



Civil Aviation Authority of Singapore

**MANUAL OF STANDARDS
- METEOROLOGICAL SERVICE FOR
INTERNATIONAL AIR NAVIGATION
VOLUME I**

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TABLE OF CONTENT

AMENDMENT RECORDS.....III
 FOREWORD.....V
 ABBREVIATIONS.....VI
 DEFINITIONS.....VII

CHAPTER 1: INTRODUCTION 1
 1.1 BACKGROUND.....1
 1.2 NON-COMPLIANCE WITH MANUAL.....2

CHAPTER 2: SAFETY MANAGEMENT SYSTEM
 2.1 INTRODUCTION3
 2.2 SAFETY MANAGEMENT SYSTEM3

CHAPTER 3: PERSONNEL AND TRAINING REQUIREMENT
 3.1 COMPETENCY STANDARDS FOR AERONAUTICAL METEOROLOGICAL
 PERSONNEL.....8
 3.2 QUALIFICATIONS AND TRAINING REQUIREMENTS FOR AERONAUTICAL
 METEOROLOGICAL FORECASTER.....8
 3.3 QUALIFICATIONS AND TRAINING REQUIREMENTS FOR AERONAUTICAL
 METEOROLOGICAL TECHNICIAN.....9
 3.4 QUALIFICATIONS AND TRAINING REQUIREMENTS FOR SAFETY PERSONNEL.....9

CHAPTER 4: SAFETY REVIEW AND INVESTIGATION
 4.1 INCIDENT/ACCIDENT REPORTS.....10
 4.2 SEVERE WEATHER REPORTS.....10
 4.3 SYSTEMS FAULT REPORTS.....10
 4.4 SYSTEMS REVIEW.....11
 4.5 SYSTEM COMMISSION AND UPGRADE PROCESS.....11
 4.6 SAFETY INVESTIGATION.....12

CHAPTER 5: METEOROLOGICAL FACILITY – OPERATION AND MAINTENANCE
 5.1 OPERATION AND MAINTENANCE PLAN.....14

CHAPTER 6: DOCUMENTATION AND RECORDS
 6.1 DOCUMENTS AND RECORDS.....15
 6.2 DOCUMENT CONTROL.....15

APPENDICES
 APPENDIX 1: WEATHER REPORT FOR INCIDENT/ACCIDENT FORM.....APP 1-1

Amendment Records

Version No.	Source	Sections Affected	Entered By	Effective Date
1.0	Annex 3 incorporating Amendment 74	-	Ang Chieng Hai	14 July 2008
2.0	Ongoing review of document	Changes made to better reflect roles of SOU and Service Provider	Audrey Eun / Ng Kian Peng	1 Jun 2009
3.0	Ongoing review of document	<p>Changes to reflect the setting up of AMSRC by CAAS.</p> <p>Re-write of the Manual of Standards with inclusion of Annex 3-based SARPs in Volume II with its own amendment records.</p> <p>The section on safety investigation has been inserted.</p>	Audrey Eun / Ng Kian Peng	12 Aug 2010
3.1	Incorporating Amendment 75 of Annex 3	Updated to incorporate changes as in Amendment 75 of Annex 3	Audrey Eun / Ng Kian Peng	18 Nov 2010
4.0	Changes in aeronautical meteorological service oversight from AMSRC to CAAS and alignment of document with CAAS's requirements.	<p>Cover page</p> <p>Table of contents paragraph 1.2</p> <p>Foreword</p> <p>Abbreviations</p> <p>Chapter 2, pages 3 – 4</p> <p>Chapter 3, page 7</p> <p>Chapter 4, page 10</p>	Ong Chuan Bin	10 August 2012

4.1	Incorporating Amendment 76 of Annex 3, Annex 19 on safety management and oversight framework for competency standards for AMP	Foreword Chapter 2, pages 3 – 4 Chapter 3, page 7 Chapter 4, page 10	Lim Lay Eng	21 Mar 2014
4.2	Compliance to new ISO standard Introduce regulation on safety investigation	Chapter 2.3, page 6 Chapter 4.6, page 13	Lim Lay Eng	10 Nov 2016
4.3	SMS requirements Revision on safety reviews and investigations	Chapter 2, 2.2.1 (a) (vi) and 2.2.1 (c) Chapter 4, 4.1.2, 4.2 and 4.4.1	Lim Lay Eng	1 Aug 2018
5.0	Remove requirement on QMS as it is duplicated in Volume II	Chapter 2 para 2.3	Lim Lay Eng	5 Nov 2020

Foreword

Pursuant to paragraph 88E of the Air Navigation Order (ANO), this Manual of Standards – Meteorological Service for International Air Navigation (MOS-MET(IAN)) is issued by the Authority specifying the national standards and requirements to be met by the meteorological Service Provider.

The MOS-MET(IAN) contains the standards, requirements and procedures pertaining to the provision of meteorological services. The standards and requirements in this Manual are based mainly on standards and recommended practices stipulated in Annex 3 (entitled “Meteorological Service for International Air Navigation”) to the Chicago Convention on International Civil Aviation (as in force and amended from time to time by the Council of the International Civil Aviation Organisation), and with such modifications as may be determined by the Authority to be applicable in Singapore.

The MOS-MET(IAN) is organised into two volumes. The first volume, MOS-MET(IAN) Volume I contains general regulations and requirements and the second volume (MOS-MET(IAN) Volume II) establishes the standards and recommended practices for the aeronautical meteorological service provider. Volume II also contains regional specifications endorsed through Regional Air Navigation (RAN) agreements and practices that the meteorological and air traffic services authorities have agreed upon.

Readers should forward advice of errors, inconsistencies or suggestions for improvement to this Manual to the addressee stipulated below.

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Abbreviations

AMF	Aeronautical Meteorological Forecaster
AMO	Aeronautical Meteorological Observer
AMP	Aeronautical Meteorological Personnel
AMT	Aeronautical Meteorological Technician
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
AWOS	Automated Weather Observing System
BIP-M	Basic Instruction Package for Meteorologists
BIP-MT	Basic Instruction Package for Meteorological Technicians
CAAS	Civil Aviation Authority of Singapore
CFO	Central Forecast Office
CMS	Changi Meteorological Station
CSA	Comprehensive Systems Approach
DGMS	Director- General of Meteorological Service Singapore, NEA
FASID	Facilities and Services Implementation Document
ICAO	International Civil Aviation Organisation
LLWAS	Low Level Wind-shear Alert System
MET	Meteorological/Meteorology
MOS-MET(IAN)	MOS - Meteorological Service for International Air Navigation (in 2 volumes)
MSS	Meteorological Service Singapore
NEA	National Environment Agency
OPMET	Operational Meteorological
QMS	Quality Management System
SARPs	Standards and Recommended Practices
WMO	World Meteorological Organisation

Definitions

A list of definitions used in this manual has been included in Chapter 1 of Volume II. In addition the following terms/abbreviations have quite specific meanings when used in this Manual. They are defined below:

Accident	<p>Accidents refer to occurrences associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all persons have disembarked, , in which:</p> <ul style="list-style-type: none"> (a) a person is fatally or seriously injured as a result of — <ul style="list-style-type: none"> (i) being in the aircraft; (ii) direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or (iii) direct exposure to jet blast, <p>except where the injuries arise from natural causes, are self-inflicted or inflicted by other persons, or where the person injured is a stowaway hiding outside the areas normally available to passengers and crew;</p> (b) the aircraft sustains damage or structural failure which — <ul style="list-style-type: none"> (i) adversely affects the structural strength, performance or flight characteristics of the aircraft; and (ii) would normally require major repair or replacement of the affected component, <p>except for engine failure or damage which is limited to the engine, its cowlings or accessories, or for damage limited to propellers, wing tips, antennas, tyres, brakes, fairings, small dents or puncture holes in the aircraft skin;</p> (c) the weather element is a possible contributing factor; or (d) the aircraft is missing or completely inaccessible
Aeronautical MET Personnel (AMP)	<p>AMP refers to the Aeronautical MET Forecasters (AMF), Aeronautical MET Observers (AMO) and Aeronautical MET Technicians (AMT) whose duties and responsibilities support aeronautical MET services.</p>
Authority	<p>Refers to the Civil Aviation Authority of Singapore (CAAS) established under Section 4 of the Civil Aviation Authority of Singapore Act.</p>
Incident	<p>Incidents refer to events occurring in the airports during adverse weather (precipitation, lightning, wind-shear, strong wind, low visibility) which have impacted the air traffic or ground aircraft</p>

movements. These may be flight diversions or missed approaches due to bad weather, or hydroplaning occurrences.

Safety Safety is the state in which the risk of harm to persons or property damage is reduced to and maintained to an acceptable level through a continuous process of hazard identification and risk management.

Annex If not indicated otherwise, the word refers to Annex to the Convention of International Civil Aviation.

Chapter 1: Introduction

1.1 Background

1.1.1 This Manual of Standards – Meteorological Service for International Air Navigation (MOS-MET(IAN)) contains the standards, requirements and procedures pertaining to the planning and operation of generating meteorological products for air navigation. These include the maintenance of meteorological facilities.

1.1.2 This Manual is prepared with the primary objective of ensuring that the MET Service Provider maintains a high level of safety standards and is based on the SARPs as specified in the following Annexes to the Convention of International Civil Aviation in its provision of Aeronautical MET services and products. The Annexes concerned are primarily:

- a) Annex 3: Meteorological Service for International Air Navigation,
- b) Annex 11: Air Traffic Services (MET related issues only)
- c) Annex 12: Search and Rescue (MET related issues only)
- d) Annex 19: Safety Management

References are also made to a set of ICAO documents including:

	Document Number	Document Title
a.	4444	Air Traffic Management
b.	8896	Manual of Aeronautical Meteorological Practice
c.	9328	Manual of Runway Visual Range Observing and Reporting Practices
d.	9377	Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services
e.	9673	Asia and Pacific Regions Air Navigation Plan (Volume I & II)
f.	9691	Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds
g.	9734	Safety Oversight Manual
h.	9735	Safety Oversight Audit Manual
i.	9817	Manual on Low Level Wind-shear
j.	9837	Manual on Automatic Meteorological Observing Systems at Aerodromes
k.	9859	Safety Management Manual
l.	9873	Manual on the Quality Management System for the provision of Meteorological Service to International Air Navigation

1.1.3 In addition to the Manual of Standards, the following may also be issued as and when required to supplement the Manual of Standards:

- a) Safety Directive – this is a mandatory requirement to be complied by the MET Service Provider. It is published for purposes of immediate promulgation of local standards and recommended practices in response to, but not limited to, amendments to ICAO Annexes. The Safety Directives will be incorporated into subsequent amendments of the Manual of Standards.
- b) Safety Publication – this is published for purposes of promulgating supplementary guidance materials to the standards and recommended practices in the Manual of Standards. The publications are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the Manual of Standards. Safety Publications may explain certain regulatory requirements by providing interpretive and explanatory materials.
- c) Information Circular – this is published for purposes of bringing to the attention of the MET Service Provider educational materials related to aviation safety. The publications could be initiated as a result of ICAO State letters which do not require immediate changes to local regulations, new safety initiatives or international best practices as identified by the Authority. The MET Service Provider is encouraged to review and adopt the material if practicable. Where appropriate, the material in the publications may be incorporated into subsequent amendments of the Manual of Standards.

1.2 Non-Compliance with Manual

1.2.1 When the MET Service Provider is not able to comply with any standards specified or referenced in this Manual, the MET Service Provider shall apply to the Authority for exemption or deviation from the relevant standards. Applications shall be submitted in writing supported with the reasons for such exemption or deviation including any safety assessment or other studies undertaken, and an indication of when compliance with the current standards can be expected.

Chapter 2: Safety Management System

2.1 Introduction

- 2.1.1 The MET Service Provider shall establish a Safety Management System (SMS).
- 2.1.2 The key to a successful SMS is that all senior staff, from managers to meteorologists, weather observers and technical officers shall be trained to understand the need for it, and this understanding must permeate to staff of all levels. The MET Service Provider shall work towards nurturing a safety culture within the organisation and all of its maintenance contractors.
- 2.1.3 The MET Service Provider is responsible for responding to end-users queries, carrying out risk assessments, providing the assessment reports to the Authority for review and comments, and up-keeping of safety-related data and records.
- 2.1.4 To foster a safety culture within the organisation, the MET Service Provider shall share the following information with the Authority:
- a) Updates and changes in their aeronautical procedures and products, and its impact on safety (if any), including those listed in the Aviation Intranet;
 - b) Changes in key staff providing aviation weather support such as the Accountable Executive, Directors, Safety Manager, Senior MET Officers and Supervisors of Main MET Office and MET Stations;
 - c) Best practises of other meteorological offices which can enhance aviation safety;
 - d) Any service lapses in the delivery of their products, as well as their analysis on what can be done to prevent it from occurring again, to show their commitment to continually improve their processes.

2.2 Safety Management System

- 2.2.1 The SMS to be established shall comply with a SMS framework consisting of the following key components:
- a) **Safety Policy and Objectives**
 - (i) Management commitment and responsibility

The organisation shall adopt a clear fundamental approach for the management of safety. This includes setting the safety policies and how they relate to the operation and maintenance processes of the MET Service Provider. The policies shall also clearly encapsulate the senior management's commitment to improve safety in the organisation as a top priority, with the provision of the necessary human and financial resources for its implementation. The safety policy shall be periodically reviewed to ensure its continued relevance.

(ii) SMS Structure and accountabilities of managers

The SMS shall have a well-defined structure with clear lines of responsibilities and individual safety accountabilities. Safety accountabilities and authorities shall be documented and communicated throughout the organisation.

(iii) Appointment of key safety personnel

The MET Service Provider shall appoint a safety manager to serve as the focal point and driving force for the implementation and maintenance of SMS activities. The safety manager shall be sufficiently senior so as to expedite rapid implementation of safety measures. However, the safety manager shall not be held solely responsible for all the safety issues. Relevant functional and operational personnel are responsible for the operational safety performance and outcomes.

(iv) Coordination of emergency response planning

The MET Service Provider shall ensure that an emergency response plan and business continuity plan are in place to provide the essential weather services to support aviation. The plan shall also be properly coordinated with the emergency response plans and business continuity plans of those organisations it must interface with during the provision of its products and services.

(v) SMS implementation plan

The objective of the SMS is to systematically manage safety in a manner that meets the organisation's safety needs. A committee shall be formed to endorse and oversee the plans of SMS and their implementation. It shall also serve as a forum to discuss any safety issues in relation to the provision of services to support international air navigation. The committee shall include key AMP and the relevant maintenance contractor if the issues call for it.

(vi) SMS Documentation

- (1) A manual for SMS shall be produced for guiding and communicating the organisation's SMS approach and methodology to the whole organisation. Operating an SMS generates large amounts of data, documents and records. A systematic record of all these documents including risk assessment and incident/accident investigation reports shall be maintained and kept up to date.
- (2) The MET Service Provider shall submit the SMS manual and relevant materials to the Authority for acceptance.
- (3) The MET Service Provider shall submit any amendments to the SMS manual to the Authority for acceptance in a timely manner prior to implementation.

b) Safety Risk Management

(1) Hazard identification

The MET Service Provider shall develop and maintain a process that ensures that hazards associated with its aviation met products or services are identified. Hazard identification shall be based on a combination of reactive, proactive and predictive methods of safety data collection.

(2) Risk assessment and mitigation process

The MET Service Provider shall develop and maintain a process for effectively collecting data critical for risk assessment. The MET Service Provider is responsible for carrying out the assessment based on reports of incidents (which may be minor by themselves) and fault reports of critical systems/processes. These reports shall be submitted to the Authority.

(3) Safety Review Reports

Safety review of weather reports is critical to the effectiveness of SMS, and it shall be used as a means to improve the system. It is through a systematic safety review of the weather reports related to the incidents or accidents that short-comings of the system could be uncovered and rectified. The following shall be reviewed by the MET Service Provider and the reports as well as possible remedial actions shall be submitted to the Authority:

- a) Weather reviews of related Incident/accident and severe weather reports
- b) Safety related fault reports of critical systems

c) Safety Assurance

i. Safety performance monitoring and measurement

- (1) The MET Service Provider shall propose safety performance indicators (SPIs) and target levels to the Authority for agreement. These shall:
 - a) be pertinent to the MET Service Provider's aeronautical MET services; and
 - b) be commensurate with the scope and complexity of the MET Service Provider's aeronautical MET services;
- (2) The MET Service Provider shall submit a report on its achievement of the SPIs to the Authority on an agreed time interval.
- (3) The MET Service Provider shall develop and maintain the means to verify the safety performance of the organisation and to validate the effectiveness of safety risks controls. The safety performance of the

organisation shall be verified in reference to the safety performance indicators and safety performance targets of the SMS.

ii. The management of change

The MET Service Provider shall develop and maintain a process to identify changes (e.g. major organisational change, or changes in equipment/software deemed critical for provision of aviation services) within the organisation, which may significantly affect established processes and services. A risk assessment shall be carried out before the implementation of such changes, such as when upgrading or modification is made to a MET facility, in order to ensure safety performance. The risk assessment shall be submitted to the Authority for comments and acceptance at least one month before the implementation of the safety-related change.

iii. Continuous improvement of the SMS

The MET Service Provider shall monitor and assess the effectiveness of its SMS processes to enable continuous improvement of the overall performance of the SMS.

iv. Safety audit

The MET Service Provider shall prepare for regular internal/external safety audits. Maintenance contractors of critical systems, such as low-level wind-shear detection systems, shall also be subject to regular auditing.

d) Safety Promotion

i. Training and education

The MET Service Provider shall develop and maintain a safety training programme that ensures that personnel are trained and competent to perform the SMS duties. The scope of the safety training shall be appropriate to each individual's involvement in the SMS.

ii. Safety Communication

The MET Service Provider shall develop and maintain a formal means for safety communication that:

- 1) ensures personnel are aware of the SMS to a degree commensurate with their positions;
- 2) conveys safety-critical information;
- 3) explains why particular safety actions are taken; and
- 4) explains why safety procedures are introduced or changed.

CHAPTER 3: Personnel and Training Requirement

3.1 Competency Standards For Aeronautical MET Personnel (AMP)

3.1.1 Conduct of Assessment

The MET Service Provider shall:

- a) assess the competency of its AMP.
- b) ensure that the competency assessment is in accordance to the guidelines developed and endorsed by the WMO Commission for Aeronautical Meteorology (CAeM).
- c) ensure that all AMPs satisfy the competency standards.

3.1.2 Requirement for Assessors

The MET Service Provider shall:

- a) appoint Assessors to conduct the competency assessment for its AMP;
- b) ensure that the Assessors are not the direct Supervisor of the AMP under assessment in order to prevent conflict of interest;
- c) ensure that the Assessors are adequately trained to conduct the assessment;
- d) ensure that the Assessors of the AMF possess a meteorological qualification which satisfies the WMO's Basic Instruction Package for Meteorologists (BIP-M) and have at least three years of operational experience as an AMF; and
- e) ensure that the Assessors for the AMO and AMT possess a meteorological qualification which satisfies the WMO's Basic Instruction Package for Meteorological Technician (BIP-MT) and have at least five years operational experience as an AMO or AMT.

3.2 Qualifications and Training Requirements for Aeronautical Meteorological Forecaster

3.2.1 The Aeronautical Meteorological Forecaster (AMF) shall be a WMO meteorologist: a person who holds a university degree or equivalent; has acquired an appropriate level of knowledge of mathematics, physics, chemistry and computer science, and has completed the Basic Instruction Package for Meteorologists (BIP-M) or equivalent.

3.2.2 The AMF shall also be trained in the Aeronautical Meteorology specialisation either through courses at WMO-certified training institutions along with BIP-M or less formally during attachments to aeronautical meteorological office. The AMF shall be familiar with:

- a) phenomena that may impact on flight operations (aircraft Icing, turbulence, volcanic ash, etc);
- b) procedures for meteorological services for international air navigation, as in MOS-MET Vol II and MET part of Air Traffic Service Manual;
- c) WMO/ICAO regulatory roles and documentation.

3.2.3 The AMF shall undergo on-the-job training for a period of at least 3 to 4 months as an aeronautical meteorological forecaster. The on-the-job experience shall encompass situations where the trainee will be exposed to both hazardous and non-hazardous weather conditions.

3.2.4 For an experienced meteorological forecaster from an alternative meteorological specialisation, the on-the-job experience can be shortened to a period not more than 3 months.

3.3 Qualification and Training Requirements for Aeronautical Meteorological Technician

3.3.1 The Aeronautical Meteorological Technician/Observer (AMT/AMO) shall be a Meteorological Technician, a person who has completed the Basic Instruction Package for Meteorological Technicians (BIP-MT) or equivalent.

3.3.2 The AMT shall also be trained in the Aeronautical Meteorology for technicians elective option which covers the following topics:

- a) Basic Meteorology including phenomena that may impact on flight operations;
- b) Observation and relevant WMO/ICAO codes;
- c) Meteorological aspects of flight planning;
- d) Procedures for meteorological services for international aviation;
- e) Instrumentation and/or any other appropriate topics as decided by the MET Service Provider.

3.3.3 The AMT/AMO shall undergo at least 4 months of on-the-job training as an aeronautical meteorological technician. The on-the-job experience shall encompass situations where the trainee will be exposed to both hazardous and non-hazardous weather conditions.

3.3.4 For an experienced technician from an alternative meteorological specialisation, the on-the-job experience can be shortened to not more than 4 months.

3.4 Qualifications and Training Requirements for Safety Personnel

3.4.1 Safety Manager / Senior Safety Management Staff identified shall undergo relevant aeronautical safety management system training.

Chapter 4: Safety Review and Investigation

4.1 Incident / Accident Reports

- 4.1.1 For the MET Service Provider, the source of information regarding incidents/accidents affecting aviation operations often comes from requests for weather data on a particular date/time from end-users. Owing to internal policies of some organisation (e.g. an airline's policy) end-users may not divulge details of the events. However, for the purpose of risk assessment, the knowledge of an event occurring when significant weather is prevailing may be sufficient. The MET Service Provider shall examine the Meteorological products (observations, forecasts, warnings and alerts, etc.) and services provided in the context of safety, compliance with Vol II of this manual and quality targets and take corrective/improvement actions when necessary.
- 4.1.2 The requests or queries by the end-users on weather conditions in relation to an aviation incident/accident may be made to various sections/departments of MSS. For ease of access and review, the MET Service Provider shall establish a centralised archive (preferably in electronic form) of all the reports provided to end-users. In addition to responding to the queries, the MET Service Provider shall examine the meteorological products related to any weather-related aviation incidents/accidents. The MET Service Provider shall examine the performance of the products issued with regards to safety, compliance with this manual and quality target and submit a report in standard format (Appendix 1: Weather Report for Incident/Accident Form) within 3 weeks from the occurrence of the aviation incident/accident.

4.2 Severe Weather Reports

- 4.2.1 In view of the potential danger of low-level wind-shear and microburst and their relative common occurrences, the MET Service Provider shall keep a severe weather database of all wind-shear (including microbursts) events detected by the weather radar system that are stronger than or equal to 30 knots for Changi airports.
- 4.2.2 Low visibility due to various weather phenomena can have an impact on the safety of aircraft operation. Hence, the severe weather database shall also include weather events that resulted in reduced visibility of 800 metres or less at Changi and Seletar airports.
- 4.2.3 The MET Service Provider shall provide a summary quarterly, reviewing the effectiveness of warnings (wind-shear and aerodrome) and trend forecasts with regards to the timing and intensity of significant weather concerned for all events in the severe weather database. These quarterly reports shall be submitted to the Authority within one month from the end of the quarter. For example, report for the period of January – March shall be submitted by the last day of Apr.

4.3 System Fault Reports

- 4.3.1 Any fault discovered for critical meteorological system managed/maintained by the MET Service Provider shall be reported to the maintenance vendors; and details

recorded in a fault report. In the context of this manual, systems are considered critical if data generated are to be used directly for Air-traffic management. An example of such system is the Meteorological Doppler Weather Radar which provides wind-shear and microburst alerts to Air-traffic controllers. Also to be considered as critical systems are software applications/packages that feed data to air-traffic management systems.

- 4.3.2 The MET Service Provider shall be responsible for keeping records of all fault reports of critical systems which shall include
- a) Date/Time fault is discovered,
 - b) Description of the fault,
 - c) Remedy action taken,
 - d) Date/time fault is resolved.

Records of routine and ad hoc equipment servicing shall also be maintained.

4.4 Systems Review

- 4.4.1 The MET Service Provider shall submit to the Authority a summary report for critical meteorological systems at least once every quarter, within one month of the end of the period. Where appropriate, calibration results shall also be included. The report shall include:
- a) Total downtime for the month
 - b) Number of faults for the month.
 - c) Detailed report of a fault if it causes the system to be down for more than 24 hours. This report shall be submitted to the Authority within 2 weeks from the time the system is first down. In more complex cases whereby input from external parties is needed, a preliminary report shall be submitted within 2 weeks from the time the system is first down and the full detailed report shall be submitted within 4 weeks from the time the system is first down.
- 4.4.2 The MET Service Provider shall use suitable performance indicators, including the actual system uptime of the critical systems, to monitor the performance of the critical systems. The MET Service Provider shall take steps to improve the performance of the systems if the performance of any of the system is deemed unsatisfactory.
- 4.4.3 For critical meteorological systems owned by external parties, the MET Service Provider shall provide monthly feedback to the Authority of any faults encountered in the systems for the purpose of review and performance monitoring. The Changi AWOS and LLWAS systems which are currently owned by CAAS fall under this category.

4.5 System Commission and Upgrade Process

- 4.5.1 The MET Service Provider shall establish procedures to ensure that each new facility is commissioned to meet the specifications for that facility. The purposes of the procedure are to ensure that the system performance of the new facility has been

validated by all the necessary tests and that the MET Service Provider, its maintenance contractors as well as the appropriate representatives of the User have accepted and are satisfied with the results of the tests.

- 4.5.2 The procedures shall include the documentation of all the tests conducted on the facility prior to the commissioning. The documentation shall also include the names and signatures of all persons who conduct or witness the tests, including representatives from the User of the facility as well as the maintenance contractor. The purpose of this process is to ensure that the introduction of new meteorological system or changes to existing meteorological systems will not compromise the quality and reliability in the provision of information for ensuring safety performance.
- 4.5.3 Pre-functional testing shall be conducted for all meteorological systems (including critical systems as well as software that are used to generate products for aeronautical MET) according to governing codes, regulations, manufacturer's recommendations and International SARPs.
- 4.5.4 Critical systems shall undergo a minimum test period of 2 months, while other systems/software shall undergo a minimum test period of at least 1 month.
- 4.5.5 The performance of the system shall be closely monitored during the testing period and all faults reported and the corrective actions taken shall be recorded.
- 4.5.6 Before the actual upgrade or commission of the system, the MET Service Provider shall submit an implementation and failure mitigation plan to the Authority.
- 4.5.7 The report shall also include results of the pre-functional testing and all records of faults and corrective actions during the test period.
- 4.5.8 In any special circumstances whereby the minimum test period cannot be adhered to, the MET Service Provider shall submit a report detailing the justification for not adhering to the minimum test period.

4.6 Safety Investigation

- 4.6.1 Any serious service failures or safety incidents shall be reported to the Authority (via handphone and/or email) within 24 hours of occurrence and be investigated by the MET Service Provider. The purpose of the investigation is to understand how and why the

incident happened, including possible organisational contributing factors and to recommend actions to prevent a recurrence.

- 4.6.2 Serious service failures refer to those incidents which affect the loss of performance of the critical systems causing a breach to the established service level agreement and/or the safety performance targets.
- 4.6.3 Safety incidents refer to any incident involving a hazard to the provision of aeronautical MET services. Safety incidents include, but not limited, to the followings:
- a) Fire hazards – such as a fire or explosion at a MET location such as at CFO, Changi or Seletar MET station
 - b) Operational manning hazards - such as loss of manpower to man 24/7 observations and/or forecast
 - c) Security breaches at a MET location - such as resulting in theft of critical Met equipment used to support aviation MET services or generate forecasts.
 - d) IT security breaches – such as resulting in breakdown of aviation MET intranet services.
- 4.6.4 A copy of the investigation report shall be forwarded to the Authority within 6 weeks of occurrence. The lessons learnt from such investigation shall also be disseminated to relevant AMP to raise their safety awareness.

Note – Depending on the circumstances of the serious service failure or safety incident, such as whether the MET Service provider has violated any regulatory requirements, the Authority may conduct its own investigation in addition to that conducted by the MET Service Provider.

Chapter 5: Meteorological Facility – Operation and Maintenance

5.1 Operation and Maintenance Plan

5.1.1 Safety Critical MET Facilities are those hardware or software applications that generate/disseminate meteorological data directly for use in managing air-traffic. These include low-level wind-shear detection systems (Meteorological Doppler Weather Radar, LLWAS), applications for formatting VOLMET broadcast or server to upload data to LORADS. In order to maintain the required level of performance, the MET Service Provider shall establish an overall operation and maintenance plan, which shall meet the following safety requirements as stipulated in ICAO Doc 4444 (ATM/501), Chapter 2:

- a) The MET facilities shall:
 - i. be tested for normal operations on a routine basis;
 - ii. meet the required level of accuracy, reliability and availability through a combination of routine calibrations, testing and/or regular parts replacement, and timely resolution of system failures;
 - iii. provide for the timely and appropriate detection and warning of system failures and degradations.
 - iv. include documentation on the consequences of system, sub-system and equipment failures and degradations; and
 - v. include measures to control the probability of failures and degradations.
- b) Detailed records of systems and equipment serviceability shall be kept and periodically reviewed.

5.1.2 In addition to meeting the above safety requirements, the MET Service Provider shall also establish an operation and maintenance plan for each facility. The plan shall include:

- a) A procedure for the periodic inspection of each facility to verify that it meets the operational and performance specification of that facility;
- b) The operation and maintenance instructions for each facility;
- c) An analysis of the number of personnel required to operate and maintain each facility taking into account the workload required;
- d) The corrective plan and procedures for each facility, such as whether the repair of modules and component are undertaken in-house or by equipment manufacturers;
- e) The spare support plan for each facility.

Chapter 6: Documentation and Records

6.1 Documents and Records

- 6.1.1 The MET Service Provider shall maintain documents and records of operation and maintenance of the service for both safety oversight and quality management purposes. These documents shall include:
- a) The MET Service Provider's Quality Management System;
 - b) The MET Service Provider's quality records (weather forecasts assessments) for an appropriate length of time;
 - c) Record of malfunction/fault of critical safety facilities;
 - d) Reports of queries on weather information for incidents/accidents that occurred in the airports (Seletar/Changi). These are for risk assessment purposes;
 - e) Documents related to Audits conducted by the Authority;
 - f) Archive of low- low-level wind shear/microburst and periodic analysis for risk assessment purposes;
 - g) Record of job description, training programme and training record of each staff.

6.2 Document Control

- 6.2.1 The MET Service Provider shall establish a process for the authorisation and amendment of these documents to ensure that they are updated all the time. The process shall ensure that:
- a) the currency of the documentation can be readily determined;
 - b) all amendments to the documentation are controlled in accordance with established quality management principles;
 - c) only current versions of documents are available.
- 6.2.2 Documents may be held as computer based records provided that where paper copies of computer-based records are made, they are subjected to the same control as paper documents.

Weather Report for Incident/Accident Form

REPORT NUMBER (e.g. WR/2018/01): INCIDENT/ACCIDENT LOCATION : DATE/TIME OF INCIDENT/ACCIDENT : PREPARER NAME AND DEPT: _____ SIGN : _____
DETAILS OF INCIDENT/ACCIDENT (PROVIDE AS MUCH INFORMATION AS POSSIBLE) :
SUMMARY OF WEATHER CONDITION :
ATTACHMENTS FOR DETAILED WEATHER RECORDS/RESPONSES TO END USERS (AIRLINES/CAAS) :
SAFETY MANAGER
REVIEW / AREAS OF CONCERN / ACTION TAKEN (in consultation with Dept Dirs): Estimated date of completion (if any): _____
OTHER COMMENTS:
Safety Manager Sign: _____ Date: _____