE VOLCANO OBSERVATORIES

4.1 Information from State volcano observatories

IAVWOPSG & MET/14

Recommendation.— *The information required to be sent by State volcano observatories to their associated ACCs/FICs, MWO and VAAC should comprise:*

. . .

Note 2.— The State volcano observatories may use the Volcano Observatory Notice for Aviation (VONA) format to send information to ~~its~~ their associated ACCs/FICs, MWO and VAAC. The VONA format is included in the Handbook on the International Airways Volcano Watch (IAVW) — Operational Procedures and Contact List *(Doc 9766) which is available on the ICAO IAVWOPSG website.*

5. TROPICAL CYCLONE ADVISORY CENTRES (TCAC)

5.1 Tropical cyclone advisory information

. . .

MARIE-PT

~~5.1.3 **Recommendation.** *The tropical cyclone advisory information listed in Table A2-2, when prepared in graphical format, should be as specified in Appendix 1 and issued using:*~~

~~*a) the portable network graphics (PNG) format; or*~~

~~*b) the BUFR code form, when exchanged in binary format.*~~

~~*Note. — The BUFR code form is contained in WMO Publication No. 306,* Manual on Codes*, Volume I.2, Part B — Binary Codes.*~~

Editorial note.— Insert the following new text.

5.1.3 **Recommendation.—** *Tropical cyclone advisory centres should issue tropical cyclone advisory information in digital form in addition the issuance of this advisory information in abbreviated plain language in accordance with 5.1.2.*

5.1.4 Tropical cyclone advisory information, if disseminated in digital form shall be formatted in accordance with a globally interoperable information exchange model and shall use extensible markup language (XML)/geography markup language (GML).

5.1.5 Tropical cyclone advisory information if disseminated in digital form shall be accompanied by the appropriate metadata.

Note.— Guidance on the information exchange model, XML/GML and the metadata profile is provided in the Manual on the Digital Exchange of Aeronautical Meteorological Information *(Doc 10003).*

5.1.6 The tropical cyclone advisory information listed in Table A2-2, when prepared in graphical format, shall be as specified in Appendix 1 and issued using the portable network graphics (PNG) format.

End of new text.

. . .

APPENDIX 3. TECHNICAL SPECIFICATIONS RELATED TO METEOROLOGICAL OBSERVATIONS AND REPORTS

. . .

2. GENERAL CRITERIA RELATED TO METEOROLOGICAL REPORTS

2.1 Format of meteorological reports

. . .

MARIE-PT & MET/14

2.1.3 **Recommendation**.— *METAR and SPECI should be disseminated~~, under bilateral agreements between States in a position to do so~~, in digital form, in addition to the dissemination of the METAR and SPECI in accordance with 2.1.2.*

. . .

2.3 Criteria for issuance of local special reports and SPECI

. . .

2.3.3 **Recommendation.—** *Where required in accordance with Chapter 4, 4.4.2 b), SPECI should be issued whenever changes in accordance with the following criteria occur:*

. . .

AMOFSG

h) any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority and the operators concerned.

. . .

3. DISSEMINATION OF METEOROLOGICAL REPORTS

3.1 METAR and SPECI

WAFSOPSG

3.1.1 METAR and SPECI shall be disseminated to international OPMET databanks and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services, in accordance with regional air navigation agreement.

. . .

3.2 Local routine and special reports

. . .

AMOFSG

3.2.2 Local special reports shall be transmitted to local air traffic services units as soon as the specified conditions occur. However, ~~by agreement~~ as agreed between the meteorological authority and the appropriate ATS authority concerned, they need not be issued in respect of:

. . .

4. OBSERVING AND REPORTING OF METEOROLOGICAL ELEMENTS

. . .

4.3 Runway visual range

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4.3.5 Runway light intensity

Recommendation.— *When instrumented systems are used for the assessment of runway visual range, computations should be made separately for each available runway.* ~~*Runway visual range should not be computed for a light intensity of 3 per cent or less of the maximum light intensity available on a runway.*~~ *For local routine and special reports, the light intensity to be used for the computation should be:*

a) for a runway with the lights switched on and the light intensity of more than 3 per cent, the light intensity actually in use on that runway; ~~*and*~~

b) for a runway with the lights switched on and the light intensity of 3 per cent or less, the optimum light intensity that would be appropriate for operational use in the prevailing conditions; and

~~*b)*~~*c) for a runway with lights switched off (or at the lowest setting pending the resumption of operations), the optimum light intensity that would be appropriate for operational use in the prevailing conditions.*

. . .

4.4 Present weather

Secretariat

4.4.1 Siting

Recommendation.— *When instrumented systems are used for observing present weather phenomena listed under 4.4.2.3~~, 4.4.2.5 and 4.4.2.6,~~ and 4.4.2.4 representative information should be obtained by the use of sensors appropriately sited.*

. . .

4.4.2 Reporting

. . .

AMOFSG

4.4.2.7 **Recommendation.—** *In automated local routine and special reports and METAR and SPECI when showers (SH) referred to in 4.4.2.6 cannot be determined based upon a method that takes account of the presence of convective cloud, the precipitation should not be characterized by SH.*

4.4.2.~~7~~8 **Recommendation.—** *In local routine and special reports and in METAR and SPECI, the relevant intensity or, as appropriate, the proximity to the aerodrome of the reported present weather phenomena should be indicated as follows:*

	(local routine and special reports)	*(METAR and SPECI)*
Light	*FBL*	*—*
Moderate	*MOD*	*(no indication)*
Heavy	*HVY*	*+*

Used with types of present weather phenomena in accordance with the templates shown in Tables A3-1 and A3-2. Light intensity should be indicated only for precipitation.

Vicinity *VC*

— *Between approximately 8 and 16 km of the aerodrome reference point and used only in METAR and SPECI with present weather in accordance with the template shown in Table A3-2 when not reported under 4.4.2.5 and 4.4.2.6.*

Secretariat

4.4.2.~~8~~9 In local routine and special reports and in METAR and SPECI:

a) one or more, up to a maximum of three, of the present weather abbreviations given in 4.4.2.3~~,~~ ~~4.4.2.5~~ and 4.4.2.~~6~~4 shall be used, as necessary, together with an indication, where appropriate, of the characteristics given in 4.4.2.5 and 4.4.2.6 and intensity or proximity to the aerodrome given in 4.4.2.8, so as to convey a complete description of the present weather of significance to flight operations;

. . .

4.4.2.~~9~~10 **Recommendation.—** *In automated local routine and special reports and METAR and SPECI, the present weather should be replaced by "//" when the present weather cannot be observed by the automatic observing system due to a temporary failure of the system/sensor.*

4.5 Clouds

4.5.1 Siting

AMOFSG

Recommendation.— *When instrumented systems are used for the measurement of the cloud amount and the height of cloud base, representative observations should be obtained by the use of sensors appropriately sited. For local routine and special reports, in the case of aerodromes with precision approach runways, sensors for cloud amount and height of cloud base should be sited to give the best practicable indications of the cloud amount and height of cloud base ~~and cloud amount~~ at the ~~middle marker site of the instrument landing system or, at aerodromes where a middle marker beacon is not used, at a distance of~~ threshold of the runway in use. For that purpose, a sensor should be installed at a distance of less than ~~900 to~~ 1 200 m (~~3 000 to~~ 4 000 ft) ~~from~~ before the landing threshold ~~at the approach end of the runway~~.*

~~*Note.— Specifications concerning the middle marker site of an instrument landing system are given in Annex 10, Volume I, Chapter 3 and at Attachment C, Table C-5.*~~

. . .

4.5.4 Reporting

. . .

4.5.4.2 **Recommendation.**— *At aerodromes where low-visibility procedures are established for approach and landing, as agreed between the meteorological authority and the appropriate ATS authority concerned, in local routine and special reports the height of cloud base should be reported in steps of 15 m (50 ft) up to and including 90 m (300 ft) and in steps of 30 m (100 ft) between 90 m (300 ft) and 3 000 m (10 000 ft), and the vertical visibility in steps of 15 m (50 ft) up to and including 90 m (300 ft) and in steps of 30 m (100 ft) between 90 m (300 ft) and 600 m (2 000 ft). Any observed value which does not fit the reporting scale ~~shall~~ should be rounded down to the nearest lower step in the scale.*

. . .

4.7 Atmospheric pressure

. . .

4.7.3 Reporting

. . .

4.7.3.2 In local routine and special reports:

. . .

b) QFE shall be included if required by users or, ~~if so~~ as agreed ~~locally~~ between the meteorological authority, ~~and air traffic services~~ the ATS authorities and the operators concerned, on a regular basis;

. . .

AMOFSG & Secretariat

Table A3-1. Template for the local routine (MET REPORT) and local special (SPECIAL) reports

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, dependent on meteorological conditions;
O = inclusion optional.

Note 1.— The ranges and resolutions for the numerical elements included in the local routine and special reports are shown in Table A3-4 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400).*

Element as specified in Chapter 4	*Detailed content*	*Template(s)*			*Examples*
. . . **Secretariat**					
Present weather (C)[9, 10]	Intensity of present weather (C)[9]	FBL *or* MOD *or* HVY	—		
	Characteristics and type of present weather (C)[9,11]	DZ *or* RA *or* SN *or* SG *or* PL *or* DS *or* SS *or* FZDZ *or* FZUP[12] *or* FC[13] *or* FZRA *or* SHGR *or* SHGS *or* SHRA *or* SHSN *or* SHUP[12] *or* TSGR *or* TSGS *or* TSRA *or* TSSN *or* TSUP[12] *or* UP[12]	FG *or* BR *or* SA *or* DU *or* HZ *or* FU *or* VA *or* SQ *or* PO *or* ~~FC *or*~~ TS *or* BCFG *or* BLDU *or* BLSA *or* BLSN *or* DRDU *or* DRSA *or* DRSN *or* FZFG *or* MIFG *or* PRFG *or* //[12]	MOD RA HVY TSRA HVY DZ FBL SN HZ FG VA MIFG HVY TSRASN FBL SNRA FBL DZ FG HVY SHSN BLSN HVY TSUP //
. . . **AMOFSG**					
Supplementary information (C)[9]	Significant meteorological phenomena (C)[9]	CB *or* TS *or* MOD TURB *or* SEV TURB *or* WS *or* GR *or* SEV SQL *or* MOD ICE *or* SEV ICE *or* FZDZ *or* FZRA *or* SEV MTW *or* SS *or* DS *or* BLSN *or* FC[15]			FC IN APCH WS IN APCH 60M-WIND 360/13MPS WS RWY 12
	Location of the phenomena (C)[9]	IN APCH [n[n][n][n]M-WIND nnn/n[n]MPS] *or* IN CLIMB-OUT [n[n][n][n]M-WIND nnn/n[n]MPS] (IN APCH [n[n][n][n]FT-WIND nnn/n[n]KT] *or* IN CLIMB-OUT [n[n][n][n]FT-WIND nnn/n[n]KT]) *or* RWY nn[L] *or* RWY nn[C] *or* RWY nn[R]			
	Recent weather (C)[9, 10]	REFZDZ *or* REFZRA *or* REDZ *or* RE[SH]RA *or* ~~RERASN *or*~~ RE[SH]SN *or* RESG *or* RESHGR *or* RESHGS *or* REBLSN *or* RESS *or* REDS *or* RETSRA *or* RETSSN *or* RETSGR *or* RETSGS *or* REFC *or* REPL or REUP[12] *or* REFZUP[12] *or* RETSUP[12] *or* RESHUP[12] *or* REVA *or* RETS			REFZRA CB IN CLIMB-OUT RETSRA
. . .					

. . .

AMOFSG

Table A3-2. Template for METAR and SPECI

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, dependent on meteorological conditions or method of observation;
O = inclusion optional.

Note 1.— The ranges and resolutions for the numerical elements included in METAR and SPECI are shown in Table A3-5 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400).*

Element as specified in Chapter 4	*Detailed content*	*Template(s)*	*Examples*
…			
Supplementary information (C)	Recent weather (C)[2, 9]	REFZDZ *or* REFZRA *or* REDZ *or* RE[SH]RA *or* ~~RERASN *or*~~ RE[SH]SN *or* RESG *or* RESHGR *or* RESHGS *or* REBLSN *or* RESS *or* REDS *or* RETSRA *or* RETSSN *or* RETSGR *or* RETSGS *or* RETS *or* REFC *or* REVA *or* REPL *or* REUP[12] *or* REFZUP[12] *or* RETSUP[12] *or* RESHUP[12]	REFZRA RETSRA
…			

. . .

APPENDIX 4. TECHNICAL SPECIFICATIONS RELATED TO AIRCRAFT OBSERVATIONS AND REPORTS

(See Chapter 5 of this Annex.)

1. CONTENTS OF AIR-REPORTS

1.1 Routine air-reports by air-ground data link

METWSG

1.1.1 When air-ground data link is used and automatic dependent surveillance — contract (ADS-C) or SSR Mode S is being applied, the elements contained in routine air-reports shall be:

. . .

Note.— When ADS-C or SSR Mode S is being applied, the requirements of routine air-reports may be met by the combination of the basic ADS-C/SSR Mode S data block (data block 1) and the meteorological information data block (data block 2), available from ADS-C or SSR Mode S reports. The ADS-C message format is specified in the PANS-ATM (Doc 4444), 4.11.4 and Chapter 13 and the SSR Mode S

message format is specified in Annex 10, Volume III, Part I — Digital Data Communication Systems*, Chapter 5.*

. . .

1.1.2 When air-ground data link is used while ADS-C and SSR Mode S are not being applied, the elements contained in routine reports shall be:

Note.— When air-ground data link is used while ADS-C and SSR Mode S are not being applied, the requirements of routine air-reports may be met by the controller-pilot data link communication (CPDLC) application entitled "Position report". The details of this data link application are specified in the Manual of Air Traffic Services Data Link Applications *(Doc 9694) and in Annex 10, Volume III, Part I.*

. . .

3. EXCHANGE OF AIR-REPORTS

3.1 Responsibilities of the meteorological watch offices

3.1.1 The meteorological watch office shall transmit without delay the special air-reports received by voice communications to the WAFCs and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution system and the Internet-based services.

. . .

3.1.3 When a special air-report is received at the meteorological watch office but the forecaster considers that the phenomenon causing the report is not expected to persist and, therefore, does not warrant issuance of a SIGMET, the special air-report shall be disseminated in the same way that SIGMET messages are disseminated in accordance with Appendix 6, 1.2.1, i.e. to meteorological watch offices, WAFCs, and other meteorological offices in accordance with regional air navigation agreement.

METWSG
MARIE-PT

Note.— The format for special air-reports (uplink) is in Appendix 6, 1.1. The template used for special air-reports which are uplinked to aircraft in flight is in Appendix 6, Table ~~A6-1~~ A6-1B.

. . .

AMOFSG

3.3 Supplementary dissemination of air-reports

Recommendation.— *Where supplementary dissemination of air-reports is required to satisfy special aeronautical or meteorological requirements, such dissemination should be arranged and agreed between the meteorological authorities concerned.*

. . .

APPENDIX 5. TECHNICAL SPECIFICATIONS RELATED TO FORECASTS

(See Chapter 6 of this Annex.)

1. CRITERIA RELATED TO TAF

1.1 TAF format

. . .

MARIE-PT

1.1.2 **Recommendation**.— *TAF should be disseminated~~, under bilateral agreements between States in a position to do so~~, in digital form, in addition to the dissemination of the TAF in accordance with 1.1.1.*

. . .

1.2 Inclusion of meteorological elements in TAF

. . .

1.2.3 Weather phenomena

One or more, up to a maximum of three, of the following weather phenomena or combinations thereof, together with their characteristics and, where appropriate, intensity, shall be forecast if they are expected to occur at the aerodrome:

. . .

AMOFSG

— other weather phenomena given in Appendix 3, 4.4.2.3, as agreed ~~by~~ between the meteorological authority with the ATS authority and operators concerned.

. . .

1.3 Use of change groups

. . .

1.3.2 **Recommendation.**— *The criteria used for the inclusion of change groups in TAF or for the amendment of TAF should be based on the following:*

. . .

j) any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority and the operators concerned.

. . .

WAFSOPSG

1.6 Dissemination of TAF

TAF and amendments thereto shall be disseminated to international OPMET databanks and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services, in accordance with regional air navigation agreement.

. . .

Table A5-1. Template for TAF

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, dependent on meteorological conditions or method of observation;
O = inclusion optional.

Note 1.— The ranges and resolutions for the numerical elements included in TAF are shown in Table A5-4 of this appendix.

Note 2.— The explanations for the abbreviations can be found in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(PANS-ABC, Doc 8400).*

AMOFSG

Element as specified in Chapter 6	*Detailed content*	*Template(s)*	*Examples*
. . .			
Days and period of validity of forecast (M)	Days and period of the validity of the forecast in UTC (M)	nnnn/nnnn	1606/~~16~~24~~1~~700 0812/0918
. . .			

. . .

METWSG

Table A5-3. Template for GAMET

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, dependent on meteorological conditions;
O = inclusion optional;
= = a double line indicates that the text following it should be placed on the subsequent line.

Element	*Detailed content*	*Template(s)*	*Examples*

Element	*Detailed content*	*Template(s)*	*Examples*
Location indicator of FIR/CTA (M)	ICAO location indicator of the ATS unit serving the FIR or CTA to which the GAMET refers (M)	nnnn	YUCC[1]
Identification (M)	Message identification (M)	GAMET	GAMET
Validity period (M)	Day-time groups indicating the period of validity in UTC (M)	VALID nnnnnn/nnnnnn	VALID 220600/221200
Location indicator of aerodrome meteorological office or meteorological watch office (M)	Location indicator of aerodrome meteorological office or meteorological watch office originating the message with a separating hyphen (M)	nnnn–	YUDO–[1]
Name of the FIR/CTA *or* part thereof (M)	Location indicator and name of the FIR/CTA, *or* part thereof for which the GAMET is issued (M)	nnnn nnnnnnnnnn FIR[/n] [BLW FLnnn] *or* nnnn nnnnnnnnnn CTA[/n] [BLW FLnnn]	YUCC AMSWELL FIR/2 BLW FL120 YUCC AMSWELL FIR

Editorial note.— In the following part of the template, the order of the columns titled "Content" and "Location" has been reversed.

Element	*Detailed content*	*Template(s)*			*Examples*
		Identifier and time	*Location*	*Content*	
Indicator for the beginning of Section I (M)	Indicator to identify the beginning of Section I (M)	SECN I			SECN I
Surface wind (C)	Widespread surface wind exceeding 15 m/s (30 kt)	SFC ~~WSPD~~WIND: [nn/nn]	[N ~~of~~OF Nnn *or* Snn] *or* [S ~~of~~OF Nnn *or* Snn] *or* [W ~~of~~OF Wnnn *or* Ennn] *or* [E ~~of~~OF Wnnn *or* Ennn] *or* [nnnnnnnnnn][2]	~~[n]nn MPS~~ ~~(*or*~~ ~~[n]nn KT)~~ nnn/[n]nnMPS (*or* nnn/[n]nnKT)	~~SFC WSPD: 10/12 16 MPS~~ SFC WIND: 10/12 310/16MPS ~~SFC WSPD: 40 KT E OF W110~~ SFC WIND: E OF W110 050/40KT
Surface visibility (C)	Widespread surface visibility below 5 000 m including the weather phenomena causing the reduction in visibility	SFC VIS: [nn/nn]		~~nnnn M~~ nnnnM FG *or* BR *or* SA *or* DU *or* HZ *or* FU *or* VA *or* PO *or* DS *or* SS *or* DZ *or* RA *or* SN *or* SG ~~*or* IC~~ *or* FC *or* GR *or* GS *or* PL *or* SQ	~~SFC VIS: 06/08 3000 M BR N of N51~~ SFC VIS: 06/08 N OF N51 3000M BR

Element	Detailed content	Template(s)			Examples
		Identifier and time	*Location*	*Content*	
Significant weather (C)	Significant weather conditions encompassing thunderstorms, ~~and~~ heavy sandstorm and duststorm, and volcanic ash	SIGWX: [nn/nn]		ISOL TS *or* OCNL TS *or* FRQ TS *or* OBSC TS *or* EMBD TS *or* HVY DS *or* HVY SS *or* SQL TS *or* ISOL TSGR *or* OCNL TSGR *or* FRQ TSGR *or* OBSC TSGR *or* EMBD TSGR *or* SQL TSGR *or* VA	SIGWX: 11/12 ISOL TS ~~SIGWX: 12/14 SS S OF N35~~ SIGWX: 12/14 S OF N35 HVY SS
Mountain obscuration (C)	Mountain obscuration	MT OBSC: [nn/nn]		nnnnnnnnnn[2]	~~MT OBSC: MT PASSES S OF N48~~ MT OBSC: S OF N48 MT PASSES
Cloud (C)	Widespread areas of broken *or* overcast cloud with height of base less than 300 m (1 000 ft) above ground level (AGL) *or* above mean sea level (AMSL) *and/or* any occurrence of cumulonimbus (CB) *or* towering cumulus (TCU) clouds	SIG CLD: [nn/nn]		BKN *or* OVC ~~nnn[n]/nnn[n] M (*or* nnn[n]/nnn[n] FT)~~ [n]nnn/[n]nnnM *(or* [n]nnn/[n]nnnFT) AGL *or* AMSL ISOL *or* OCNL *or* FRQ *or* OBSC *or* EMBD CB[3] *or* TCU[3] ~~nnn[n]/nnn[n] M or nnn[n]/nnn[n] FT~~ [n]nnn/[n]nnnM *(or* [n]nnn/[n]nnnFT) AGL *or* AMSL	~~SIG CLD: 06/09 OVC 800/1100 FT AGL N OF N51 10/12 ISOL TCU 1200/8000 FT AGL~~ SIG CLD: 06/09 N OF N51 OVC 800/1100FT AGL 10/12 ISOL TCU 1200/8000FT AGL
Icing (C)	Icing (except for that occurring in convective clouds and for severe icing for which a SIGMET message has already been issued)	ICE: [nn/nn]		MOD FLnnn/nnn *or* MOD ABV FLnnn *or* SEV FLnnn/nnn *or* SEV ABV FLnnn	ICE: MOD FL050/080
Turbulence (C)	Turbulence (except for that occurring in convective clouds and for severe turbulence for which a SIGMET message has already been issued)	TURB: [nn/nn]		MOD FLnnn/nnn *or* MOD ABV FLnnn *or* SEV FLnnn/nnn *or* SEV ABV FLnnn	TURB: MOD ABV FL090
Mountain wave (C)	Mountain wave (except for severe mountain wave for which a SIGMET message has already been issued)	MTW: [nn/nn]		MOD FLnnn/nnn *or* MOD ABV FLnnn *or* SEV FLnnn/nnn *or* SEV ABV FLnnn	~~MTW: MOD ABV FL080 N OF N63~~ MTW: N OF N63 MOD ABV FL080

Element	*Detailed content*	*Template(s)*			*Examples*
		Identifier and time	*Location*	*Content*	
SIGMET (C)	SIGMET messages applicable to the FIR/CTA concerned or a sub-area thereof, for which the area forecast is valid	SIGMET APPLICABLE:	~~—~~	~~n [,n] [,n]~~ [n][n]n[4]	SIGMET APPLICABLE: 3, A5, B06
or HAZARDOUS WX NIL (C)[45]		HAZARDOUS WX NIL			
Indicator for the beginning of Section II (M)	Indicator to identify the beginning of Section II (M)	SECN II			SECN II
Pressure centres and fronts (M)	Pressure centres and fronts and their expected movements and developments	PSYS: [nn]	Nnnnn *or* Snnnn Wnnnnn *or* Ennnnn *or* Nnnnn *or* Snnnn Wnnnnn *or* Ennnnn TO Nnnnn *or* Snnnn Wnnnnn *or* Ennnnn	~~L [n]nnn HPA *or* H [n]nnn HPA~~ L [n]nnnHPA *or* H [n]nnnHPA *or* FRONT *or* NIL	~~PSYS: 06 L 1004 HPA N5130 E01000 MOV NE 25KT WKN~~ PSYS: 06 N5130 E01000 L 1004HPA MOV NE 25KT WKN
			—	MOV N *or* MOV NE *or* MOV E *or* MOV SE *or* MOV S *or* MOV SW *or* MOV W *or* MOV NW nnKMH (*or* nnKT) WKN *or* NC *or* INTSF	
Upper winds and temperatures (M)	Upper winds and upper-air temperatures for at least the following altitudes: 600, 1 500 and 3 000 m (2 000, 5 000 and 10 000 ft)	WIND/T:	Nnnnn *or* Snnnn Wnnnnn *or* Ennnnn *or*	~~[n]nnn M (*or* [n]nnn FT)~~ ~~nnn/[n]nn MPS (*or* nnn/[n]nn KT)~~ [n]nnnM (*or* [n]nnnFT) nnn/[n]nnMPS (*or* nnn/[n]nnKT) PSnn *or* MSnn	~~WIND/T: 2000 FT 270/18 MPS PS03 5000 FT 250/20 MPS MS02 10000 FT 240/22 MPS MS11~~ WIND/T: 2000FT N5500 W01000 270/18MPS PS03 5000FT N5500 W01000 250/20MPS MS02 10000FT N5500 W01000 240/22MPS MS11
Cloud (M)	Cloud information not included in Section I giving type, height of base and top above ground level (AGL) or above mean sea level (AMSL)	CLD: [nn/nn]	[N ~~of~~OF Nnn *or* Snn] *or* [S ~~of~~OF Nnn *or* Snn] *or* [W ~~of~~OF Wnnn *or* Ennn] *or* [E ~~of~~OF Wnnn *or* Ennn] *or* [nnnnnnnnn][2]	FEW or SCT *or* BKN *or* OVC ST *or* SC *or* CU *or* AS *or* AC *or* NS ~~[n]nnn/[n]nnn M (*or* [n]nnn/[n]nnn FT)~~ [n]nnn/[n]nnnM (*or* [n]nnn/[n]nnnFT) AGL *or* AMSL *or* NIL	CLD: BKN SC ~~2500/8000 FT~~2500/8000FT AGL CLD: NIL
Freezing level (M)	Height indication of 0°C level(s) above ground level (AGL) or above mean sea level (AMSL), if lower than the top of the airspace for which the forecast is supplied	FZLVL:		[ABV] ~~nnnn FT~~ [n]nnnFT AGL *or* AMSL	FZLVL: ~~3000 FT~~3000FT AGL
Forecast QNH (M)	Forecast lowest QNH during the period of validity	MNM QNH:		~~[n]nnn HPA~~ [n]nnnHPA	MNM QNH: ~~1004 HPA~~1004HPA
Sea-surface temperature and state of the sea (O)	Sea-surface temperature and state of the sea if required by regional air navigation agreement	SEA:		Tnn HGT ~~[n]n M~~[n]nM	SEA: T15 HGT ~~5 M~~5M

Element	Detailed content	Template(s)			Examples
		Identifier and time	*Location*	*Content*	
Volcanic eruptions (M)	Name of volcano	VA:		nnnnnnnnnn *or* NIL	VA: ETNA VA: NIL

Notes.—

1. Fictitious location.
2. Free text describing well-known geographical locations should be kept to a minimum.
3. The location of the CB and/or TCU should be specified in addition to any widespread areas of broken or overcast cloud as given in the example.
4. Repeat as necessary, with comma separating.
4.5. When no elements are included in Section I.

. . .

AMOFSG

Example A5-1. TAF

TAF for YUDO (Donlon/International):*

TAF YUDO 160000Z 1606/~~1624~~1700 13005MPS 9000 BKN020 BECMG 1606/1608 SCT015CB BKN020 TEMPO 1608/1612 17006G12MPS 1000 TSRA SCT010CB BKN020 FM161230 15004MPS 9999 BKN020

Meaning of the forecast:

TAF for Donlon/International* issued on the 16th of the month at 0000 UTC valid from 0600 UTC on the 16th of the month to ~~2400~~0000 UTC on the ~~16th~~17th of the month; surface wind direction 130 degrees; wind speed 5 metres per second; visibility 9 kilometres, broken cloud at 600 metres; becoming between 0600 UTC and 0800 UTC on the 16th of the month, scattered cumulonimbus cloud at 450 metres and broken cloud at 600 metres; temporarily between 0800 UTC and 1200 UTC on the 16th of the month surface wind direction 170 degrees; wind speed 6 metres per second gusting to 12 metres per second; visibility 1 000 metres in a thunderstorm with moderate rain, scattered cumulonimbus cloud at 300 metres and broken cloud at 600 metres; from 1230 UTC on the 16th of the month surface wind direction 150 degrees; wind speed 4 metres per second; visibility 10 kilometres or more; and broken cloud at 600 metres.

* Fictitious location

Note.— In this example, the primary units "metre per second" and "metre" were used for wind speed and height of cloud base, respectively. However, in accordance with Annex 5, the corresponding non-SI alternative units "knot" and "foot" may be used instead.

Example A5-2. Cancellation of TAF

Cancellation of TAF for YUDO (Donlon/International):*

TAF AMD YUDO 161500Z 1606/~~1624~~1700 CNL

Meaning of the forecast:

Amended TAF for Donlon/International* issued on the 16th of the month at 1500 UTC cancelling the previously issued TAF valid from 0600 UTC on the 16th of the month to ~~2400~~0000 UTC on the ~~16th~~17th of the month.

* Fictitious location

METWSG &
MET/14

Example A5-3. GAMET area forecast

YUCC GAMET VALID 220600/221200 YUDO –
YUCC AMSWELL FIR/2 BLW FL120
SECN I

SFC ~~WSPD~~WIND:	10/12 ~~16 MPS~~ 310/16MPS
SFC VIS:	06/08 ~~3000 M BR N OF N51~~ 06/08 N OF N51 3000M BR
SIGWX:	11/12 ISOL TS
SIG CLD:	06/09 ~~OVC 800/1100 FT AGL N OF N51~~ N OF N51 OVC 800/1100FT AGL 10/12 ISOL TCU ~~1200/8000 FT~~ 1200/8000FT AGL
ICE:	MOD FL050/080
TURB:	MOD ABV FL090
SIGMETS APPLICABLE:	3, 5
SECN II	
PSYS:	06 ~~L 1004 HPA N5130 E01000~~ N5130 E01000 1004HPA MOV NE 25 KT WKN
WIND/T:	~~2000 FT 270/18 MPS PS03 5000 FT 250/20 MPS MS02 10000 FT 240/22 MPS MS11~~ 2000FT N5500 W01000 270/18MPS PS03 5000FT N5500 W01000 250/20MPS MS02 10000FT N5500 W01000 240/22MPS MS11
CLD:	BKN SC ~~2500/8000 FT~~ 2500/8000FT AGL
FZLVL:	~~3000 FT~~ 3000FT AGL
MNM QNH:	~~1004 HPA~~ 1004HPA
SEA:	T15 HGT ~~5 M~~ 5M
VA:	NIL

Meaning: An area forecast for low-level flights (GAMET) issued for sub-area two of the Amswell* flight information region (identified by YUCC Amswell area control centre) for below flight level 120 by the Donlon/International* aerodrome meteorological office (YUDO); the message is valid from 0600 UTC to 1200 UTC on the 22nd of the month.

Section I:

surface wind speeds ~~and~~ direction:	between 1000 UTC and 1200 UTC surface wind direction 310 degrees; wind speed 16 metres per second;
surface visibility:	between 0600 UTC and 0800 UTC north of 51 degrees north 3 000 metres ~~north of 51 degrees north~~ (due to mist);
significant weather phenomena:	between 1100 UTC and 1200 UTC isolated thunderstorms without hail;
significant clouds:	between 0600 UTC and 0900 UTC north of 51 degrees north overcast base 800, top 1 100 feet above ground level ~~north of 51 degrees north~~; between 1000 UTC and 1200 UTC isolated towering cumulus base 1 200, top 8 000 feet above ground level;
icing:	moderate between flight level 050 and 080;
turbulence:	moderate above flight level 090 (at least up to flight level 120);
SIGMET messages:	3 and 5 applicable to the validity period and sub-area concerned.

Section II:

pressure systems:	at 0600 UTC low pressure of 1 004 hectopascals at 51.5 degrees north 10.0 degrees east, expected to move north-eastwards at 25 knots and to weaken;
winds and temperatures:	at 2 000 feet above ground level at 55 degrees north 10 degrees west wind direction 270 degrees; wind speed 18 metres per second, temperature plus 3 degrees Celsius; at 5 000 feet above ground level at 55 degrees north 10 degrees west wind direction 250 degrees; wind speed 20 metres per second, temperature minus 2 degrees Celsius; at 10 000 feet above ground level at 55 degrees north 10 degrees west wind direction 240 degrees; wind speed 22 metres per second, temperature minus 11 degrees Celsius;
clouds:	broken stratocumulus, base 2 500 feet, top 8 000 feet above ground level;
freezing level:	3 000 feet above ground level;
minimum QNH:	1 004 hectopascals;
sea:	surface temperature 15 degrees Celsius; and state of the sea 5 metres;
volcanic ash:	nil.

* Fictitious location

APPENDIX 6. TECHNICAL SPECIFICATIONS RELATED TO SIGMET AND AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS AND ALERTS

(See Chapter 7 of this Annex.)

Note.— Data type designators to be used in abbreviated headings for SIGMET, AIRMET, tropical cyclone and volcanic ash advisory messages are given in WMO Publication No. 386, Manual on the Global Telecommunication System.

1. SPECIFICATIONS RELATED TO SIGMET INFORMATION

METWSG

1.1 Format of SIGMET messages

1.1.1 The content and order of elements in a SIGMET message shall be in accordance with the template shown in Table ~~A6-1~~ A6-1A.

. . .

1.1.3 The sequence number referred to in the template in Table ~~A6-1~~ A6-1A shall correspond with the number of SIGMET messages issued for the flight information region since 0001 UTC on the day concerned. The meteorological watch offices whose area of responsibility encompasses more than one FIR and/or CTA shall issue separate SIGMET messages for each FIR and/or CTA within their area of responsibility.

1.1.4 In accordance with the template in Table ~~A6-1~~ A6-1A, only one of the following phenomena shall be included in a SIGMET message, using the abbreviations as indicated below:

. . .

MARIE-PT

1.1.6 **Recommendation.**— *Meteorological watch offices ~~in a position to do so~~ should issue SIGMET information in digital form, in addition to the issuance of this SIGMET information in abbreviated plain language in accordance with 1.1.1.*

. . .

METWSG

1.1.9 **Recommendation.**—*SIGMET, when issued in graphical format, should be as specified in Appendix 1, including the use of applicable symbols and/or abbreviations.*

. . .

1.2 Dissemination of SIGMET messages

. . .

WAFSOPSG

1.2.2 SIGMET messages shall be disseminated to international OPMET databanks and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services, in accordance with regional air navigation agreement.

2. SPECIFICATIONS RELATED TO AIRMET INFORMATION

2.1 Format of AIRMET messages

METWSG

2.1.1 The content and order of elements in an AIRMET message shall be in accordance with the template shown in Table ~~A6-1~~ A6-1A.

2.1.2 The sequence number referred to in the template in Table ~~A6-1~~ A6-1A shall correspond with the number of AIRMET messages issued for the flight information region since 0001 UTC on the day concerned. The meteorological watch offices whose area of responsibility encompasses more than one FIR and/or CTA shall issue separate AIRMET messages for each FIR and/or CTA within its area of responsibility.

. . .

2.1.4 In accordance with the template in Table ~~A6-1~~ A6-1A, only one of the following phenomena shall be included in an AIRMET message, using the abbreviations as indicated below:

At cruising levels below flight level 100 (or below flight level 150 in mountainous areas, or higher, where necessary):

. . .

Secretariat

— surface visibility – widespread areas affected by reduction of visibility to less than 5 000 m, including the weather phenomenon causing the reduction of visibility	SFC VIS (+ visibility) (+ one of the following weather phenomena or combinations thereof: BR, DS, DU, DZ, FC, FG, FU, GR, GS, HZ, ~~IC,~~ PL, PO, RA, SA, SG, SN, SQ, SS or VA)

. . .

MARIE-PT

Editorial note.— Insert the following new text.

2.1.6 **Recommendation.**— *Meteorological offices should issue AIRMET information in digital form, in addition to the issuance of this AIRMET information in abbreviated plain language in accordance with 2.1.1.*

2.1.7 AIRMET if disseminated in digital form shall be formatted in accordance with a globally interoperable information exchange model and shall use extensible markup language (XML)/geography markup language (GML).

2.1.8 AIRMET if disseminated in digital form shall be accompanied by the appropriate metadata.

Note.— Guidance on the information exchange model, XML/GML and the metadata profile is provided in the Manual on the Digital Exchange of Aeronautical Meteorological Information *(Doc 10003).*

End of new text.

2.2 Dissemination of AIRMET messages

. . .

WAFSOPSG

2.2.2 **Recommendation.—** *AIRMET messages should be transmitted to international operational meteorological databanks and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution ~~systems~~ system and the Internet-based services, in accordance with regional air navigation agreement.*

. . .

5. SPECIFICATIONS RELATED TO AERODROME WARNINGS

5.1 Format and dissemination of aerodrome warnings

. . .

METWSG

5.1.3 **Recommendation.—** *In accordance with the template in Table A6-2, aerodrome warnings should relate to the occurrence or expected occurrence of one or more of the following phenomena:*

. . .

— *tsunami*

. . .

Note.— Aerodrome warnings related to the occurrence or expected occurrence of tsunami are not required where a national public safety plan for tsunami is integrated with the "at risk" aerodrome concerned.

. . .

AMOFSG

5.2 Quantitative criteria for aerodrome warnings

Recommendation.— *When quantitative criteria are necessary for the issue of aerodrome warnings covering, for example, the expected maximum wind speed or the expected total snowfall, the criteria used should be ~~established by agreement~~ as agreed between the aerodrome meteorological office and the users ~~of the warnings~~concerned.*

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METWSG

Editorial note.— Delete Table A6-1 in its entirety.

Editorial note.— Insert the following new table.

(Tracked changes are used to show the changes from existing Table A6-1. The template to be used for special air-reports (uplink) is presented in Table A6-1B.)

Table A6-1A. Template for SIGMET and AIRMET messages ~~and special air-reports (uplink)~~

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable;
= = a double line indicates that the text following it should be placed on the subsequent line.

Note 1.— The ranges and resolutions for the numerical elements included in SIGMET and AIRMET messages ~~and in special air-reports~~ are shown in Table A6-4 of this appendix.

Note 2.— In accordance with 1.1.5 and 2.1.5, severe or moderate icing and severe or moderate turbulence (SEV ICE, MOD ICE, SEV TURB, MOD TURB) associated with thunderstorms, cumulonimbus clouds or tropical cyclones should not be included.

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
Location indicator of FIR/CTA (M)[21]	ICAO location indicator of the ATS unit serving the FIR or CTA to which the SIGMET/AIRMET refers ~~(M)~~	nnnn		YUCC[32] YUDD[32]	
Identification (M)	Message identification and sequence number[43] ~~(M)~~	SIGMET [n][n]n	AIRMET [n][n]n	~~SIGMET 5~~ ~~AIGMET A3~~ SIGMET 1 SIGMET 01 SIGMET A01	~~AIRMET 2~~ AIRMET 9 AIRMET 19 AIRMET B19
Validity period (M)	Day-time groups indicating the period of validity in UTC ~~(M)~~	VALID nnnnnn/nnnnnn		VALID 010000/010400 VALID 221215/221600 VALID 101520/101800 VALID 251600/252200 VALID 152000/160000 VALID 192300/200300	
Location indicator of MWO (M)	Location indicator of MWO originating the message with a separating hyphen ~~(M)~~	nnnn–		YUDO–[32] YUSO–[32]	
Name of the FIR/CTA ~~*or* aircraft identification~~ (M)	Location indicator and name of the FIR/CTA[64] for which the SIGMET/AIRMET is issued ~~*or* aircraft radiotelehpony call sign~~ ~~(M)~~	nnnn nnnnnnnnnn FIR[/UIR] *or* nnnn nnnnnnnnnn CTA	nnnn nnnnnnnnnn FIR[/n]	YUCC AMSWELL FIR[32] YUDD SHANLON FIR/UIR[32] YUDD SHANLON CTA[2]	YUCC AMSWELL FIR/2[32] YUDD SHANLON FIR[32]
IF THE SIGMET OR AIRMET MESSAGE IS TO BE CANCELLED, SEE DETAILS AT THE END OF THE TEMPLATE.					
Phenomenon (M)[75]	Description of phenomenon causing the issuance of SIGMET/AIRMET ~~(C)~~	OBSC[86] TS[GR[97]] EMBD[108] TS[GR[7]] FRQ[119] TS[GR[7]] SQL[1210] TS[GR[7]]	~~SFC WSPD nn[n]MPS~~ ~~(*or* SFC WSPD nn[n]KT)~~ SFC WIND nnn/nn[n]MPS (*or* SFC WIND	OBSC TS OBSC TSGR EMBD TS EMBD TSGR	SFC WIND 040/40MPS SFC WIND 310/20KT SFC VIS 1500M (BR)

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
		TC nnnnnnnnnn PSN Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] CB *or* TC NN[13~~11~~] PSN Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] CB SEV TURB[14~~12~~] SEV ICE[15~~13~~] SEV ICE (FZRA)[15~~13~~] SEV MTW[16~~14~~] HVY DS HVY SS [VA ERUPTION] [MT] [nnnnnnnnnn] [PSN Nnn[nn] *or* Snn[nn] Ennn[nn] *or* Wnnn[nn]] VA CLD RDOACT CLD	nnn/nn[n]KT) SFC VIS nnnnM (nn)[17~~15~~] ISOL[18~~16~~] TS[GR[7]][9] OCNL[19~~17~~] TS[GR[7]] MT OBSC BKN CLD nnn/[ABV]nnnnM (*or* BKN CLD nnn/[ABV][n]nnnnFT) *or* BKN CLD SFC/[ABV]nnnnM (*or* BKN CLD SFC/[ABV][n]nnnnFT) OVC CLD nnn/[ABV]nnnnM (*or* OVC CLD nnn/[ABV][n]nnnnFT) *or* OVC CLD SFC/[ABV]nnnnM (*or* OVC CLD SFC/[ABV][n]nnnnFT) ISOL[18~~16~~] CB[20~~18~~] OCNL[19~~17~~] CB[18] FRQ[11~~9~~] CB[18] ISOL[18~~16~~] TCU[20~~18~~] OCNL[19~~17~~] TCU[20~~18~~] FRQ[11~~9~~] TCU[18] MOD TURB[14~~12~~] MOD ICE[15~~13~~] MOD MTW[16~~14~~]	FRQ TS FRQ TSGR SQL TS SQL TSGR TC GLORIA PSN N10 W060 TC NN PSN S2030 E06030 SEV TURB SEV ICE SEV ICE (FZRA) SEV MTW HVY DS HVY SS VA ERUPTION MT ASHVAL[2] PSN S15 E073 VA CLD RDOACT CLD	ISOL TS ISOL TSGR OCNL TS OCNL TSGR MT OBSC BKN CLD 120/900M (BKN CLD 400/3000FT) BKN CLD SFC/3000M BKN CLD SFC/ABV10000FT OVC CLD 270/ABV3000M (OVC CLD 900/ABV10000FT) OVC CLD SFC/3000M OVC CLD SFC/ABV10000FT ISOL CB OCNL CB FRQ CB ISOL TCU OCNL TCU FRQ TCU MOD TURB MOD ICE MOD MTW
Observed or forecast phenomenon (M)	Indication whether the information is observed and expected to continue, *or* forecast ~~(M)~~	OBS [AT nnnnZ] *or* FCST [AT nnnnZ]		OBS OBS AT 1210Z FCST FCST AT 1815Z	

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
Location (C)[21][19]	Location (referring to latitude and longitude (in degrees and minutes))	Nnn[nn] Wnnn[nn] *or* Nnn[nn] Ennn[nn] *or* Snn[nn] Wnnn[nn] *or* Snn[nn] Ennn[nn] *or* N OF Nnn[nn] *or* S OF Nnn[nn] *or* N OF Snn[nn] *or* S OF Snn[nn] *or* [AND] W OF Wnnn[nn] *or* E OF Wnnn[nn] *or* W OF Ennn[nn] *or* E OF Ennn[nn] *or* N OF Nnn[nn] *or* N OF Snn[nn] AND S OF Nnn[nn] *or* S OF Snn[nn] *or* W OF Wnnn[nn] *or* W OF Ennn[nn] AND E OF Wnnn[nn] *or* E OF Ennn[nn] *or* ~~[N OF, NE OF, E OF, SE OF, S OF, SW OF, W OF, NW OF] [LINE]~~ N OF LINE[23] *or* NE OF LINE[23] *or* E OF LINE[23] *or* SE OF LINE[23] *or* S OF LINE[23] *or* SW OF LINE[23] *or* W OF LINE[23] *or* NW OF LINE[23] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [AND N OF LINE[23] *or* NE OF LINE[23] *or* E OF LINE[23] *or* SE OF LINE[23] *or* S OF LINE[23] *or* SW OF LINE[23] *or* W OF LINE[23] *or* NW OF LINE[23] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]] *or* WI[~~27~~23, 25] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – [Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] *or* APRX nnKM WID LINE[23] BTN (*or* nnNM WID LINE[23] BTN) Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] *or* ENTIRE FIR[/UIR][24] *or* ENTIRE CTA[24] *or*[21] WI nnnKM (*or* nnnNM) OF TC CENTRE	N48 E010 N2020 W07005 ~~N2706 W07306~~ S60 W160 S0530 E16530 N OF N50 S OF ~~N54~~N5430 N OF S10 S OF S4530 W OF W155 W OF E15540 E OF W45 E OF E09015 N OF N1515 AND W OF E13530 S OF N45 AND N OF N40 N OF LINE S2520 W11510 – S2520 W12010 SW OF LINE N50 W005 – N60 W020 SW OF LINE N50 W020 – N45 E010 AND NE OF LINE N45 W020 – N40 E010 WI N6030 E02550 – N6055 E02500 – N6050 E02630 – N6030 E02550 APRX 50KM WID LINE BTN N64 W017 – N60 W010 – N57 E010 ENTIRE FIR ENTIRE FIR/UIR ENTIRE CTA WI 400KM OF TC CENTRE WI 250NM OF TC CENTRE	

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
Level (C)[21][19]	Flight level or altitude ~~and extent (C)~~[22]	[SFC/]FLnnn *or* [SFC/]nnnnM (*or* [SFC/][n]nnnnFT) *or* FLnnn/nnn *or* TOP FLnnn *or* [TOP] ABV FLnnn *or* [nnnn/]nnnnM (*or* [[n]nnnn/][n]nnnnFT) or [nnnnM/]FLnnn (*or* [[n]nnnnFT/]FLnnn) ~~*or*~~[23] ~~CB TOP [ABV] FLnnn WI nnnKM OF CENTRE~~ ~~(*or* CB TOP [ABV] FLnnn WI nnnNM OF CENTRE) *or*~~ ~~CB TOP [BLW] FLnnn WI nnnKM OF CENTRE~~ ~~(*or* CB TOP [BLW] FLnnn WI nnnNM OF CENTRE)~~ *or*[21] TOP [ABV *or* BLW] FLnnn ~~*or*~~[24] ~~FLnnn/nnn [APRX nnnKM BY nnnKM]~~ ~~[nnKM WID LINE[25] BTN (nnNM WID LINE BTN)]~~ ~~[Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]~~ ~~– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]~~ ~~[– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]~~ ~~[– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]]~~ ~~(*or* FLnnn/nnn [APRX nnnNM BY nnnNM]~~ ~~[Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]~~ ~~– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]~~ ~~[– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]~~ ~~[– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]]~~)		FL180 SFC/FL070 SFC/3000M SFC/10000FT FL050/080 TOP FL390 ABV FL250 TOP ABV FL100 ~~FL310/450~~ 3000M 2000/3000M 8000FT 6000/12000FT 2000M/FL150 10000FT/FL250 ~~CB TOP FL500 WI 270KM OF CENTRE~~ ~~(CB TOP FL500 WI 150NM OF CENTRE)~~ TOP FL500 TOP ABV FL500 TOP BLW FL450 ~~FL310/350 APRX 220KM BY 35KM~~ ~~FL390~~	
Movement *or* expected movement (C)[21][19, 26]	Movement *or* expected movement (direction and speed) with reference to one of the sixteen points of compass, *or* stationary ~~(C)~~	MOV N [nnKMH] *or* MOV NNE [nnKMH] *or* MOV NE [nnKMH] *or* MOV ENE [nnKMH] *or* MOV E [nnKMH] *or* MOV ESE [nnKMH] *or* MOV SE [nnKMH] *or* MOV SSE [nnKMH] *or* MOV S [nnKMH] *or* MOV SSW [nnKMH] *or* MOV SW [nnKMH] *or* MOV WSW [nnKMH] *or* MOV W [nnKMH] *or* MOV WNW [nnKMH] *or* MOV NW [nnKMH] *or* MOV NNW [nnKMH] (*or* MOV N [nnKT] *or* MOV NNE [nnKT] *or* MOV NE [nnKT] *or* MOV ENE [nnKT] *or* MOV E [nnKT] *or* MOV ESE [nnKT] *or* MOV SE [nnKT] *or* MOV SSE [nnKT] *or* MOV S [nnKT] *or* MOV SSW [nnKT] *or* MOV SW [nnKT] *or* MOV WSW [nnKT] *or* MOV W [nnKT] *or* MOV WNW [nnKT] *or* MOV NW [nnKT] *or* MOV NNW [nnKT]) *or* STNR		MOV SE MOV NNW MOV E 40KMH ~~(~~MOV E 20KT~~)~~ MOV WSW 20KT STNR	
Changes in intensity (C)[21][19]	Expected changes in intensity ~~(C)~~	INTSF *or* WKN *or* NC		INTSF WKN NC	
Forecast time (C)[26]	Indication of the forecast time of phenomenon	FCST nnnnZ	—	FCST 2200Z	—

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
Forecast position (C)~~[21, 22, 31]~~[19, 26, 28]	Forecast position of ~~volcanic ash cloud or the centre of the TC *or* other hazardous phenomena[28]~~ phenomenon at the end of the validity period of the SIGMET message ~~(C)~~	~~*or*[29]~~ ~~[~~FCST nnnnZ~~]~~ Nnn[nn] Wnnn[nn] *or* Nnn[nn] Ennn[nn] *or* Snn[nn] Wnnn[nn] *or* Snn[nn] Ennn[nn] *or* N OF Nnn[nn] *or* S OF Nnn[nn] *or* N OF Snn[nn] *or* S OF Snn[nn] [AND] W OF Wnnn[nn] *or* E OF Wnnn[nn] *or* W OF Ennn[nn] *or* E OF Ennn[nn] *or* N OF Nnn[nn] *or* N OF Snn[nn] AND S OF Nnn[nn] *or* S OF Snn[nn] *or* W OF Wnnn[nn] *or* W OF Ennn[nn] AND E OF Wnnn[nn] *or* E OF Ennn[nn] *or* ~~[N OF, NE OF, E OF, SE OF, S OF, SW OF, W OF, NW OF] [LINE]~~ N OF LINE[23] *or* NE OF LINE[23] *or* E OF LINE[23] *or* SE OF LINE[23] *or* S OF LINE[23] *or* SW OF LINE[23] *or* W OF LINE[23] *or* NW OF LINE[23] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [AND N OF LINE[23] *or* NE OF LINE[23] *or* E OF LINE[23] *or* SE OF LINE[23] *or* S OF LINE[23] *or* SW OF LINE[23] *or* W OF LINE[23] *or* NW OF LINE[23] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]]] *or* WI[27][23, 25] Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]~~]~~ *or*	—	N30 W170 N OF N30 S OF S50 AND W OF E170 S OF N46 AND N OF N39 NE OF LINE N35 W020 – N45 W040 SW OF LINE N48 W020 – N43 E010 AND NE OF LINE N43 W020 – N38 E010 WI N20 W090 – N05 W090 – N10 W100 – N20 W100 – N20 W090 APRX 50KM WID LINE BTN N64 W017 – N57 W005 – N55 E010 – N55 E030 ENTIRE FIR ENTIRE FIR/UIR ENTIRE CTA TC CENTRE PSN N2740 W07345 NO VA EXP ~~FCST 1700Z VA CLD APRX S15 E075 – S15 E081 – S17 E083 – S18 E079 – S15 E075~~ ~~FCST 0500Z ENTIRE FIR~~ ~~FCST 0500Z ENTIRE CTA~~ ~~FCST 0500Z NO VA EXP~~ ~~FCST 2200Z TC CENTRE N2740 W07345~~	—

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	SIGMET template	AIRMET template	SIGMET message examples	AIRMET message examples
		~~FCST nnnnZ VA CLD~~ APRX nnKM WID LINE~~25~~23 BTN (nnNM WID LINE23 BTN) Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] – Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] [– Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn]] ~~[AND]~~26 *or* ~~FCST nnnnZ~~ ENTIRE FIR[/UIR]24 *or* ~~FCST nnnnZ~~ ENTIRE CTA24 *or*21 ~~FCST nnnnZ~~ TC CENTRE PSN Nnn[nn] *or* Snn[nn] Wnnn[nn] *or* Ennn[nn] *or*22 ~~FCST nnnnZ~~ NO VA EXP			
Repetition of elements (C)24	Repetition of elements included in a SIGMET message for volcanic ash cloud or tropical cyclone	[AND]24	—	AND	—
OR					
Cancellation of SIGMET/ AIRMET (C)~~30~~27	Cancellation of SIGMET/AIRMET referring to its identification	CNL SIGMET [n][n]n nnnnnn/nnnnnn *or*22 CNL SIGMET [n][n]n nnnnnn/nnnnnn [VA MOV TO nnnn FIR]24	CNL AIRMET [n][n]n nnnnnn/nnnnnn	CNL SIGMET 2 101200/101600~~30~~ CNL SIGMET ~~3~~A13 251030/251430 VA MOV TO YUDO FIR~~30~~2	CNL AIRMET 05 151520/151800~~30~~

Notes.—

~~1. No wind and temperature to be uplinked to other aircraft in flight in accordance with 3.2.~~
~~2.~~1. See 4.1.
~~3.~~2. Fictitious location.
~~4.~~3. In accordance with 1.1.3 and 2.1.2.
~~5. See 3.1.~~
~~6.~~4. See 2.1.3.
~~7.~~5. In accordance with 1.1.4 and 2.1.4.
~~8.~~6. In accordance with 4.2.1 a).
~~9.~~7. In accordance with 4.2.4.
~~10.~~8. In accordance with 4.2.1 b).
~~11.~~9. In accordance with 4.2.2.
~~12.~~10. In accordance with 4.2.3.
~~13.~~11. Used for unnamed tropical cyclones.
~~14.~~12. In accordance with 4.2.5 and 4.2.6.
~~15.~~13. In accordance with 4.2.7.
~~16.~~14. In accordance with 4.2.8.
~~17.~~15. In accordance with 2.1.4.
~~18.~~16. In accordance with 4.2.1 c).
~~19.~~17. In accordance with 4.2.1 d).

~~20.~~18. The use of cumulonimbus~~, CB,~~ (CB) and towering cumulus~~, TCU,~~ (TCU) is restricted to AIRMETs in accordance with 2.1.4.

~~21.~~19. In the case of ~~the same phenomenon~~ volcanic ash cloud or tropical cyclone covering more than one area within the FIR, these elements can be repeated, as necessary.

~~22.~~20. Only for SIGMET messages for volcanic ash cloud and tropical cyclones.

~~23.~~21. Only for SIGMET messages for tropical cyclones.

~~24.~~22. Only for SIGMET messages for volcanic ash.

~~25.~~23. A straight line is to be used between two points drawn on a map in the Mercator projection or ~~a straight line~~ between two points which crosses lines of longitude at a constant angle.

~~26.~~24. To be used for two volcanic ash clouds or two centres of tropical cyclones simultaneously affecting the FIR concerned.

~~27.~~25. The number of coordinates should be kept to a minimum and should not normally exceed seven.

~~28.~~26. ~~Optionally can be used in addition to Movement or Expected Movement.~~ The elements 'Forecast Time' and 'Forecast Position' are not to be used in conjunction with the element 'Movement or Expected Movement'.

~~29. To be used for hazardous phenomena other than volcanic ash cloud and tropical cyclones.~~

~~30.~~27. End of the message (as the SIGMET/AIRMET message is being cancelled).

~~31.~~28. The levels of the phenomena remain fixed throughout the forecast period.

~~*Note. In accordance with 1.1.5 and 2.1.5, severe or moderate icing and severe or moderate turbulence (SEV ICE, MOD ICE, SEV TURB, MOD TURB) associated with thunderstorms, cumulonimbus clouds or tropical cyclones should not be included.*~~

Editorial note.— Insert the following new table.

(Tracked changes are used to show the changes from existing Table A6-1. The template to be used for SIGMET and AIRMET messages is presented in Table A6-1A.)

Table A6-1B. Template for ~~SIGMET and AIRMET messages and~~ special air-reports (uplink)

Key: M = inclusion mandatory, part of every message;
C = inclusion conditional, included whenever applicable;
= = a double line indicates that the text following it should be placed on the subsequent line.

Note.— The ranges and resolutions for the numerical elements included ~~in SIGMET/AIRMET messages and~~ in special air-reports are shown in Table A6-4 of this appendix.

Element ~~as specified in Chapter 5 and Appendix 6~~	*Detailed content*	*~~SPECIAL AIR-REPORT~~ Template*[1,2]	*Examples*
Identification (M)	Message identification ~~and sequence number~~[4] ~~(M)~~	ARS	ARS
~~Name of the FIR/CTA *or* a~~Aircraft identification (M)	~~Location indicator and name of the FIR/CTA[6] for which the SIGMET/AIRMET is issued *or* a~~Aircraft radiotelephony call sign ~~(M)~~	nnnnnn	VA812[3]
Observed ~~P~~phenomenon (M)[7]	Description of observed phenomenon causing the issuance of ~~SIGMET/AIRMET (C)~~ the special air-report[4]	TS TSGR SEV TURB SEV ICE SEV MTW HVY SS VA CLD ~~[FLnnn/nnn]~~ VA [MT nnnnnnnnnn] MOD TURB MOD ICE	TS TSGR SEV TURB SEV ICE SEV MTW HVY SS VA CLD VA VA MT ASHVAL[5] MOD TURB MOD ICE
~~Observed or forecast phenomenon~~ Observation time (M)	~~Indication whether the information is observed and expected to continue, *or* forecast (M)~~ Time of observation of observed phenomenon	OBS AT nnnnZ	OBS AT 1210Z
Location (C)[21]	Location (referring to latitude and longitude (in degrees and minutes)) of observed phenomenon	NnnnnWnnnnn *or* NnnnnEnnnnn *or* SnnnnWnnnnn *or* SnnnnEnnnnn	N2020W07005 S4812E01036
Level (C)[21]	Flight level or altitude ~~and extent (C)[22]~~ of observed phenomenon	FLnnn *or* FLnnn/nnn *or* nnnnM (*or* [n]nnnnFT)	FL390 FL180/210 3000M 12000FT

Notes.—

1. No wind and temperature to be uplinked to other aircraft in flight in accordance with 3.2.
2. See 4.13.1.
3. Fictitious call sign.
4. In the case of special air-report for volcanic ash cloud, the vertical extent (if observed) and name of the volcano (if known) can be used.
3.5. Fictitious location.
4. ~~In accordance with 1.1.3 and 2.1.2.~~
5. ~~See 3.1.~~
6. ~~See 2.1.3.~~
7. ~~In accordance with 1.1.4 and 2.1.4.~~
8. ~~In accordance with 4.2.1 a).~~
9. ~~In accordance with 4.2.4.~~
10. ~~In accordance with 4.2.1 b).~~
11. ~~In accordance with 4.2.2.~~
12. ~~In accordance with 4.2.3.~~
13. ~~Used for unnamed tropical cyclones.~~
14. ~~In accordance with 4.2.5 and 4.2.6.~~
15. ~~In accordance with 4.2.7.~~
16. ~~In accordance with 4.2.8.~~
17. ~~In accordance with 2.1.4.~~
18. ~~In accordance with 4.2.1 c).~~
19 ~~In accordance with 4.2.1 d).~~
20. ~~The use of cumulonimbus, CB, and towering cumulus, TCU, is restricted to AIRMETs in accordance with 2.1.4.~~
21. ~~In the case of the same phenomenon covering more than one area within the FIR, these elements can be repeated, as necessary.~~
22. ~~Only for SIGMET messages for volcanic ash cloud and tropical cyclones.~~
23. ~~Only for SIGMET messages for tropical cyclones.~~
24. ~~Only for SIGMET messages for volcanic ash.~~
25. ~~A straight line between two points drawn on a map in the Mercator projection or a straight line between two points which crosses lines of longitude at a constant angle.~~
26. ~~To be used for two volcanic ash clouds or two centres of tropical cyclones simultaneously affecting the FIR concerned..~~
27. ~~The number of coordinates should be kept to a minimum and should not normally exceed seven.~~
28. ~~Optionally can be used in addition to Movement or Expected Movement.~~
29. ~~To be used for hazardous phenomena other than volcanic ash cloud and tropical cyclones.~~
30. ~~End of the message (as the SIGMET/AIRMET message is being cancelled).~~
31. ~~The levels of the phenomena remain fixed throughout the forecast period.~~

~~*Note. — In accordance with 1.1.5 and 2.1.5, severe or moderate icing and severe or moderate turbulence (SEV ICE, MOD ICE, SEV TURB, MOD TURB) associated with thunderstorms, cumulonimbus clouds or tropical cyclones should not be included.*~~

. . .

Example A6-1. SIGMET and AIRMET message and the corresponding cancellations

SIGMET YUDD SIGMET 2 VALID 101200/101600 YUSO – YUDD SHANLON FIR/UIR OBSC TS FCST S OF N54 AND E OF W012 TOP FL390 MOV E 20KT WKN ~~FCST 1600Z S OF N54 AND E OF W010~~	**Cancellation of SIGMET** YUDD SIGMET 3 VALID 101345/101600 YUSO – YUDD SHANLON FIR/UIR CNL SIGMET 2 101200/101600
AIRMET YUDD AIRMET 1 VALID 151520/151800 YUSO – YUDD SHANLON FIR ISOL TS OBS N OF S50 TOP ABV FL100 STNR WKN	**Cancellation of AIRMET** YUDD AIRMET 2 VALID 151650/151800 YUSO – YUDD SHANLON FIR CNL AIRMET 1 151520/151800

Example A6-2. SIGMET message for tropical cyclone

YUCC SIGMET 3 VALID 251600/252200 YUDO –
YUCC AMSWELL FIR TC GLORIA PSN N2706 W07306 CB OBS AT 1600Z ~~N2706 W07306 CB~~ WI 250NM OF TC CENTRE TOP FL500 ~~WI 150NM OF CENTRE MOV NW 10KT~~ NC FCST 2200Z TC CENTRE PSN N2740 W07345

Meaning:

The third SIGMET message issued for the AMSWELL* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1600 UTC to 2200 UTC on the 25th of the month; tropical cyclone Gloria at 27 degrees 6 minutes north and 73 degrees 6 minutes west; cumulonimbus was observed at 1600 UTC ~~at 27 degrees 6 minutes north and 73 degrees 6 minutes west with~~ within 250 nautical miles of the centre of the tropical cyclone ~~cumulonimbus~~ with top at flight level 500; ~~within 150 nautical miles of the centre; the tropical cyclone is expected to move northwestwards at 10 knots and not to undergo any~~ no changes in intensity are expected; at 2200 UTC ~~the forecast position of~~ the centre of the tropical cyclone ~~at 2200 UTC~~ is ~~expected~~ forecast to be located at 27 degrees 40 minutes north and 73 degrees 45 minutes west.

* Fictitious location

Example A6-3. SIGMET message for volcanic ash

YUDD SIGMET 2 VALID 211100/211700 YUSO –
YUDD SHANLON FIR/UIR VA ERUPTION MT ASHVAL PSN S1500 E07348 VA CLD OBS AT 1100Z APRX ~~220KM BY 35KM~~ 50KM WID LINE BTN S1500 E07348 – S1530 E07642 FL310/450 ~~MOV SE 65KMH~~ FCST 1700Z ~~VA CLD~~ APRX 50KM WID LINE BTN S1506 E07500 – S1518 E08112 – S1712 E08330~~— S1824 E07836~~

Meaning:

The second SIGMET message issued for the SHANLON* flight information region (identified by YUDD Shanlon area control centre/upper flight information region) by the Shanlon/International* meteorological watch office (YUSO) since 0001 UTC; the message is valid from 1100 UTC to 1700 UTC on the 21st of the month; volcanic ash eruption of Mount Ashval* located at 15 degrees south and 73 degrees 48 minutes east; volcanic ash cloud observed at 1100 UTC in an ~~approximate area of 220 km by 35 km~~ approximately 50km wide line between 15 degrees south and 73 degrees 48 minutes east, and 15 degrees 30 minutes south and 76 degrees 42 minutes east; between flight levels 310 and 450~~, the volcanic ash cloud is expected to move southeastwards at 65 kilometres per hour~~; at 1700 UTC the volcanic ash cloud is forecast to be located ~~approximately in an area bounded by the following points:~~ in an approximately 50km wide line between 15 degrees 6 minutes south and 75 degrees east, 15 degrees 18 minutes south and 81 degrees 12 minutes east, and 17 degrees 12 minutes south and 83 degrees 30 minutes east~~, and 18 degrees 24 minutes south and 78 degrees 36 minutes east~~.

* Fictitious location

Example A6-4. SIGMET message for radioactive cloud

YUCC SIGMET 2 VALID 201200/201600 YUDO –
YUCC AMSWELL FIR RDOACT CLD OBS AT 1155Z WI S5000 W14000 – S5000 W13800 – S5200 W13800 – S5200 W14000 – S5000 W14000 SFC/FL100 ~~STNR~~ WKN FCST 1600Z WI S5200 W14000 – S5200 W13800 – S5300 W13800 – S5300 W14000 – S5200 W14000

Meaning:

The second SIGMET message issued for the AMSWELL* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1200 UTC to 1600 UTC on the 20th of the month; radioactive cloud was observed at 1155 UTC within an area bounded by 50 degrees 0 minutes south 140 degrees 0 minutes west to 50 degrees 0 minutes south 138 degrees 0 minutes west to 52 degrees 0 minutes south 138 degrees 0 minutes west to 52 degrees 0 minutes south 140 degrees 0 minutes west to 50 degrees 0 minutes south 140 degrees 0 minutes west and between the surface and flight level 100; the radioactive cloud is expected ~~to remain stationary and~~ to weaken in intensity; at 1600 UTC the radioactive cloud is forecast to be located within an area bounded by 52 degrees 0 minutes south 140 degrees 0 minutes west to 52 degrees 0 minutes south 138 degrees 0 minutes west to 53 degrees 0 minutes south 138 degrees 0 minutes west to 53 degrees 0 minutes south 140 degrees 0 minutes west to 52 degrees 0 minutes south 140 degrees 0 minutes west.

* Fictitious location

Example A6-5. SIGMET message for severe turbulence

YUCC SIGMET 5 VALID 221215/221600 YUDO –
YUCC AMSWELL FIR SEV TURB OBS AT 1210Z N2020 W07005 FL250 ~~MOV E 40KMH WKN~~ INTSF FCST 1600Z S OF N2020 AND E OF W06950

Meaning:

The fifth SIGMET message issued for the AMSWELL* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1215 UTC to 1600 UTC on the 22nd of the month; severe turbulence was observed at 1210 UTC 20 degrees 20 minutes north and 70 degrees 5 minutes west at flight level 250; the turbulence is expected to ~~move eastwards at 40 kilometres per hour and to weaken~~ strengthen in intensity; ~~forecast position~~ at 1600 UTC the severe turbulence is forecast to be located south of 20 degrees 20 minutes north and east of 69 degrees 50 minutes west.

* Fictitious location

. . .

APPENDIX 8. TECHNICAL SPECIFICATIONS RELATED TO SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

. . .

1. MEANS OF SUPPLY AND FORMAT OF METEOROLOGICAL INFORMATION

AMOFSG

1.1 Meteorological information shall be supplied to operators and flight crew members by one or more of the following, as agreed between the meteorological authority and the operator concerned, and with the order shown below not implying priorities:

. . .

4. SPECIFICATIONS RELATED TO FLIGHT DOCUMENTATION

4.1 Presentation of information

. . .

4.1.2 **Recommendation.—** *The flight documentation related to concatenated route-specific upper wind and upper-air temperature forecasts should be provided ~~when~~ as agreed between the meteorological authority and the operator concerned.*

. . .

4.2 Charts in flight documentation

4.2.1 Characteristics of charts

4.2.1.1 **Recommendation.—** *Charts included in flight documentation should have a high standard of clarity and legibility and should have the following physical characteristics:*

a) for convenience, the largest size of charts should be about 42 × 30 cm (standard size A3) and the smallest size should be about 21 × 30 cm (standard size A4). The choice between these sizes should depend on the route lengths and the amount of detail that needs to be given in the charts as agreed between the meteorological authorities and the users concerned;

. . .

5. SPECIFICATIONS RELATED TO AUTOMATED PRE-FLIGHT INFORMATION SYSTEMS FOR BRIEFING, CONSULTATION, FLIGHT PLANNING AND FLIGHT DOCUMENTATION

5.1 Access to the systems

. . .

5.2 Detailed specifications of the systems

Recommendation.— *Automated pre-flight information systems for the supply of meteorological information for self-briefing, pre-flight planning and flight documentation should*:

. . .

c) use access and interrogation procedures based on abbreviated plain language and, as appropriate, ICAO location indicators, and aeronautical meteorological code data-type designators prescribed by the WMO, or based on a menu-driven user interface, or other appropriate mechanisms as agreed between the meteorological authority and the operators concerned; and

. . .

APPENDIX 9. TECHNICAL SPECIFICATIONS RELATED TO INFORMATION FOR AIR TRAFFIC SERVICES, SEARCH AND RESCUE SERVICES AND AERONAUTICAL INFORMATION SERVICES

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1.5 Format of information

. . .

1.5.2 **Recommendation.—** *When computer-processed upper-air data for grid points are made available to air traffic services units in digital form for use by air traffic services computers, the contents, format and transmission arrangements should be as agreed between the meteorological authority and the appropriate ATS authority concerned. The data should normally be supplied as soon as is practicable after the processing of the forecasts has been completed.*

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APPENDIX 10. TECHNICAL SPECIFICATIONS RELATED TO REQUIREMENTS FOR AND USE OF COMMUNICATIONS

(See Chapter 11 of this Annex.)

1. SPECIFIC REQUIREMENTS FOR COMMUNICATIONS

1.1 Required transit times of meteorological information

Recommendation.— ~~*Unless otherwise determined by regional air navigation agreement, AFTN messages and bulletins containing operational meteorological information should achieve transit times of less than the following:*~~

~~*SIGMET and AIRMET messages, volcanic ash and tropical cyclone advisory information and special air-reports ..... 5 minutes*~~

~~*Abbreviated plain-language amendments to significant weather and upper-air forecasts ..... 5 minutes*~~

~~*Amended TAF and corrections to TAF ..... 5 minutes*~~

~~*METAR*~~
~~*Trend forecasts*~~
~~*TAF*~~
~~*SPECI*~~
~~*0–900 km (500 NM) 5 minutes*~~
~~*more than 900 km (500 NM) 10 minutes*~~

AFTN messages and bulletins containing operational meteorological information shall achieve transit times of less than 5 minutes, unless otherwise determined by regional air navigation agreement.

1.2 Grid point data for ATS and operators

1.2.1 **Recommendation.—** *When upper-air data for grid points in digital form are made available for use by air traffic services computers, the transmission arrangements should be as agreed between the meteorological authority and the appropriate ATS authority concerned.*

1.2.2 **Recommendation.—** *When upper-air data for grid points in digital form are made available to operators for flight planning by computer, the transmission arrangements should be as agreed ~~among~~ between the ~~world area forecast centre~~ WAFC concerned, the meteorological authority and the operators.*

. . .

ATTACHMENT A. OPERATIONALLY DESIRABLE ACCURACY OF MEASUREMENT OR OBSERVATION

METWSG

Note.— The guidance contained in this table relates to Chapter 2 — Supply, use, quality management and interpretation of meteorological information, in particular to 2.2.7, and Chapter 4 — Meteorological observations and reports~~, in particular to 4.1.9~~.

. . .

ATTACHMENT B. OPERATIONALLY DESIRABLE ACCURACY OF FORECASTS

Note 1.— The guidance contained in this table relates to Chapter 2 — Supply, use, quality management and interpretation of meteorological information, in particular to 2.2.8, and Chapter 6 — Forecasts~~, in particular to 6.1.1~~.

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AMOFSG

ATTACHMENT C. SELECTED CRITERIA APPLICABLE TO AERODROME REPORTS

(The guidance in this table relates to Chapter 4 and Appendix 3.)

	Surface wind				. . .
Specifications	Directional variations[3]			Speed variations[3]	
	≥ 60° and < 180°		≥ 180°	Exceeding the mean speed by ≥ 5 m/s (10 kt)	
	Mean speed				
	< 1.5 m/s (3 kt)	≥ 1.5 m/s (3 kt)			
Local routine and special report	2/10 min [7] VRB + 2 extreme directions[8]	2/10 min [7] mean + 2 extreme directions[8]	2 min VRB (no extremes)[8]	10 min [8] Minimum and maximum speed	
METAR/ SPECI	10 min VRB (no extremes)	10 min mean + 2 extreme directions	10 min VRB (no extremes)	10 min [8] Maximum speed[8]	
Relevant reporting scales for all messages	Direction in three figures rounded off to the nearest 10 degrees (degrees 1 – 4 down, degrees 5 – 9 up)			Speed in 1 m/s or 1 kt Speed < 0.5 m/s (1 kt) indicated as CALM	

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APPENDIX B

PROPOSED CONSEQUENTIAL AMENDMENT TO

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AIR TRAFFIC SERVICES

ANNEX 11 TO THE CONVENTION OF INTERNATIONAL CIVIL AVIATION

THIRTEENTH EDITION — JULY 2001

. . .

CHAPTER 1. DEFINITIONS

. . .

AMOFSG

***SIGMET information*.** Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather ~~phenomena which~~ and other phenomena in the atmosphere that may affect the safety of aircraft operations.

— — — — — — — —

APPENDIX C

PROPOSED CONSEQUENTIAL AMENDMENT TO

PROCEDURES FOR AIR NAVIGATION SERVICES
ABBREVIATIONS AND CODES

(PANS-ABC, Doc 8400)

EIGHTH EDITION — 2010

. . .

H

. . .

H…	Significant wave height *(followed by figures in METAR/SPECI)*

. . .

I

. . .

~~IC~~	~~Ice crystals *(very small ice crystals in suspension, also known as diamond dust)*~~

. . .

S

. . .

SIGMET†	Information concerning en-route weather ~~phenomena which~~ and other phenomena in the atmosphere that may affect the safety of aircraft operations

. . .

Editorial note.— Amend Decode section accordingly.

— — — — — — — — —

APPENDIX D

PROPOSED CONSEQUENTIAL AMENDMENT TO

PROCEDURES FOR AIR NAVIGATION SERVICES
AIR TRAFFIC MANAGEMENT

(PANS-ATM, Doc 4444)

FIFTEENTH EDITION — 2007

. . .

CHAPTER 1. DEFINITIONS

. . .

AMOFSG

***SIGMET information*.** Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather ~~phenomena which~~ and other phenomena in the atmosphere that may affect the safety of aircraft operations.

. . .

METWSG

CHAPTER 4 GENERAL PROVISIONS FOR AIR TRAFFIC SERVICES

. . .

4.12 REPORTING OF OPERATIONAL AND METEOROLOGICAL INFORMATION

. . .

4.12.6 Forwarding of meteorological information

. . .

4.12.6.2 When receiving special air-reports by data link communications, air traffic services units shall forward them without delay to their associated meteorological watch office, ~~and~~ the WAFCs, and the centres designated by regional air navigation agreement for the operation of the aeronautical fixed service satellite distribution system and the Internet-based services.

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APPENDIX E

PRINCIPLES TO BE FOLLOWED IN THE RESTRUCTURING OF ANNEX 3 AND THE DEVELOPMENT OF A NEW PANS-MET

The restructured Annex 3/Technical Regulations [C.3.1] and the new PANS-MET will:

1) contain functional and performance requirements (in the Annex) and technical specifications as means of compliance (in the PANS);

2) take into account the identification of provisions according to State obligations, service provider obligations and technical requirements for the service;

3) solely link the notion of meteorological authority with the roles and responsibilities associated with the category of State obligations referenced in 2); and

4) be developed in time for adoption no later than 2018, in line with Block 1 of the aviation system block upgrades (ASBU) methodology contained in the *Global Air Navigation Plan* (GANP) (Doc 9750).

— END —

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