Full automation of aeronautical meteorological observations and reports at aerodromes

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Amendments and corrigenda

Date of issue	Detail
10 February 2017	First edition (body part only) issued
6 March 2017	Attachments and annexes added (provisional; to be revised after proofreading) along with editorial amendments
29 March 2017	Revised based on proofreading
19 March 2019	Addition of aerodromes with full automation
30 March 2020	Addition of aerodromes with full automation
8 October 2020	Subtraction of an aerodrome due to suspension of aviation weather service
2 September 2021	Addition of an aerodrome with full automation
22 December 2021	Addition of aerodromes with full automation
27 January 2022	Addition of an aerodrome with full automation
16 March 2022	Addition of aerodromes with full automation and amendments of Attachments 1, 5 and 6
1 December 2022	Amendment of Attachment 5 to include possible switching back to automated METAR/SPECI functionality
16 March 2023	Addition of aerodromes with full automation and an amendment of Attachment 6
1 February 2024	Addition of aerodromes with full automation and amendments due to expansion of time slots for full automation

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Full automation of aeronautical meteorological observations and reports at aerodromes

1 Introduction

The Japan Meteorological Agency (JMA) commenced fully automated meteorological observations and reports for selected airports in March 2017. This is referred to here as *full automation*, and the observations and reports involved are collectively referred to as *automated METAR/SPECI*[*1].

After full automation, automated METAR/SPECI replace conventional reports, which partly depend on manned (including visual) observations. Through the development and introduction of cutting-edge technologies and algorithms, JMA's new automatic observing system monitors weather phenomena and related changes more accurately and more objectively than the conventional system, and automated METAR/SPECI report weather conditions along runways more appropriately.

However, it should be noted that automated observation differs from manned observation and involves a number of technological limitations. Accordingly, JMA also provides aerodrome weather camera images to support the maintenance and improvement of aviation safety and add to the convenience of meteorological information users. JMA's Aviation Weather Service Centers and Aviation Weather Stations are additionally available to answer weather-related inquiries from users.

Full automation has been made possible by joint efforts among users (Skymark Airlines, All Nippon Airways and Japan Airlines), the Japan Civil Aviation Bureau and JMA in evaluating the potential for such development at aerodromes and identifying/resolving related issues. JMA takes relevant actions as necessary, including quality assessment for automated METAR/SPECI.

This document describes outlines the characteristics of full automation and gives an overview of automated METAR/SPECI, in consideration of the joint efforts mentioned above.

**1 Descriptions regarding automated local routine/special reports are omitted in this document except when such reports need to be clearly distinguished from automated METAR/SPECI. Where no such distinction is made, this type of reporting is comparable to that of automated METAR/SPECI.*

2 Overview

2.1 Background

Aeronautical meteorological information is essential not only for the safety and regularity of aircraft operations but also, especially in recent years, for flight efficiency and comfort. Against such a background, there is a need for even more detailed and precise information of this kind. However, the increasingly challenging conditions of the air transportation field also call for further optimization.

In consideration of these worldwide circumstances, full automation has been or is being implemented in some European countries and the US following the approval of provisions enabling the use of fully automatic observing systems in Annex 3 to the Convention on International Civil Aviation — *Meteorological Service for International Air Navigation*. Users of automated meteorological reports (similar to the automated METAR/SPECI to be introduced in Japan) value the efficiency,

consistency and regularity of the information provided. Against this background, JMA has carefully considered the potential for full automation and proceeded with the development of its own technologies for introduction in Japan.

In tandem with the phased renovation of aerodrome meteorological observation systems, JMA has leveraged modern technological development to introduce a new system that can automatically determine elements previously covered by manned observation (e.g., visibility, present weather and cloud ceiling) and include them in automated METAR/SPECI.

2.2 Status of full automation (as of 1 February 2024)

- Attachment 1 shows the aerodromes with full-automation time slots.
- The format of automated METAR/SPECI is similar to that of the conventional manned METAR/SPECI. As outlined here, differences include the use of an AUTO identifier after the date and time of observation and the use of the term UP (unidentified precipitation) in the present-weather section (see Section 5).
- JMA provides aerodrome weather category information for aerodromes where all-day full automation is implemented (see the **Appendix**).

JMA will continue developing new technologies and improving the new automatic observing system. Users are also invited to submit feedback after the commencement of full automation and JMA will review the algorithms and settings as required.

3 Automated observations and reports

3.1 Characteristics of automated observations and reports

The service provided by automated METAR/SPECI is equivalent to or better than that of the current manned METAR/SPECI thanks to the experience and expertise of the contributing European nations and the US, as well as cutting-edge technologies and algorithms developed and introduced by JMA. The system can report weather phenomena and related changes more accurately and more objectively, clarifying weather conditions around runways appropriately. Aerodromes where reports are provided in Japan's SCAN code form derive particular benefit from full automation. These reports are replaced with information in METAR and SPECI international standard code forms, in conjunction with which aerodrome special meteorological reports are commenced. Accordingly, weather reports for these aerodromes become more detailed and more user-friendly than ever before.

However, differences between manned and automated observations and reports, technological limitations and the potential for missing reports due to system failure should be noted. As outlined later, weather phenomena in the vicinity of aerodromes (except thunderstorms) cannot be observed/reported in automated METAR/SPECI, and types of freezing or frozen precipitation cannot be identified with current technology. To address such issues and maintain/improve aviation safety and convenience for aeronautical meteorological information users, JMA implements measures such as the provision of aerodrome weather camera images and partial continuation of manned observation for freezing/frozen precipitation in winter. In regard to possible system failure, JMA takes action to reduce related impacts on reporting and takes precautionary measures such as introducing system duplication and enhanced lightning protection. JMA's relevant Aviation Weather Service Centers and Aviation Weather Stations are also available to answer user inquiries on automated METAR/SPECI content.

3.2 Routine observations and reports

- Automated routine reports (automated METAR) have the same headers as manned reports (data type codes: SAJP (METAR) or SAARP (local routine reports)).
- Automated METAR reporting frequency is the same as that of current manned METAR and SCAN (routine reports).
- Full automation ensures high reporting regularity.
  - During full-automation time slots, TREND reports for Narita International Airport, Chubu Centrair International Airport, Kansai International Airport and Fukuoka Airport (issued between 23:00 and 05:30 JST (1400 and 2030 UTC)) are appended to automated METAR (but not to local routine reports).

3.3 Special observations and reports

- Automated special reports (automated SPECI) have the same headers as manned reports (data type codes: SPJP (SPECI) or SPARP (local special reports)).
- Automated SPECI is issued in line with criteria for special observations (referred to here as *SPECI criteria*).
- At aerodromes listed in Table 1 and 2 of Attachment 1, the SPECI criteria for manned hours (daytime) are applied.
- At the aerodromes where special observations are commenced with full automation, it becomes possible to automatically report changes between routine observations on the hour. SPECI criteria for these aerodromes are established on the basis of weather minima and other considerations.
- Automated observations and reports provide detailed weather information that also highlights deterioration/improvement of meteorological conditions.
- As reporting every minor detail of deterioration/improvement would be excessive, deteriorations in visibility (VIS), ceiling (CLG) or present weather are reported only after the deterioration has continued for around 2 minutes, and improvements are reported after continuation for around 5 minutes.

3.4 Provision of meteorological information services in extended aerodrome operational hours and full-automation time slots.

- When aerodrome operational hours are extended or aviation meteorological services are required for emergency helicopter operations during nighttime at the aerodromes listed in Tables 2 and 3 of Attachment 1, automated METAR/SPECI will be issued. Special reports in response to requests (Q reports) compiled using data from the automatic observing system are also available.

3.5 Special observations and reports in response to requests or aircraft emergencies

- During full-automation hours, Q reports or aircraft emergencies (A reports) for automated aerodromes are compiled using data from the automatic observing system.
- Headers are not changed (data type code: REQUE).
- At aerodromes where air-report content is provided to users via Q reports, there will be no change in this status after the commencement of full automation.

3.6 Others

- On JMA's dedicated MetAir website for aeronautical users, automated METAR/SPECI are displayed in place of the conventional manned METAR/SPECI or SCAN.
- PIREP are appended to automated METAR/SPECI as with manned METAR/SPECI.

4 Characteristics of values to be reported by automated METAR/SPECI

4.1 Observation procedures

- Surface wind direction and speed, air temperature, dew-point temperature, pressure for altimeter setting (QNH) and runway visual range (RVR; aerodromes listed in Table 1 and 2 of Attachment 1) are already instrumentally monitored in manned METAR/SPECI and SCAN. There is no difference between manned and automated observations and reports of these elements.
- Visibility, present weather and cloud amount/base height are monitored using newly developed algorithms and methods (as outlined below) with data from aerodrome-based sensors, ground weather radars and other equipment (see **Annex 1**).

a) Visibility

- Visibility is monitored with 1-minute mean values (calculated every 15 seconds) of meteorological optical range (MOR) measured using RVR observing equipment or visibility meters.

b) Present weather (except TS in d))

- Determination of rain (RA), snow (SN), sleet (RASN/SNRA), fog (FG), mist (BR), haze (HZ) and unidentified precipitation (UP) is conducted every 15 seconds using RVR observing equipment (or visibility meter), thermometer, hygrometer and rain gauge data.
- Squall (SQ) is identified using surface wind sensor data.

c) Cloud amount and cloud base height (except for CB and TCU in d))

- Values are calculated every 15 seconds using ceilometer and surface wind sensor data.

d) Thunderstorm (TS), cumulonimbus clouds (CB) and towering cumulus clouds (TCU)

- Determination of TS, CB and TCU are conducted every 5 minutes using JMA's Lightning Detection Network System (LIDEN) and ground weather radar data.

4.2 Major characteristics of values to be reported by automated METAR/SPECI (differences from those reported by manned METAR/SPECI)

As described in 4.1, some elements in automated METAR/SPECI are determined using methods different from those of manned (visual) observations and/or observation in different locations. Such differences will in turn create differences in the characteristics of the elements. The major characteristics are listed from a) to c) below (see **Annex 2**).

In automated METAR/SPECI, except for thunderstorm (TS), weather phenomena in the vicinity of the aerodrome are not reported. Partial fog is not reported. Therefore, to clarify meteorological conditions around the aerodromes, please use aerodrome weather camera images JMA provides. Commentary on aerodrome meteorological conditions is provided on request. To request this service, contact an Aviation Weather Service Center or Aviation Weather Station for the aerodromes listed in Table 1 of Annex 1. For other aerodromes, contact the relevant caretaking Aviation Weather Service

Center or Aviation Weather Station.

a) Visibility

- Visibility in automated observation is determined using RVR observing equipment or visibility meters sited to give the best practicable indication of visibility along the runway and touchdown zone. Accordingly, data closely represents runway and touchdown zone conditions, which is expected to increase utility for decisions on take-off and landing.
- For judgement of instrument meteorological conditions (IMC) or visual meteorological conditions (VMC) and weather minima, visibility reported in automated METAR/SPECI are used in the same way as the prevailing visibility reported in manned METAR/SPECI.
- Visibility reported in automated METAR/SPECI is comparable to prevailing visibility in manned METAR/SPECI, or may tend to be slightly lower. (This tendency will be especially conspicuous with strong intermittent rain (i.e., when precipitation intensity is not uniform)).
- When fog is present only at the site of the relevant RVR observing equipment (or visibility meter) or over the whole airport except this site, visibility reporting in automated METAR/SPECI may differ significantly from that in manned METAR/SPECI data.
- Directional variations in visibility are not monitored in automated observation.

b) Present weather

- Characteristics such as showers (SH) and proximity metrics such as vicinity (VC) are not observed.
- Partial and patchy fog (PRFG and BCFG, respectively) is not observed. Any type of fog at RVR observing equipment or visibility meter sites is reported as fog (FG).

- Precipitation is identified as rain (RA), snow (SN) or sleet (RASN/SNRA) based on air temperature and humidity. Other frozen precipitation types (small hail and/or snow pellets (GS), hail (GR), etc.) and freezing (FZ) characteristics are not identified[*2].
  - Precipitation may be reported as unidentified precipitation (UP) if the precipitation type cannot be identified by the automatic observing system (including in cases of thermometer failure).
  - Thunderstorm (TS) is detected objectively using JMA Lightning Detection Network System (LIDEN) data. Unlike manned observation, such detection is not affected by sky brightness or airport noise. TS intensity is not observed or reported.

**2 Methods to identify types of freezing or frozen precipitation have not been fully established even in pioneering countries. JMA continues study and technological development in this area.*

c) Cloud

- Values are estimated using ceilometer data from the last 30 minutes with time-based weighting. This represents conditions above aerodromes and in the vicinity effectively.
- Clouds not passing above a ceilometer (e.g., still clouds at the base of mountains) are not observed.
- As ceilometer data are also used for reference in manned cloud base height observation and reporting, heights reported in automated METAR/SPECI are virtually the same as those in the manned type. However, at aerodromes where cloud base heights are observed from rooftops or other locations at altitude in manned observation, there may be large differences in low stratus or fog data.

- Cloud types are not observed (identified), and are omitted in automated METAR/SPECI. However, this does not apply to convective clouds of operational significance (CB and TCU), which are detected via special procedures.

5 Differences between automated reports (automated METAR/SPECI) and manned reports (manned METAR/SPECI and SCAN)

Automated local routine reports, local special reports, METAR and SPECI are identified with insertion of the *AUTO* identifier after the date and time of observation.

Attachment 2 shows a table comparing automated METAR/SPECI, manned METAR/SPECI and SCAN, and **Attachment 3** gives examples of manned and automated local routine reports as well as manned and automated METAR.

6 Differences between automated METAR/SPECI and conventional METAR AUTO

In automated observations and reports, advanced algorithms developed for full automation are used to determine present weather, cloud amount and cloud base height. Automated METAR/SPECI differ from the conventional METAR AUTO (data type code: SAXX95) currently issued for 75 Japanese aerodromes[*3] at 10-minute intervals via MetAir and other channels.

Attachment 4 shows a table comparing automated METAR/SPECI and conventional METAR AUTO.

**3 Issuance of conventional METAR AUTO for aerodromes with full automation will continue after the commencement of full automation. However, to avoid confusion resulting from different values obtained using different methods and algorithms, visibility, present weather and cloud are not reported, and these values will be represented by slashes (/) in conventional METAR AUTO format for the said aerodromes.*

7 Switching to manned (visual) observation when freezing/frozen precipitation is expected or observed

As mentioned above, the precipitation types reported in automated METAR/SPECI will be limited to rain (RA), snow (SN) and sleet (RASN/SNRA).

To support the setting of holdover time (HOT) for anti-icing fluid supply to departing aircraft at some of the aerodromes[*4] listed in Tables 1 and 2 of Attachment 1, automated METAR/SPECI are replaced with manned METAR/SPECI when freezing or frozen precipitation such as snow is expected or observed during full-automation time slots (see **Attachment 5**). During such times, observation and reporting are conducted as per daytime operation.

**4 Narita International Airport, Chubu Centrair International Airport, Kansai International Airport, Fukuoka Airport, Hakodate Airport, Kushiro Airport, Asahikawa Airport, Fukushima Airport, Niigata Airport, Osaka International Airport, Izumo Airport, Hiroshima Airport, Kochi Airport, Yamaguchi-Ube Airport, Kitakyushu Airport and Miyazaki Airport.*

8 System failure countermeasures and response

8.1 System failure countermeasures (including precautionary measures)

a) Central system of JMA's Airport Integrated Meteorological Observing System (AIMOS)

- The Tokyo-based AIMOS central system used to create automated reports is duplicated. An identical AIMOS back-up system in Osaka ensures regional redundancy.
- The com links between the local systems of AIMOS at each aerodrome (referred to here as *AIMOS aerodrome system*s) and the AIMOS central/back-up system are also duplicated.
- In the event that the central and back-up systems both fail, automated METAR/SPECI reporting will be continued via AIMOS aerodrome systems.

Accordingly, automated METAR/SPECI compilation and reporting are characterized by high fault-tolerance and reliability.

b) AIMOS aerodrome systems

- At aerodromes where the whole observing system (including instrumentation) is renovated, local com links are also upgraded with optical cables, and lightning arresters (SPD) are installed for enhanced lightning protection.
- Two surface wind sensors and two thermometers are installed per site.
- Spare parts for visibility meters (i.e., transmitters and receivers) and ceilometers (i.e., transmitting and receiving units) are stored at the aerodromes for early recovery in the event of system failure.
- The processing units of AIMOS aerodrome systems are standardized among the aerodromes so that spare parts can be effectively deployed, and maintenance/replacement procedures are unified. These developments are expected to optimize and speed up related work.

8.2 Response to system failure (in the event of missing automated METAR/SPECI)

If elements cannot be determined due to automated observing system failure, alternative action will be taken (see **Attachment 6**).

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Attachment 1 Aerodromes with full automation

Table 1, 2 and 3 show aerodromes where fully automated meteorological observations and reports are implemented.

Table 1 Aerodromes with full automation at certain times of day where Aviation Weather Service Centers or Aviation Weather Stations are located

Airports	**Aviation Weather Service Centers / Stations**	**Time slot for full automation**	**Types of Automated observations and reports**
Narita International Airport	Narita Aviation Weather Service Center	23:00 JST –05:59 JST*1	Routine observations and reports (every half hour) Special observations and reports Special observations and reports in response to requests (Q report) Special observations and reports in response to aircraft emergencies (A report)
Chubu Centrair International Airport	Chubu Aviation Weather Service Center		
Kansai International Airport	Kansai Aviation Weather Service Center		
Fukuoka Airport	Fukuoka Aviation Weather Service Center		
Naha Airport	Naha Aviation Weather Station		

*1 These time slots are based on consideration of periods during which there are relatively few landings and take-offs and of the night curfew. They are subject to temporary change due to weather conditions.

Table 2 Aerodromes with full automation at certain times of day where no Aviation Weather Service Centers or Aviation Weather Stations are located

Airports	Caretaking Aviation Weather Service Centers / Stations	Time slot for full automation*2	Types of Automated observations and reports
Hakodate Airport	New Chitose Aviation Weather Station	1 May to 24 October: 20:30 JST – 07:29 JST 25 October to 30 April: 20:30 JST – 07:14 JST	Routine observations and reports (every hour) Special observations and reports Special observations and reports in response to requests (Q report) Special observations and reports in response to aircraft emergencies (A report)
Kushiro Airport		21:00 JST – 07:59 JST	
Asahikawa Airport		21:00 JST – 07:59 JST	
Fukushima Airport	Tokyo Aviation Weather Service Center	April to October: 21:00 JST – 07:59 JST November to March: 21:00 JST – 07:44 JST	
Niigata Airport		April to October: 21:30 JST – 07:29 JST November to March: 21:30 JST – 07:14 JST	
Osaka International Airport	Kansai Aviation Weather Service Center	April to October: 21:00 JST – 06:59 JST November to March: 21:00 JST – 06:44 JST	
Izumo Airport		April to October: 20:30 JST – 07:29 JST November to March: 20:30 JST – 07:14 JST	
Hiroshima Airport		April to October: 22:30 JST – 07:29 JST November to March:	

Airports	Caretaking Aviation Weather Service Centers / Stations	Time slot for full automation*2	Types of Automated observations and reports
		22:30 JST – 07:14 JST	
Kochi Airport		21:00 JST – 06:59 JST	
Yamaguchi-Ube Airport	Fukuoka Aviation Weather Service Center	April to October: 21:30 JST – 07:29 JST November to March: 21:30 JST – 07:14 JST	
Kitakyushu Airport		00:00 JST – 05:59 JST	
Miyazaki Airport		21:30 JST – 07:29 JST	
Amami Airport		19:30 JST – 07:59 JST	
Miyako Airport	Naha Aviation Weather Station	21:00 JST – 07:59 JST	
New Ishigaki Airport		21:00 JST – 07:59 JST	
Shimojishima Airport		19:30 JST – 09:59 JST	

* 2 Routine reports are issued throughout these time slots, while time periods for provision of special reports are set based on coordination among relevant organizations. Slots may be changed in line with weather conditions and other factors.

Table 3 Aerodromes with all-day full automation

Airports	Caretaking Aviation Weather Service Centers / Stations	Time slot for full automation	Types of Automated observations and reports
Iki Airport	Fukuoka Aviation Weather Service Center	24 hours*3	Routine observations and reports (every one hour) Special observations and reports Special observations and reports in response to requests (Q report) Special observations and reports in response to aircraft emergencies (A report)
Kikai Airport			
Tokunoshima Airport			
Yoron Airport			
Minamidaito Airport	Naha Aviation Weather Station		
Kitadaito Airport			
Tarama Airport			
Yonaguni Airport			

* 3 Routine reports are issued on a 24-hour basis, while time periods for provision of special reports during aerodrome non-operational hours are based on coordination among relevant organizations.

Attachment 2

Table 1 Comparison of values to be reported in automated METAR/SPECI, manned METAR/SPECI and SCAN
(See notes for differences in local routine/special reports and METAR/SPECI.)

Element	**Automated METAR/SPECI** (See notes.)	**Manned METAR/SPECI** (See notes.)	**SCAN**
Visibility	− 1-minute mean values of MOR measured using RVR observing equipment or visibility meters sited along the runway − Directional variations in visibility are not reported.	− Prevailing visibility based on 360-degree observation from rooftops and other locations − Directional variations in visibility are reported in RMK (remarks) in accordance with the relevant criteria*.	− Prevailing visibility based on 360-degree observation from rooftops and other locations − Directional variations in visibility are not reported.
Present weather	[See **Table 2** for details] − Characteristics such as showers (SH), proximity metrics such as vicinity (VC), and partial and patchy fog (PRFG and BCFG, respectively) are not reported in automated METAR/SPECI. − Mist (BR), fog (FG) and haze (HZ) are the only obscuration types reported in automated METAR/SPECI. − Rain (RA), snow (SN) and sleet (RASN/SNRA) are the only precipitation types reported in automated METAR/SPECI. Characteristics such as freezing (FZ), small hail and/or snow pellets (GS) and hail (GR) are not currently reported in automated METAR/SPECI.		− Only one of the following present weather phenomena is reported as special present weather (in order of priority): FC, +TS, TS, SHGR, BLSN, +SN, SN, +RA, RA, FG, BR. − Rain and snow intensity is reported only in the categories of heavy (+RA, +SN) and moderate or lighter (RA, SN). − Proximity metrics such as vicinity (VC) are not reported.
Cloud (amount, base height and type)	− Estimated using ceilometer data from the last 30 minutes with time-based weighting. − Up to three layers are selected based on the criteria for manned (visual) observation. − Convective clouds of operational significance are reported after other layers without cloud amount and base height.	− Up to three layers of clouds are selected based on the relevant criteria* with 360-degree observation from rooftops and other locations. If no observed convective cloud of operational significance (CB or TCU) is selected, one of the observed CB/TCU is reported as the fourth group. − Types other than convective clouds of operational significance are reported only in	− All cloud layers noted in 360-degree observation from rooftops and other locations are reported regardless of the cloud amount in order of increasing cloud base height with no upper limit. However, clouds whose base height exceeds 5,000 ft are reported as a single group with the altitude "XXX." − Cloud types are not reported.

Element	**Automated METAR/SPECI** (See notes.)	**Manned METAR/SPECI** (See notes.)	**SCAN**
	− Cloud types other than CB or TCU are not reported. − Cloud groups are not reported in RMK (remarks).	RMK (remarks).	− Cumulonimbus clouds (CB) are reported only in RMK (remarks).
CAVOK	− The term CAVOK is not used (see *Notes 1* for details).	− The term CAVOK is used (see *Notes 1* for details).	− The term CAVOK is used (see *Notes 1* for details).
NSC, NCD and SKC	− The term SKC is not used (see *Notes 1* for details).	− The term NSC is not used (see *Notes 1* for details).	− The terms NSC and NCD are not used (see *Notes 1* for details).
Surface wind direction and speed	Already instrumentally monitored in manned METAR/SPECI and SCAN. There will be no difference between manned and automated observations and reports.		
Air temperature and dew-point temperature	Already instrumentally monitored in manned METAR/SPECI and SCAN. There will be no difference between manned and automated observations and reports.		
QNH	Already instrumentally monitored in manned METAR/SPECI and SCAN. There will be no difference between manned and automated observations and reports.		
RVR	Already instrumentally monitored in manned METAR/SPECI. There will be no difference between manned and automated observations and reports.		N/A
RMK (remarks)	− Cloud groups are not reported. − TS location and movement direction are reported, but intensity is not. − CB and TCU location and movement direction are reported. − Virga associated with low clouds (VIRGA), lightning within sight (LIGHTNING), funnel clouds (FC), tornadoes (TDO) and waterspouts (WTSPT) are not reported. − PIREP is reported.	− Cloud groups are reported (along with cloud types). − TS intensity, location and movement direction are reported. − CB and TCU location and movement direction are reported. − Location and movement direction of Virga associated with low clouds (VIRGA), lightning within sight (LIGHTNING), funnel clouds (FC), tornadoes (TDO) and waterspouts (WTSPT) are reported.	− CB location (direction and distance) is reported, but movement direction is not. − QNH [inHg] is reported. − RMK is used only for the above cases.

Element	**Automated METAR/SPECI** (See notes.)	**Manned METAR/SPECI** (See notes.)	**SCAN**
	− Rapid rises or falls in pressure (P/RR or P/FR) are reported. − Observed precipitation intensity of 3 mm/h or more is reported as RIxxx (where xxx is a three-digit number (unit: mm/h)). RI++ is not used.	− PIREP is reported. − Rapid rises or falls in pressure (P/RR or P/FR) are reported. − Observed precipitation intensity of 30 mm/h or more is reported as RI++.	

* The criteria are prescribed in JMA's *Manual on Codes for Aeronautical Meteorology* (available exclusively in Japanese at https://www.jma.go.jp/jma/kishou/books/tsuhoshiki/tsuhoshiki.html).

Note 1 CAVOK, NSC, NCD and SKC

- The term CAVOK is not used in automated METAR/SPECI, but is used in manned METAR/SPECI and SCAN. In automated local routine/special reports, the term is not used as it is in manned local routine/special reports.
- In automated METAR/SPECI (but not in local routine/special reports), the term NSC is used when the cloud status is CAVOK (except when NCD is used as outlined below).
- In automated local routine reports, local special reports, METAR and SPECI, the term NCD is used when there are no clouds to be reported.

Note 2 Automated local routine/special reports

- Visibility of 10 km or more is reported as 9999 in automated local routine/special reports and as multiples of 5 km (e.g., 25 km) in manned local routine/special reports.
- In cloud reporting other than for convective clouds of operational significance (CB and TCU) in cloud groups of automated local routine/special reports, cloud types are expressed as // (unknown).
- Other differences from manned local routine/special reports are the same as those of automated METAR/SPECI from manned METAR/SPECI.

Table 2 Abbreviations used in automated and manned METAR/SPECI

- Abbreviations marked with *1 (shaded in gray) are not used in automated METAR/SPECI.
- Abbreviations marked with *2 (in blue) are not currently used in automated METAR/SPECI.
- Abbreviations marked with *3 (in red) are used only in automated METAR/SPECI.

Qualifiers		**Present weather phenomena**		
Intensity and proximity to aerodrome	Characteristics	Precipitation	Obscurations	Other phenomena
– (Light)	MI*1 (Shallow)	DZ*2 (Drizzle)	BR (Mist) ➢ Reported when visibility is 1,000 – 5,000 m.	PO*1 (Dust/sand whirls (dust devils))
No indication (Moderate)	BC*1 (Patches)	RA (Rain)	FG (Fog) ➢ Reported when visibility is less than 1,000 m, except when qualified by MI, BC, PR or VC.	SQ (Squall)
+ (Heavy)	PR*1 (Partial)	SN (Snow)	FU*1 (Smoke) ➢ Reported when visibility is 5,000 m or less.	FC*1 (Funnel cloud (tornado or waterspout))
VC*1 ➢ Used for phenomena between approximately 8 and 16 km for the aerodrome reference point.	DR*1 (Low drifting) ➢ Used with present weather phenomena raised by wind to less than 2 m (6 ft) above ground level.	SG*2 (Snow grains)	VA*1 (Volcanic ash)	SS*1 (Sandstorm)

Qualifiers		Present weather phenomena		
Intensity and proximity to aerodrome	Characteristics	Precipitation	Obscurations	Other phenomena
	BL*1 (Blowing) ➢ Used with present weather phenomena raised by wind to a height of 2 m (6 ft) or more above ground level.	PL*2 (Ice pellets)	DU*1 (Dust (widespread)) ➢ Reported when visibility is 5,000 m or less.	DS*1 (Duststorm)
	SH*1 (Shower)	GR*2 (Hail)	SA*1 (Sand) ➢ Reported when visibility is 5,000 m or less.	
	TS (Thunderstorm)	GS*2 (Small hail and/or snow pellets)	HZ (Haze) ➢ Reported when visibility is 5,000 m or less.	
	FZ*2 (Freezing)	UP*3 (Unidentified precipitation)		

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Attachment 3 Examples of manned/automated METAR and manned/automated local routine reports

Example 1

Manned METAR

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METAR RJBB 301930Z 07015G30KT 1200 R06R/0350V1100D R06L/P1800N

      +TSRA BR FEW005 BKN010CB 14/13 Q1001   (TREND)
                      (2)
      RMK 1ST005 7CB010 A2956 MOD TS OHD MOV E P/FR RI++=
          (3)                 (5)                   (6)
```

Automated METAR

```
METAR RJBB 301930Z AUTO 07015G30KT 1200 R06R/0350V1100D
R06L/P1800N        (1)

      +TSRA BR FEW005 BKN010 //////CB 14/13 Q1001   (TREND)
                             (2)
      RMK A2956 RI035 TS OHD MOV E P/FR=
                (6)   (5)
```

Manned local routine reports

```
M 301930Z 08015G30KT 1200M R06R/1100D M/1600U E/P1800N

R06L/P1800N M/1800U E/1500U +TSRA BR FEW005ST BKN010CB 14/13
                                           (4)   (2)
Q1001/A2956 RMK MOD TS OHD MOV E P/FR RI++=
                (5)                   (6)
```

Automated local routine reports

```
M 301930Z AUTO 08015G30KT 1200M R06R/1100D M/1600U E/P1800N
          (1)
R06L/P1800N M/1800U E/1500U +TSRA BR FEW005// BKN010// //////CB
14/13                                      (4)      (4)   (2)

Q1001/A2956 RMK RI035 TS OHD MOV E P/FR=
                (6)   (5)
```

Notes on Example 1

(1) Insertion of the AUTO identifier

- An AUTO identifier is inserted after the date and time of observation (before the surface wind group).

(2) Reporting of CB

- Types of convective clouds of operational significance (CB or TCU) are reported after other layers, with preceding cloud amount and base height replaced by //////.

(3) Reporting of clouds in RMK (for automated METAR/SPECI but not for automated local routine/special reports)

- In automated METAR/SPECI, cloud groups are not reported in RMK.

(4) Reporting of cloud types (for automated local routine/special reports only)

- In automated local routine/special reports, all cloud types except CB and TCU are reported as //. (See (2) for CB and TCU.)

(5) Omission of reporting of TS intensity

- TS intensity (FBL, MOD or HVY) is not reported in RMK, but is reported in manned METAR/SPECI.

(6) Reporting of precipitation intensity

- Precipitation equal to or greater than 3 mm/h is reported in RMK as RIxxx (where xxx is a three-digit number (unit: mm/h)). RI++ (used for precipitation equal to or greater than 30 mm/h in manned METAR/SPECI) is not used.

Example 2

Manned METAR

```
METAR RJBB 051300Z 09005KT CAVOK 20/16 Q1012   (TREND)
                           (2)
      RMK A2988=
```

Automated METAR

```
METAR RJBB 051300Z AUTO 09005KT 9999 NSC 20/16 Q1012   (TREND)
                   (1)          (2)  (2)
      RMK A2988=
```

Manned local routine reports

```
M 051300Z 10005KT 20KM SCT090AC 20/16 Q1012/A2988=
                  (3)      (4)
```

Automated local routine reports

```
M 051300Z AUTO 10005KT 9999 SCT090// 20/16 Q1012/A2988=
          (1)          (3)      (4)
```

Notes on Example 2

(1) Insertion of the AUTO identifier – as per note (1) for **Example 1**

- In automated METAR/SPECI, an AUTO identifier is inserted after the date and time of the observation (before the surface wind group).

(2) Reporting of CAVOK (for automated METAR/SPECI only)

- The term CAVOK is not used in automated METAR/SPECI. When the status is CAVOK, visibility is reported as 9999, and the term NSC (nil significant cloud) is used. However, when no cloud layer is observed, the term NCD (no cloud detected) is used instead of NSC.

(3) Reporting of visibility equal to or greater than 10 km (for automated local routine/special reports only)

- In automated local routine/special reports, visibility equal to or greater than 10 km is reported as 9999 (as in manned and automated METAR/SPECI).

(4) Cloud types (for automated local routine/special reports only) – as per note (4) for **Example 1**

- In automated local routine/special reports, all cloud types except CB and TCU are reported as //. (See note (2) in **Example 1** for CB and TCU.)

Other notes

(1) Information on unavailability of TS, CB and TCU due to LIDEN or other system failure

- The term TSNO is used in RMK when TS cannot be reported in the present weather group.
- The term TSCBNO is used in RMK when neither TS in the present weather group nor CB/TCU in cloud groups can be reported.

Automated METAR

```
METAR RJBB 051300Z AUTO 09005KT 9999 NSC 20/16 Q1012   (TREND)
           RMK A2988 TSNO=
```

Automated local routine reports

```
M 051300Z AUTO 10005KT 9999 SCT090// 20/16 Q1012/A2988 RMK TSNO=
```

- Phraseology for oral communication (prescribed in JMA's *Manual on Codes for Aeronautical Meteorology* (available exclusively in Japanese at https://www.jma.go.jp/jma/kishou/books/tsuhoshiki/tsuhoshiki.html)) is as follows:
  TSNO: THUNDERSTORM INFORMATION NOT AVAILABLE
  TSCBNO: THUNDERSTORM AND SIGNIFICANT CONVECTIVE CLOUDS INFORMATION NOT AVAILABLE

Attachment 4 Comparison of automated METAR/SPECI and conventional METAR AUTO

		Automated METAR/SPECI	**Conventional METAR AUTO**
Reporting frequency		Automated METAR: every hour or half-hour Automated SPECI: as necessary	Every 10 minutes
Visibility		1-minute mean values of MOR	The lower of 1-minute or 10-minute mean values of MOR
Present weather	Precipitation	(Current) RA, SN, RASN and SNRA (with intensity)	RA and SN (without intensity) N/A[*1] at some aerodromes
	Obscuration	FG, BR and HZ are identified	N/A[*1]
	Other phenomena	TS and SQ	N/A[*1]
Cloud	Amount	Available (using newly developed algorithm)	Available (using conventional algorithm) N/A[*1] at some aerodromes
	Base height	Available (using newly developed algorithm)	Available (using conventional algorithm) (instantaneous values for only the first layer at some aerodromes)
	Type (except CB and TCU)	N/A[*1]	N/A[*1]
	Number of cloud layers to be reported (except CB and TCU)	Up to three	Up to three (only one for some aerodromes)
	CB and TCU	Available	N/A[*1]
Surface wind direction and speed		Available	Available
Air temperature and dew-point temperature		Available	Available (dew-point temperature data not available for some aerodromes)
QNH (hPa)		Available	Available
RVR (for aerodromes with RVR observing equipment)		Available (when visibility or RVR meets the criteria[*2])	Available (always)

		Automated METAR/SPECI	Conventional METAR AUTO
RMK (remarks)	QNH (inHg)	Available	Available
	Precipitation intensity (RIxxx)	Available (when precipitation intensity is equal to or greater than 3 mm/h)	Available (always)
	Snow depth/difference from one hour before	N/A*1	Available (for aerodromes with a snow gauge)
	Location and movement direction of TS, CB and TCU	Available (when applicable)	N/A*1
	PIREP	Available (when applicable)	N/A*1
	Pressure rising or falling rapidly (P/RR or P/FR)	Available (when applicable)	N/A*1

*1 N/A: not available

*2 The criteria are prescribed in JMA's *Manual on Codes for Aeronautical Meteorology* (available exclusively in Japanese at https://www.jma.go.jp/jma/kishou/books/tsuhoshiki/tsuhoshiki.html).

Attachment 5 Measures relating to freezing/frozen precipitation at aerodromes with full automation in winter

The precipitation types reported in automated METAR/SPECI are limited to rain (RA), snow (SN) and sleet (RASN/SNRA).

To support the setting of holdover time (HOT) for anti-icing fluid supply to departing aircraft at some of the aerodromes listed in Table 1 and 2 of Attachment 1 in winter, automated METAR/SPECI functionality at these sites is switched to manned METAR/SPECI when freezing or frozen precipitation such as snow is expected or observed during full-automation time slots as outlined below.

1 Criteria for switching to manned METAR/SPECI

1.1 When freezing or frozen precipitation is expected during full-automation time slots[*1]

1.2 When SN, RASN or SNRA is observed and reported in automated METAR/SPECI

1.3 When freezing or frozen precipitation events commence during full-automation time slots (other than as outlined in 1.1 and 1.2)

2 Procedures for observation and reporting associated with a switch to manned observation and reporting

Manned observation and reporting will be conducted as per daytime operation (outside full-automation time slots). The procedures for each aerodrome are detailed in 2.1 – 2.4.

Operation may be switched back to automated METAR/SPECI functionality when freezing/frozen precipitation ends and is not expected to resume.

2.1 Chubu Centrair International Airport, Kansai International Airport and Kitakyushu Airport

When criterion 1.1 is met, manned observation and reporting will be conducted throughout the full-automation time slot[*2].

2.2 Narita International Airport

- When any of the criteria 1 items are met from 23:00 to 24:00, manned observation and reporting will be conducted.
- When departures are planned after 24:00 due to flight delays or other factors and any of the criteria 1 items are met during that time, manned observation and reporting will be conducted for as long as necessary[*2].
- When any of the criteria 1 items are met after 05:00, manned observation and reporting will be commenced[*2] and continued until the end of full-automation time slots (06:00).

2.3 Fukuoka Airport

When departures are planned after 23:00 due to significant extension of aerodrome operational hours and any of the criteria 1 items are met during that time, manned observation and reporting will be conducted for as long as necessary[*2].

2.4 Aerodromes listed in Table 2 of Attachment 1 (excluding Kitakyushu, Amami, Miyako, New

Ishigaki, and Shimojishima Airport)

During extended aerodrome operational hours and when temporary services are provided, manned observation and reporting are conducted for as long as necessary if aircraft operators need meteorological information to set the holdover time (HOT) and any of the criteria 1 items are met[*2].

**1 When freezing or frozen precipitation (SN, SNRA, RASN, GS, etc.) is predicted in aerodrome forecasts (TAF) or expected based on air temperature, precipitation probability and other factors*

**2 When criterion 1.2 or 1.3 is met, switching to manned observation and reporting will be commenced as soon as possible.*

Attachment 6 Response to system failure
(for missing automated METAR/SPECI data)

If certain elements cannot be determined due to system failure or inspections, the steps outlined below will be taken.

When multiple units for the same element are installed, the failed unit used for automated METAR/SPECI will be replaced with an operative one.

1 When elements (except TS, CB and TCU) cannot be monitored automatically

If visibility, present weather (except TS), cloud (other than CB and TCU) and/or other elements including wind, air temperature, dew-point temperature and QNH cannot be monitored automatically, observation and reporting will be conducted as outlined below.

1.1 Aerodromes listed in Table 1 of Attachment 1 and Kitakyushu Airport

(1) When visibility, present weather (other than TS conditions) and/or cloud (other than CB and TCU conditions) cannot be monitored automatically

a) Observers will manually issue automated METAR/SPECI covering missing elements based on manned observation*1. If RVR cannot be monitored, the relevant data will be reported as missing.

(2) When elements other than visibility, present weather and cloud cannot be monitored automatically

a) Observers will manually issue automated METAR/SPECI covering missing elements based on alternative instrumental observation[*1]. If RVR cannot be monitored, the relevant data will be reported as missing.

b) Data on dew-point temperature that cannot be monitored when automated SPECI can be reported will also be reported as missing.

1.2 Aerodromes listed in Table 2 of Attachment 1 (other than Kitakyushu and Shimojishima Airport)

(1) When visibility, present weather (other than TS conditions) and/or cloud (other than CB and TCU conditions) cannot be monitored automatically

a) Automated METAR/SPECI will be issued continuously, with missing elements reported as such. Automated SPECI corresponding to variations in missing elements will not be issued.

b) During extended aerodrome operational hours or when temporary services are provided, observers will manually issue automated METAR/SPECI covering missing elements

based on manned or alternative instrumental observation and Q reports compiled using data from the automatic observing system in response to requests. If RVR cannot be monitored, the relevant data will be reported as missing.

(2) When elements other than visibility, present weather or cloud cannot be monitored automatically

a) Automated METAR/SPECI will be issued continuously, with missing elements reported as such. Automated SPECI corresponding to variations in missing elements will not be issued.

b) During extended aerodrome operational hours, observers will manually issue automated METAR/SPECI covering missing elements based on alternative instrumental observation and Q reports compiled using data from the automatic observing system in response to request.

c) When temporary services are provided, observers*2 will manually issue automated METAR covering missing elements based on alternative instrument observation and Q reports compiled using data from the automatic observing system in response to requests.

d) Even in the event of b) and c), RVR will be reported as missing if monitoring is impractical, and dew-point temperature data will be reported as missing if monitoring is impractical when automated SPECI can be issued.

1.3 Shimojishima Airport

During aerodrome operational hours, automated METAR/SPECI may issue such as 1.2 and outside aerodrome operational hours, automated METAR/SPECI may be issued as follows:

(1) When visibility and/or cloud (except CB and TCU conditions) cannot be monitored automatically

a) Observers*2 will manually issue automated METAR/SPECI covering missing elements based on manned or alternative instrumental observation. If RVR cannot be monitored, the relevant data will be reported as missing.

b) In the event of system failure, automated METAR will be continuously issued until manned observation recommences. The relevant elements will be reported as missing in the automated METAR. Automated SPECI will be suspended, and notification of SPECI suspension will be issued with NOTAM.

(2) When elements other than visibility, present weather (TS) or cloud cannot be monitored automatically

a) Observers*2 will manually issue automated METAR/SPECI covering missing elements based on manned or alternative instrumental observation.

b) In the event of system failure, automated METAR/SPECI will be continuously issued until manned observation recommences. The relevant elements will be reported as missing in the automated METAR/SPECI. Automated SPECI corresponding to variations in missing elements will not be issued.

1.4 Aerodromes listed in Table 3 of Attachment 1

(1) When visibility and/or cloud (except CB and TCU conditions) cannot be monitored automatically

a) If visibility and/or cloud cannot be monitored during aerodrome operational hours, automated METAR will be manually issued with missing elements covered based on manned observation performed by observers[*2]. However, cloud observation is covered only for NCD and NSC, and not for other cases in which cloud data are reported as missing[*3]. Automated SPECI will be suspended, and notification of SPECI suspension will be issued with NOTAM.

b) When visibility and/or cloud cannot be monitored outside aerodrome operational hours, automated SPECI will be issued with these elements reported as missing.

c) During extended aerodrome operational hours and when temporary services are provided, observers will manually issue automated METAR/SPECI covering missing elements based on manned observation and Q reports compiled using data from the automatic observing system in response to requests. Operation will be along with note *2 until manned observation recommences.

(2) When elements other than visibility and cloud cannot be monitored automatically

a) Automated METAR/SPECI will be issued continuously, with missing elements reported as such. Automated SPECI corresponding to variations in missing elements will not be issued.

b) During extended aerodrome operational hours or when temporary services are provided, automated METAR/SPECI and Q reports compiled using data from the automatic observing system will be issued, with missing elements reported as such. Automated SPECI corresponding to variations in missing elements will not be issued.

2 When TS, CB and TCU cannot be automatically detected

- TS, CB and TCU cannot be detected if the ground weather radar network system fails. In such cases, TSCBNO will be reported in the RMK of automated METAR/SPECI.
- TS cannot be detected if LIDEN fails. In such cases, TSNO will be reported in the RMK of automated METAR/SPECI.

*1 If a number of special observations are expected, automated METAR/SPECI may be suspended and replaced with manned METAR/SPECI as per daytime operation.

*2 In the event of system failure, observers at JMA headquarters will fax or otherwise contact affected airlines, the Japan Civil Aviation Bureau and relevant airport managers to report information on meteorological conditions at the aerodrome as determined from aerodrome weather camera images (outlined below) until manned observation recommences.

When visibility information is missing, the following information will be provided:

- "5 km or greater" if visibility is clearly 5 km or more in aerodrome weather camera images
- "Less than 5 km" if visibility is not clearly 5 km or more in aerodrome weather camera images
- "Unknown" in event of aerodrome weather camera system failure (except as detailed below)
- "5 km or greater" in the event of the aerodrome weather camera system failure but visibility of 5 km or greater is expected to remain based on the last observation and prediction

When ceiling information is missing, the following information will be provided:

- "1,000 ft or greater" if the ceiling is clearly at 1,000 ft or more in aerodrome weather camera images
- "Less than 1,000 ft" if the ceiling is not clearly at 1,000 ft or more in aerodrome weather camera images
- "Unknown" in the event of aerodrome weather camera system failure (except as detailed below)
- "1,000 ft or greater" in the event of the aerodrome weather camera system failure but a ceiling at 1,000 ft or greater is expected to remain based on the last observation and prediction

*3 In such cases, ceiling information will be provided via fax or other means (as per *2).

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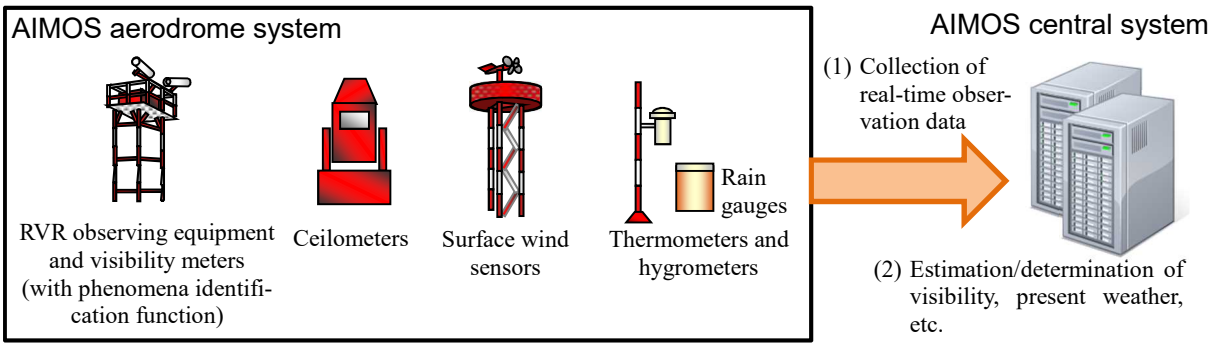
Annex 1 Automated METAR/SPECI reporting

1 Automated METAR/SPECI reporting

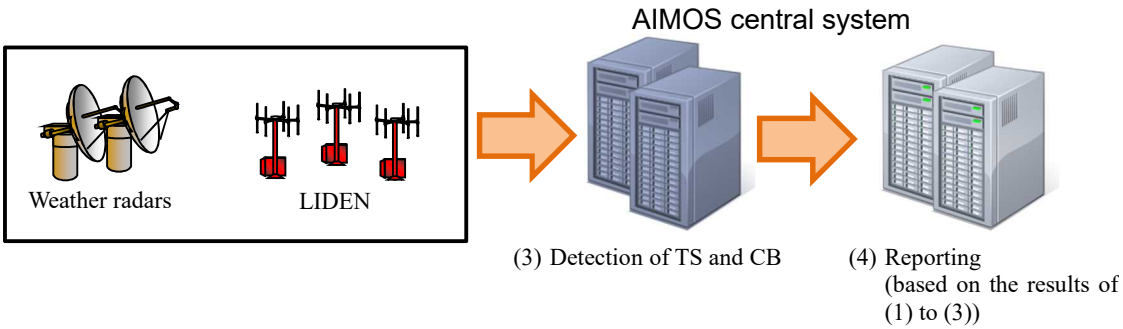
Automated METAR/SPECI information is automatically issued via the procedure outlined below.

(1) Real-time observation data (updated every six seconds) are sent from AIMOS aerodrome systems at aerodromes to the AIMOS central system.

(2) Visibility, present weather (except for TS) and cloud amount/base height are automatically estimated/determined using collected data. The estimation/determination algorithms are described later.



(3) TS, CB and TCU are determined separately using ground weather radar data and Lightning Detection Network System (LIDEN) data.



(4) Automated METAR/SPECI are created and issued from the AIMOS central system using the results of (1) to (3). The system also automatically determines the need for issuance of automated SPECI based on related criteria.

2 Estimation/determination algorithms for values to be issued in automated METAR/SPECI

2.1 Visibility

- Visibility is monitored with 1-minute mean values of MOR measured using RVR observing equipment or visibility meters. At aerodromes where multiple sets of RVR observing equipment are installed, the location of reporting values is determined in advance.

Reason for usage of 1-minute mean values of MOR

Although Annex 3 to the Convention on International Civil Aviation recommends the use of one-minute values for local reports and 10-minute mean values for METAR/SPECI, JMA uses 1-minute mean values for both.

If ten-minute mean values were used for local reports and METAR/SPECI, automated SPECI may not be issued in a timely manner in conditions of deteriorating visibility, and/or may report values greater than reality. This may exert an adverse influence on safety in aircraft landing and take-off. While the use of 10-minute mean values may reduce the frequency of automated SPECI issuance to a certain extent, such issuance would be still excessive if values continued to change based on SPECI criteria.

Accordingly, JMA uses one-minute mean values for visibility both in local reports and in METAR/SPECI.

The frequency of automated SPECI issuance can be optimized via the settings of weather phenomena continuance. Automated SPECI are issued only after visibility deterioration has continued for around 2 minutes, and improvements are reported only after continuation for around 5 minutes.

2.2 Present weather (except for TS)

- Via the process outlined in **Attachment A1-1**, classification of rain (RA), snow (SN), sleet (RASN/SNRA), fog (FG), mist (BR), haze (HZ) and unidentified precipitation (UP) is conducted. Intensity (heavy (+), moderate or light (-)) is also determined for RA, SN and RASN/SNRA via this process.
- Using surface wind sensor data, squall (SQ) conditions are identified when wind speed increases by 8 m/s (16 kt) or more within a minute and a wind speed of 11 m/s (22 kt) or more continues for a minute or more.

2.3 Cloud amount and base height (except CB and TCU)

- Through the process outlined in **Attachment A1-2**, cloud amount and base height are calculated.
- The term CAVOK is not used. The term NSC (nil significant cloud) is used in automated METAR/SPECI (but not in automated local routine/special reports) when cloud status falls under CAVOK (except in the case of NCD detailed below).
- When no cloud layer is observed, NCD (no cloud detected) is used in both automated local reports and METAR/SPECI. The term SKC as used in manned local reports is not used in automated local reports.

2.4 TS, CB and TCU

- Via the process outlined in **Attachment A1-3**, TS, CB and TCU are identified.
- Cloud amount and base height for CB and TCU cannot be calculated via the standard process. These cloud types are therefore reported after all other cloud layers with only the cloud type (CB or TCU); cloud amount and base height are reported as unknown.
- TS intensity is not qualified. (In manned METAR/SPECI, TS intensity is reported in RMK.)

2.5 Surface wind, RVR, air and dew-point temperature, QNH and precipitation intensity

- These values are instrumentally monitored in automated METAR/SPECI, as in manned METAR/SPECI.

- In automated METAR/SPECI, precipitation intensity is reported in RMK as RIxxx (where xxx is a three-digit number (unit: mm/h)) for values of 3 mm/h or more only. RI++ (which is used for precipitation of 30 mm/h or more in manned METAR/SPECI) is not used.

Attachment A1-1: Calculation for present weather
Attachment A1-2: Calculation for cloud amount and base height
Attachment A1-3: Calculation for TS, CB and TCU

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Attachment A1-1 Calculation for present weather

In automated METAR/SPECI, present weather is determined using data from RVR observing equipment (or visibility meters), thermometers, hygrometers and rain gauges. Eight categories (rain, snow, sleet, fog, mist, haze, unidentified precipitation and no weather of significance to aviation) are identified via the calculation process detailed below.

1 Outline

Present weather phenomena (as defined in WMO Manual on Codes, code-table 4678) in automated METAR/SPECI are determined via the process outlined below.

2 Calculation for determination of present weather

2.1 Calculation for determination of precipitation

Precipitation is identified using the flow shown in **Chart 1**, where T and RH denote air temperature and relative humidity, respectively.

UP (unidentified precipitation) is judged in the following cases:

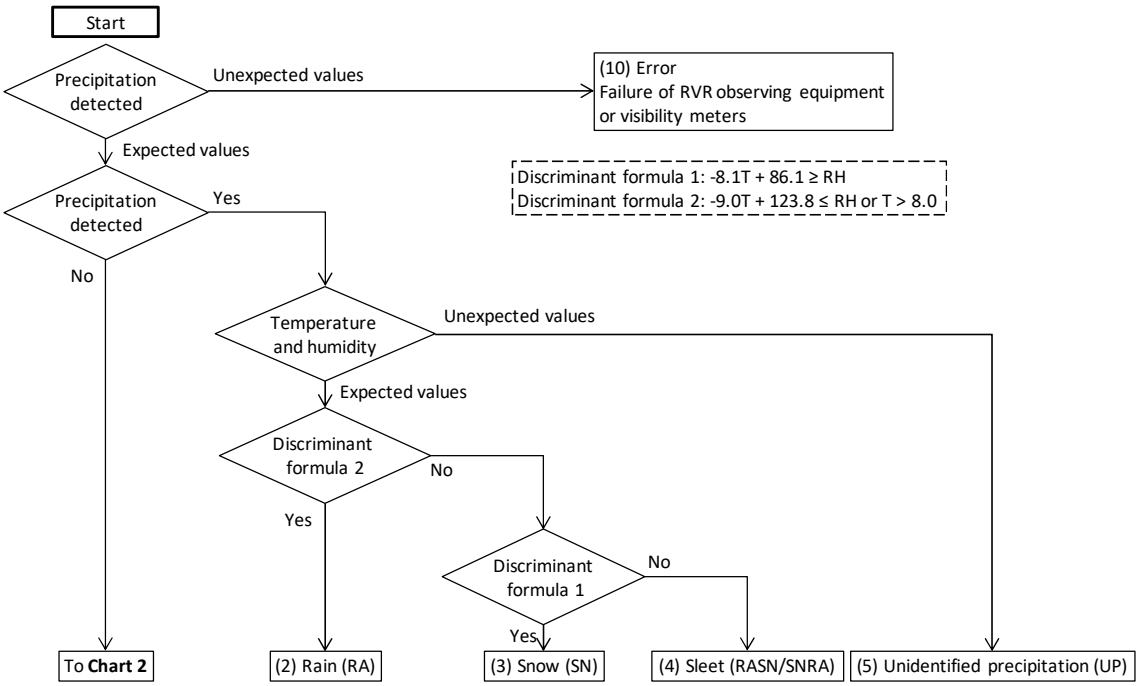
- Precipitation is detected but a thermometer or hygrometer fails.
- Snow (SN) or sleet (SNRA) is identified from air and dew-point temperature data, but RVR observing units (or visibility meters) fail.
- Rain (RA) or sleet (RASN) is identified from air and dew-point temperature data, but rain gauge equipment fails.

2.2 Calculation to identify obscuration

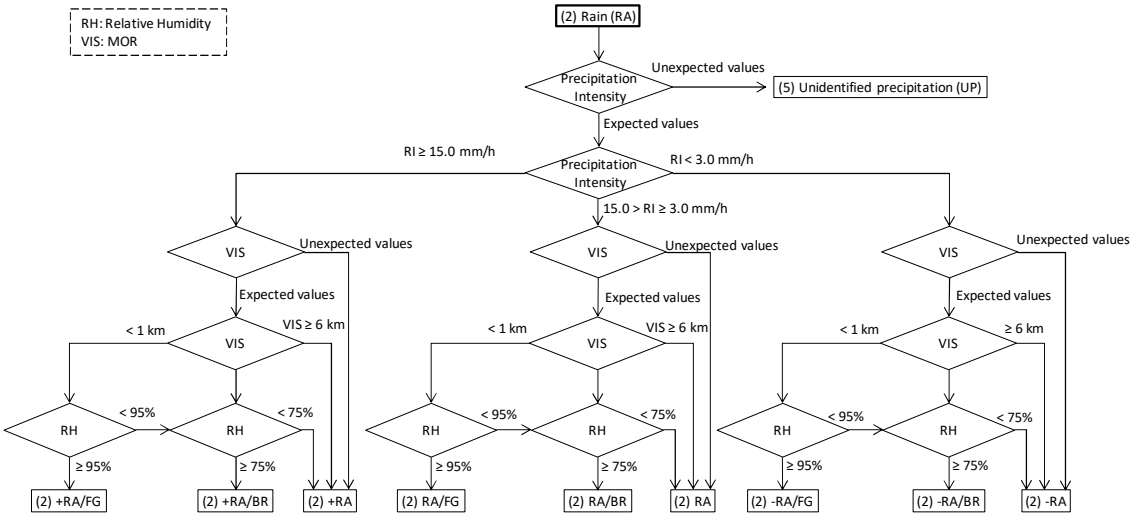
When no precipitation is detected in the process shown in **Chart 1**, the process shown in **Chart 2** is used to identify obscuration.

Chart 1 Determination of precipitation types

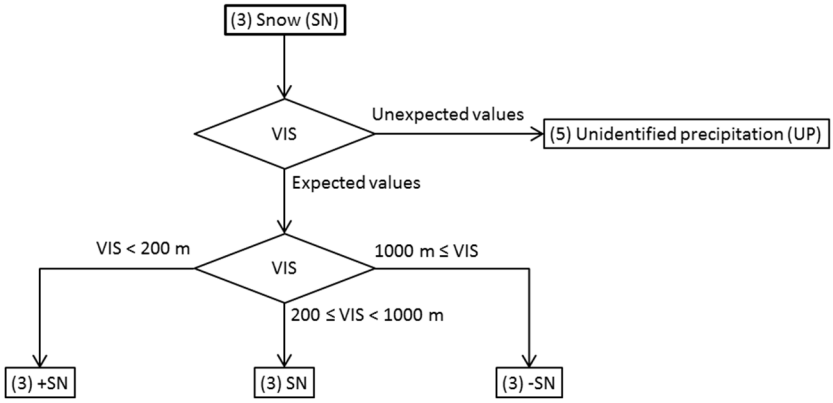
Part 1



Part 2 (Continued from **Part 1** (2) Rain (RA))



Part 3 (Continued from **Part 1** (3) Snow (SN))



Part 4 (Continued from **Part 1** (4) Sleet (RASN/SNRA))

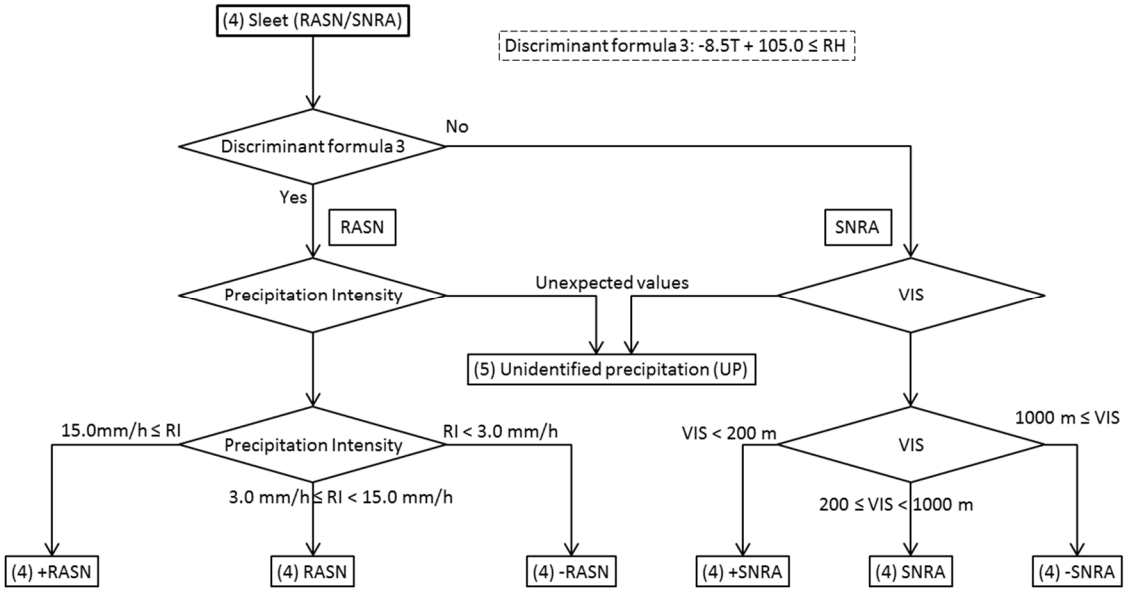
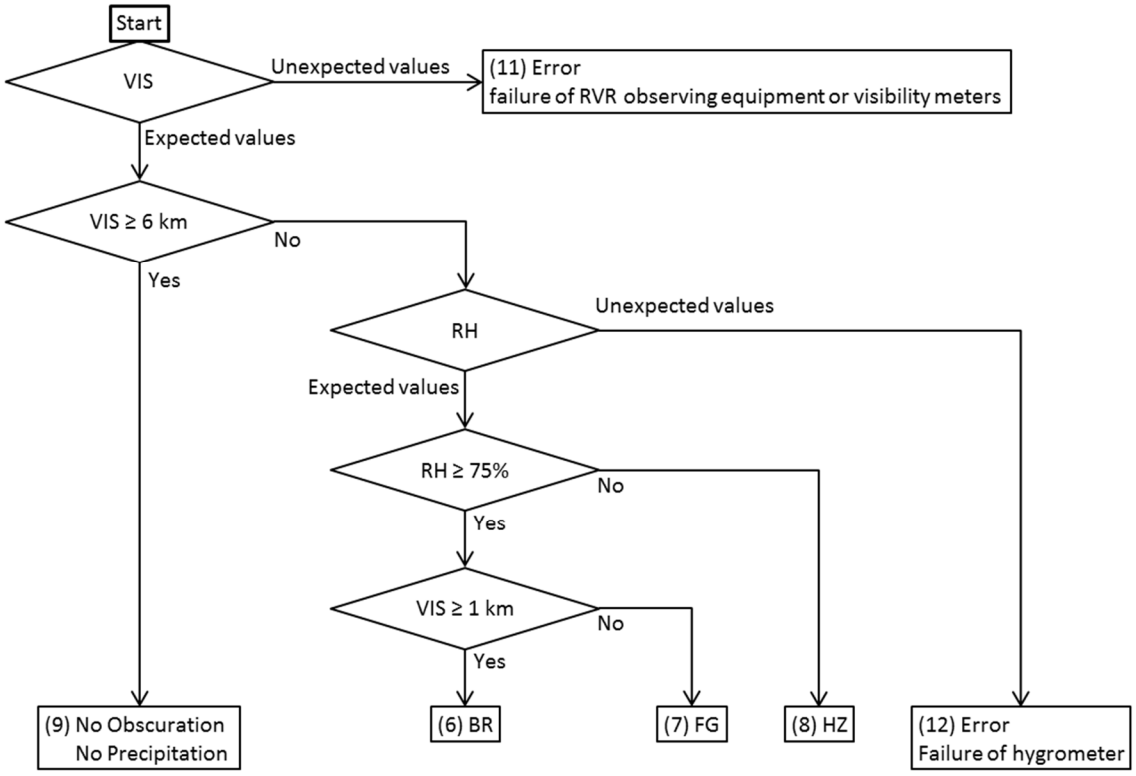


Chart 2 Obscuration type identification



Attachment A1-2 Calculation for cloud amount and base height

In automated METAR/SPECI, cloud amount and base height are calculated from ceilometer and surface wind sensor data as outlined below.

1 Selection of potential cloud layers

- Potential cloud layer base heights are calculated using scattered light* data obtained from the relevant ceilometer within the last 30 minutes.
  * Scattered light: laser light projected from and reflected back to the ceilometer (back-scattered) by cloud droplets (water droplets and ice crystals constituting cloud)

2 Estimation of cloud amount in potential cloud layers

- Upper-air wind speeds at various altitudes are estimated using surface wind speed data from surface wind sensors (based on linear approximation of wind speed vertical profiles from past wind profiler data).
- Cloud speed at a certain altitude is assumed to be proportional to wind speed at the same altitude (proportionality coefficient based on correlation with past visual observation data.)
- Cloud mass extent as determined via ceilometer sampling every 15 seconds (referred to here as the 15-second cloud extent) is expressed as a product of cloud speed and 15 seconds.
- Based on cloud speed, the AIMOS aerodrome system is used to estimate locations (migration length from the point above the ceilometer) of each 15-sec cloud extent above the ceilometer within the 30-minute period before automated METAR/SPECI reporting. The view angles of each 15-sec cloud extent are then calculated.
- Cloud amounts at each altitude are calculated by adding the relevant view angles.

3 Selection of cloud layers to be reported

- In accordance with METAR/SPECI reporting regulations, up to three lower cloud layers are selected.

Algorithm for estimation of cloud amount and base height

1 Detection of potential cloud layers and calculation of base heights

Detect potential cloud layers and calculate base heights. ← Scattered light from ceilometer data (within the last 30 minutes)

2 Estimation of cloud amount at each altitude

Calculate speed of each cloud layer from wind speed at each altitude as estimated from surface wind speed. ← Surface wind speed from surface wind sensor data; Cloud base heights from ceilometer data

↓

Calculate 15-second cloud extents (product of cloud speed and 15 seconds) above the ceilometer.

↓

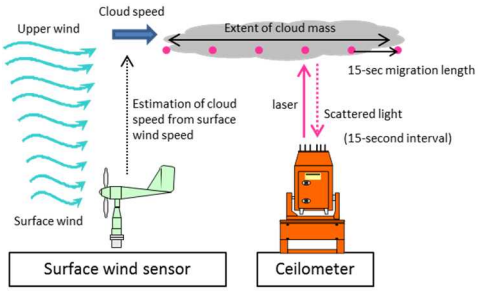
Calculate locations (migration length from point above ceilometer) of each 15-sec cloud extent at time of automated METAR/SPECI reporting using calculated speed of each cloud layer.

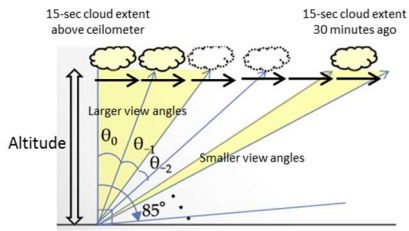
↓

Calculate view angles of each 15-sec cloud extent using 15-second cloud extents, cloud base heights and locations.

↓

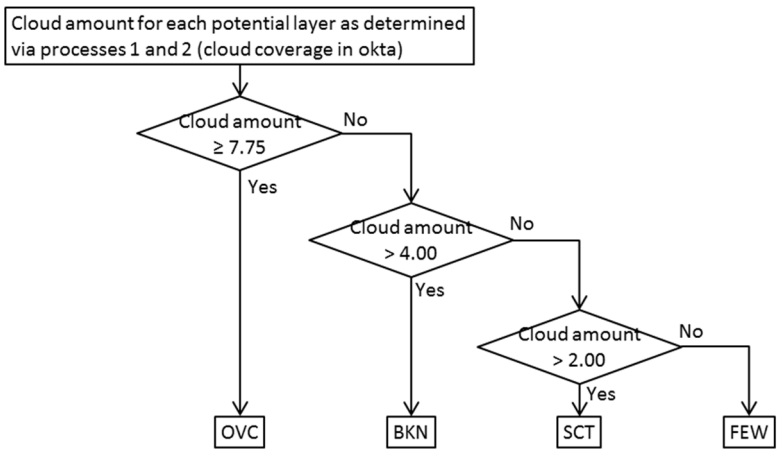
Add view angles at each altitude and calculate cloud amounts (fraction of sky covered) at each altitude.





3 Selection of cloud layers to be reported

3.1 Conversion of cloud amount data for automated METAR/SPECI reporting



3.2 Determination of cloud amount and base height to be reported

In accordance with METAR/SPECI reporting regulations, up to three lower cloud layers (cloud amounts determined as described in 3.1, such as FEW, SCT and BKN, and cloud base height) are selected for reporting.

Attachment A1-3 Calculation for TS, CB and TCU

In automated METAR/SPECI, thunderstorms (TS) and convective clouds of operational significance (CB and TCU) are identified using data from ground weather radar and JMA's Lightning Detection Network System (LIDEN) via the calculation process outlined below.

Algorithm for identification of thunderstorms (TS), cumulonimbus clouds (CB) and towering cumulus clouds (TCU)

CB/TCU information*1 is produced every 10 minutes based on the Radar Lightning Analysis Index*2 and other data.

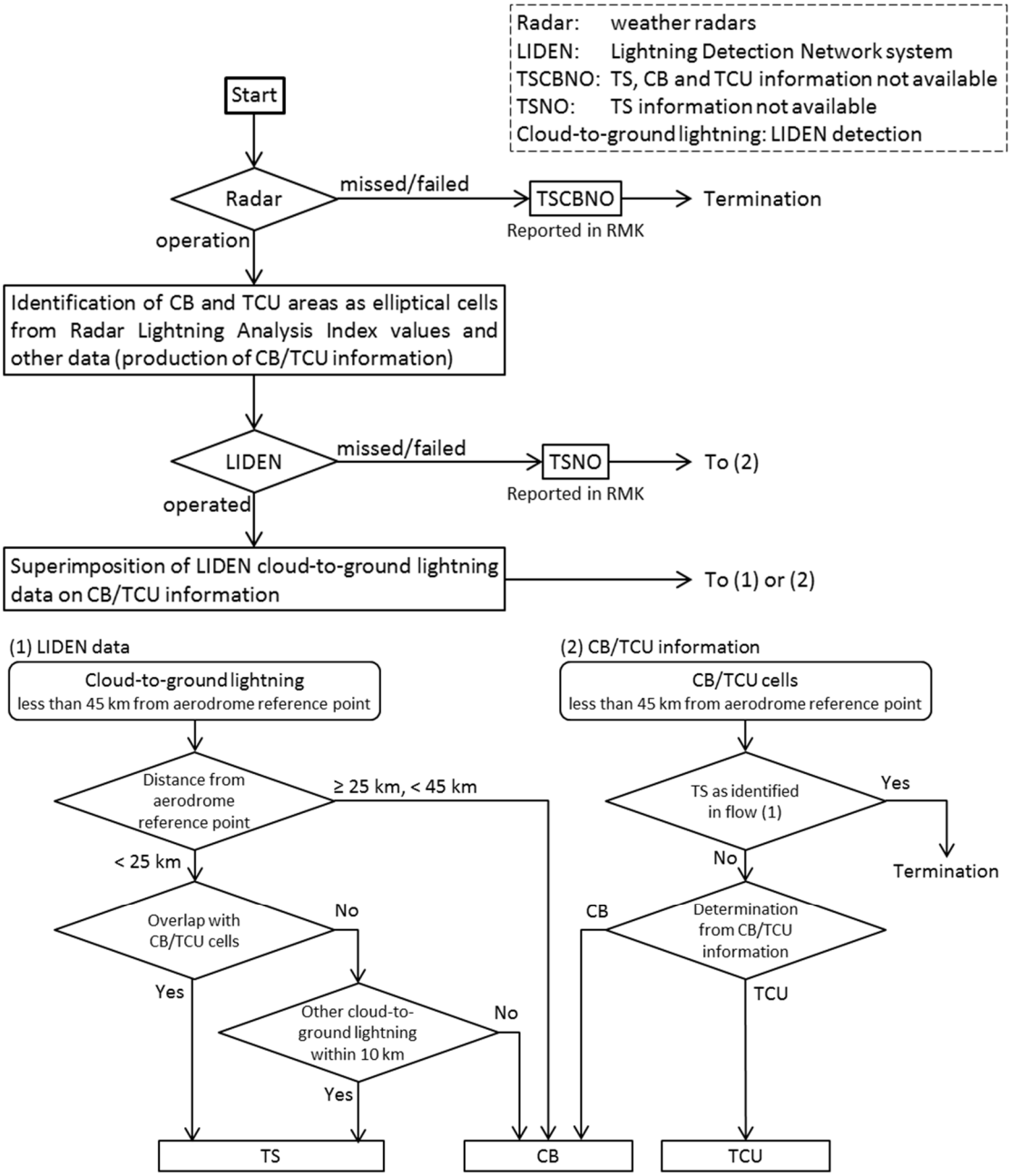
TS, CB and TCU are identified every 5 minutes along with their location and movement direction (based on difference from the previous location) using CB/TCU information and cloud-to-ground lightning data from LIDEN.

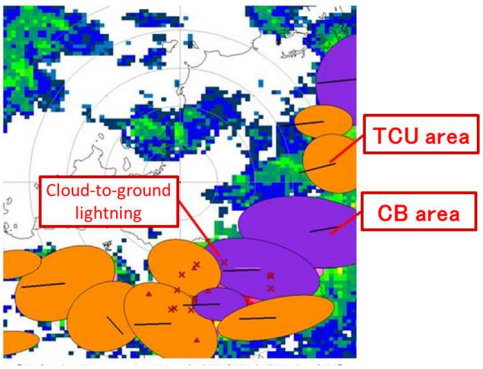
If composite weather radar data cannot be obtained due to system failure, the term TSCBNO ("thunderstorm and significant convective cloud information not available") is used. In the event of LIDEN failure, the term TSNO ("thunderstorm information not available") is used in the RMK section of automated METAR/SPECI.

*1 CB/TCU information: Automatically produced data showing estimated CB and TCU cells based on extraction of convective cloud cells from Radar Lightning Analysis Index data and subsequent threshold-based classification.

*2 Radar Lightning Analysis Index: An index expressing lightning potential (i.e., the status of convective clouds). Values are calculated every 10 minutes using composite ground weather radar data on radar echo intensity, radar echo top height, vertically integrated liquid (VIL) and other variables.

Algorithm for determination of TS, CB and TCU





CB/TCU information

- Elliptical cells denote CB areas (purple) and TCU areas (orange).
- Black lines extending from cell centers represent cell movement (direction and speed).

Cloud-to-ground lightning

- Red crosses (x) denote cloud-to-ground lightning detected using LIDEN.

CB/TCU information and cloud-to-ground lightning around Fukuoka Airport at 22:45 JST on 20 June 2016

Annex 2 Major characteristics of observation values reported in automated METAR/SPECI

1 Visibility

- Visibility reported in automated METAR/SPECI is the meteorological optical range (MOR) measured using RVR observing equipment or visibility meters at sites where such units are installed. Although visibility reported in automated METAR/SPECI does not represent prevailing values for manned METAR/SPECI, it is used in the same way as prevailing visibility for the judgement of instrument meteorological conditions (IMC) or visual meteorological conditions (VMC) and weather minima.
- Visibility reported in automated METAR/SPECI is comparable to (or may tend to be slightly lower than) prevailing visibility as reported in manned METAR/SPECI. This tendency is especially conspicuous with strong intermittent rain (i.e., with heavy rain clouds scattered around the aerodrome) (see **Example 1**).
- If fog is present only at the site of RVR observing equipment/visibility meters or at the location of visual observation, visibility reported in automated METAR/SPECI may differ significantly from that reported in manned METAR/SPECI (see **Example 2**).
- Due to the performance limitations of RVR observing equipment/visibility meters, visibility can be observed only up to 10 km with accuracy satisfying operationally desirable levels as defined by the International Civil Aviation Organization (ICAO). When visibility of 10 km or more is observed, this is uniformly reported as a single categorized value (9999) indicating visibility of 10 km or more both in automated local routine/special reports and in METAR/SPECI.

2 Present weather

- Characteristics such as showers (SH) and proximity metrics such as vicinity (VC) are not monitored.
- Partial and patchy fog (PRFG and BCFG, respectively) are not reported. Any type of fog at the site of RVR observing equipment or visibility meters are reported as fog (FG). Partial or patchy fog present at other locations is not reported.
- Rain (RA), sleet (RASN/SNRA) and snow (SN) are identified using air temperature and humidity. Although optimal thresholds for identification are based on past observations, actual snow may be rarely reported as RA, or actual rain may be rarely reported as SN.
- Detected precipitation may be reported as UP (unidentified precipitation) in the event of thermometer failure or other issues.

3 Cloud amount

- Cloud amount reported in automated METAR/SPECI is estimated using ceilometer and surface wind sensor data for the last 30 minutes. Clouds not passing above the ceilometer during the relevant period (e.g., still clouds at the base of mountains distant from the aerodrome) are not observed or reported on (see **Example 3**).
- In automated METAR/SPECI (but not in local routine/special reports), NSC is reported when no clouds are detected below the higher of 5,000 ft altitude or minimum sector altitude at the aerodrome while NCD is reported when no clouds are detected. When low clouds are present at a distance from the aerodrome, NSC or NCD is reported as long as clouds do not approach the area above the aerodrome.

4 Cloud base height

- Since ceilometer data are also used for reference in manned cloud base height observation and reporting, cloud base heights reported in automated METAR/SPECI are virtually the same as those in manned METAR/SPECI.
- At aerodromes where cloud base heights are observed from rooftops in manned (visual) observation, cloud base heights (estimated using ceilometers installed on the ground) reported in automated METAR/SPECI data may differ significantly from those of manned observation in the event of low stratus (ST) or fog. As an extreme example, if the fog top is lower than the rooftop, automated METAR/SPECI report a very low cloud base height, while such fog may not be identified as cloud in manned (visual) observation (see **Example 4**).
- While the base heights of upper clouds are reported as unknown (///) in manned METAR/SPECI, exact values are reported in automated METAR/SPECI if the ceilometer can determine cloud base heights. Based on performance specifications, ceilometers can observe cloud base heights up to 22,000 ft.
- Extremely thin cloud or cloud at very high altitudes may not be automatically observed (detected) by ceilometers, while observation in manned (visual) observation may be successful.
- When there is more than one cloud layer at 5,000 ft or higher, the relevant base heights are reported separately (i.e., as for layers lower than 5,000 ft) in automated METAR/SPECI, but are collectively reported as XXX in SCAN.

5 Cloud types

- Cloud types, except convective clouds of operational significance, are not observed (identified) or reported on.
- Convective clouds of operational significance are detected using ground weather radar and other data, and are separately reported. The amount and base height of such clouds cannot be estimated, and are reported as unknown.

6 Other characteristics (common to visually observed elements)

- Manned (visual) observation of visibility, clouds and present weather is conducted in outdoor locations such as rooftops. Manned observation is started a few minutes before the actual observation time in consideration of the time taken to access observation sites and perform data entry, while automated METAR/SPECI follows the exact observation time. This may create discrepancies between manned and automated METAR/SPECI data if, for example, rain stops just before observation and or visibility/cloud amount changes rapidly.
- Some elements may be missed due to system failure. (In manned METAR/SPECI, data on visually observed elements are always available.)

7 Surface wind, RVR, air temperature, dew-point temperature and QNH

- As these elements are already instrumentally monitored in manned METAR/SPECI, there is no difference between related data in manned and automated METAR/SPECI.

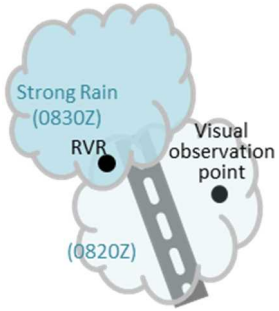
Example 1

Visibility

Visibility in automated METAR/SPECI reporting is comparable to (or may tend to be slightly lower than) prevailing visibility in manned METAR/SPECI reporting. This tendency is especially conspicuous with strong intermittent rain (i.e., when heavy rain clouds are scattered around the aerodrome).

16 August 2015, Fukuoka Airport

- At around 0820Z (the peak of visibility deterioration caused by heavy rain), automated METAR reported lower visibility than manned METAR's prevailing visibility.
- At 0830Z, rain at the location for visual observation weakened and prevailing visibility improved, while heavy rain continued around the RVR observing equipment used for automated METAR. This created a large difference between visibilities reported in manned and automated METAR.

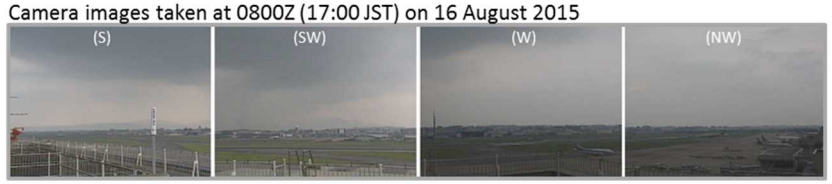


Automated METAR*1			Manned METAR/SPECI		
Observation Time	Visibility*2	Precipitation intensity	Observation time	Visibility [prevailing]	Precipitation intensity
0800Z	9999	RI000	0800Z	9999	N/A
↓			0806Z	9999	N/A
0810Z	9999	RI000	↓		
↓			0816Z	9999 [0800SW]	N/A
			0817Z	**0800**	RI++
0820Z	**0100**	RI300	↓		
↓			0821Z	**0300**	RI++
			0824Z	0300	RI++
			0825Z	0500	RI++
0830Z	**0100**	RI014	0830Z	**9999 [1500W-N]**	N/A
↓			0835Z	9999 [3000NW-N]	N/A
			0839Z	9999 [3000NW-N]	N/A
0840Z	2000	RI005	↓		
↓			0846Z	9999 [5KM NW-N]	N/A
0850Z	9999	RI002	↓		
0900Z	9999	RI001	0900Z	9999	N/A

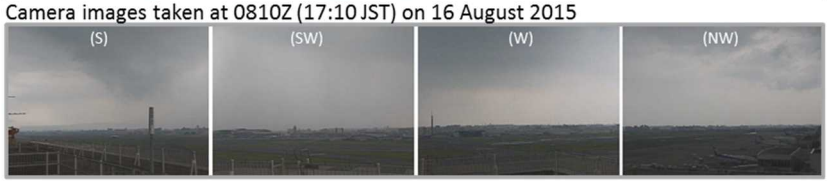
*1 As observation was being conducted on a trial basis, automated METAR was reported every 10 minutes and automated SPECI was not available.

***2 Due to the trial nature of the observation, the smaller of 1-minute or 10-minute mean MOR was reported as visibility in automated METAR.**

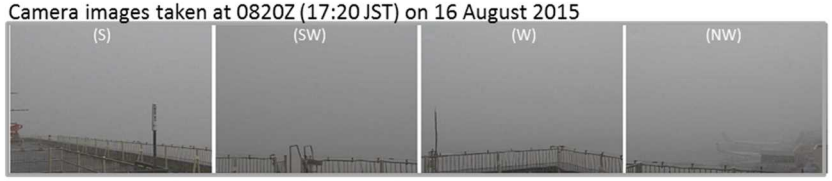
Camera images taken at 0800Z (17:00 JST) on 16 August 2015



Camera images taken at 0810Z (17:10 JST) on 16 August 2015

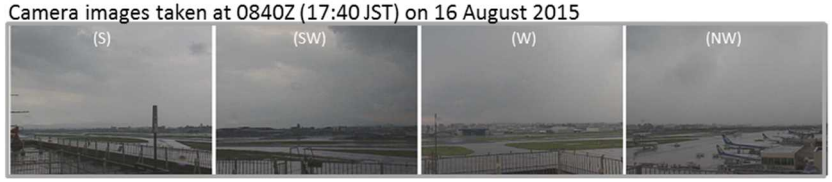


Camera images taken at 0820Z (17:20 JST) on 16 August 2015



Camera images taken at 0830Z (17:30 JST) on 16 August 2015

Camera images taken at 0840Z (17:40 JST) on 16 August 2015

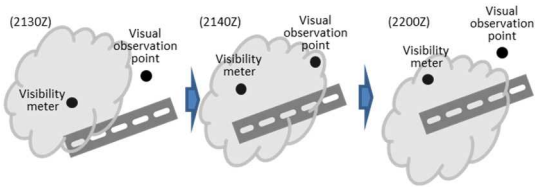


Example 2

Visibility
If fog is present only at the site of RVR observing equipment/visibility meters or at the location of visual observation, visibility in automated METAR/SPECI reporting may differ significantly from that in manned METAR/SPECI reporting.

21 November 2014, Izumo Airport

- A mass of fog passed over the aerodrome from north to south.
- At around 2140Z, the visibility meter was in the fog that covered the entire aerodrome but the location of visual observation was not. This created a large difference between visibilities reported in manned and automated METAR. In such cases, visibility in automated METAR represents conditions along the runway more appropriately.

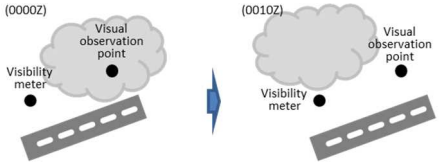


Automated METAR*1		Manned METAR/SPECI	
Observation Time	Visibility*2	Observation time	Visibility [prevailing and other information]
2130Z	0200	2130Z	9999 [0300NW-N FG SW-N]
2140Z	0100	↓	
↓		2142Z	0300 [9999E-SE]
2150Z	0100	↓	
2200Z	0100	2200Z	9999 [0200S-SW FG S-NW]

Camera images taken at 2130Z on 20 (06:30 JST on 21) November 2015

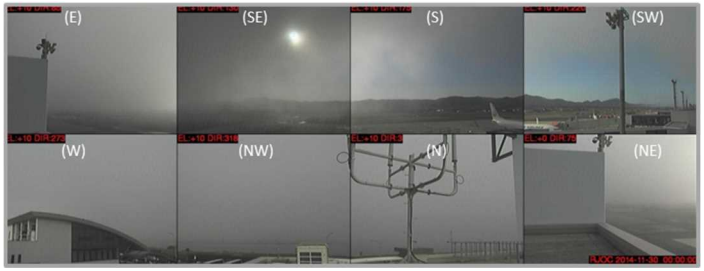
30 November 2014, Izumo Airport

- A mass of fog passed around the aerodrome (from east to west).
- At around 0000Z, the location of visual observation was covered with fog but the visibility meter on the runway was not. This created a large difference between visibilities reported in manned and automated METAR. In such cases, visibility in automated METAR represents conditions along the runway more appropriately.



Automated METAR*1		Manned METAR/SPECI	
Observation time	Visibility*2	Observation time	Visibility [prevailing and other information]
(2240Z 5000)		2344Z	7000 [1000E FG NE-SE]
2250Z	6000	↓	
↓		2353Z	0500
0000Z	4200	0000Z	0300 [9999SE-SW]
↓		0006Z	3000 [1500N FG W-E]
0010Z	9999	↓	
(omitted)		0016Z	9999 [2000NW FG W-NW]

Camera images taken at 2130Z on 20 (06:30 JST on 21) November 2015



*1 As observation was being conducted on a trial basis, automated METAR was reported every 10 minutes and automated SPECI was not available.
*2 Due to the trial nature of the observation, the smaller of 1-minute or 10-minute mean MOR was reported as visibility in automated METAR.

Example 3

Cloud amount
Cloud amount in automated METAR/SPECI reporting is estimated using ceilometer and surface wind sensor data from the last 30 minutes. Clouds not passing above the ceilometer during the period (e.g., still clouds at the base of mountains distant from the aerodrome) are not observed or reported.

22 July 2016, Fukuoka Airport

- As shown in the camera image below, there were low clouds (CU) along mountains distant from the aerodrome. These could not be observed because they did not pass above the ceilometer.
- The cumulus was not reported in automated METAR/SPECI but was in manned METAR (FEW030).
- In this case, NSC (nil significant cloud) was reported in automated METAR (but not in local routine reports) because the automatically observed base height of the lowest cloud layer was relatively high (20,000 ft) and no convective clouds of operational significance (CB or TCU) were detected.
- If clouds corresponding to FEW040 had been present immediately above the aerodrome at the time, FEW040 (i.e., the base height of such cloud) would have been reported in automated METAR/SPECI, while FEW030 (i.e., the base height of the cloud outside the aerodrome) would have been reported in manned METAR/SPECI. In this case, automated METAR/SPECI would have represented conditions above the aerodrome more appropriately.

Camera images taken at 0300Z (12:00 JST) on 22 July 2016

Automated METAR

`METAR RJFF 220300Z AUTO 33010KT 9999 NSC 29/19 Q1010 RMK A2984=`

(Clouds were noted as FEW200// in automated local routine reporting.)

Manned METAR

`METAR RJFF 220300Z 33010KT 9999 FEW030 BKN/// 29/19 Q1010 RMK 1CU030 A2984=`

(Clouds were noted as FEW030CU BKN/// in manned local routine reporting.)

Example 4

Cloud base height

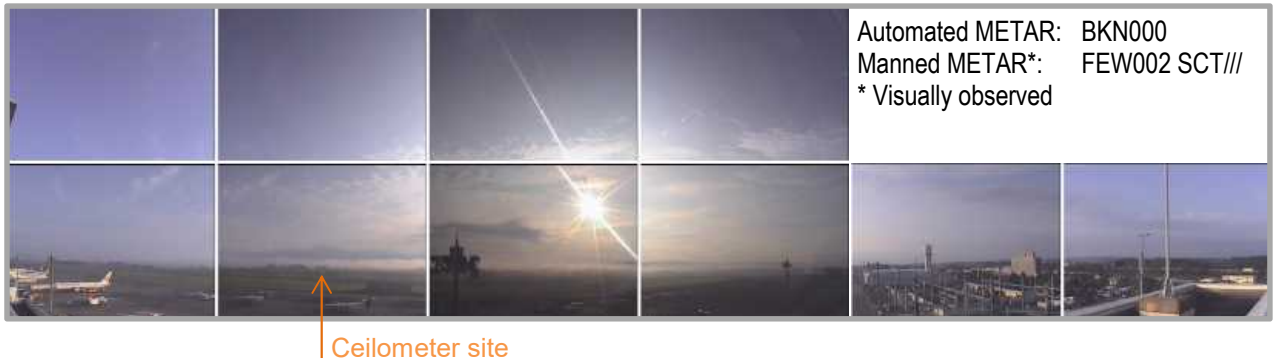
At aerodromes where cloud base heights are observed from rooftops in manned (visual) observation, automated METAR/SPECI will report a very low cloud base height if the fog top is lower than the rooftop. Such fog may not be identified as cloud in manned (visual) observation.

19 September 2015, Kagoshima Airport

- As shown in the camera images below, the sky could be clearly seen from the rooftop where the camera was at 2100Z (06:00 JST), as the fog top was lower than this level. In manned METAR, ST cloud amounts were similar to or less than SCT amounts (FEW001, SCT002). The cloud amount was reported as OVC000 and the base height as 0 ft in automated METAR.
- At 2200Z (07:00 JST) the fog was generally dissipating but remained around the site of the ceilometer along the runway. BKN000 was reported in automated METAR.

Camera images taken at 2100Z on 18 September (06:00 JST 19 September) 2015

Camera images taken at 2200Z 18 (07:00 19) on September 2015



Appendix A2-1 Standby time* settings for automated SPECI issuance

* The duration of deterioration/improvement of specific meteorological conditions that triggers SPECI issuance

Automated SPECI are issued in accordance with criteria for special observations (referred to here as SPECI criteria) established on the basis of weather minima and other conditions of each aerodrome. Automated SPECI can report comparable or more detailed meteorological information than manned SPECI without overlooking deterioration/improvement.

However, because of its automatic nature, the amount of automated SPECI information would be excessive if every minor deterioration/improvement were reported.

Against such a background, a number of airlines (Skymark Airlines, All Nippon Airways and Japan Airlines), the Japan Civil Aviation Bureau (JCAB) and the Japan Meteorological Agency (JMA) discussed the optimal frequency of automated SPECI in consideration of related advantages in the monitoring of weather conditions by aircraft operators and the operation of air traffic control by JCAB. It was agreed that automated SPECI for changes in visibility (VIS), ceiling (CLG) and present weather should be issued after deterioration continues for around 2 minutes and after improvement continues for around 5 minutes.

As with manned SPECI, automated SPECI for changes in surface wind direction and speed (10-minute mean values) - including increased maximum surface wind gust speed and increased air temperature (1-minute mean values) - will be issued as soon as these values meet the SPECI criteria. Automated SPECI for changes in RVR (10-minute mean values) are also issued with the same timing as manned SPECI (i.e., immediately and without omission in the case of deterioration, and promptly in the case of improvement).

The following pages detail standby times for automated SPECI (around 2 minutes for deterioration and around 5 minutes for improvement) regarding visibility and ceiling changes. These settings greatly affect the frequency of automated SPECI.

Standby time settings for automated SPECI issuance regarding changes in visibility (VIS) and ceiling (CLG)
(around 2 minutes for deterioration and around 5 minutes for improvement)

Specifications for local special reports and SPECI are provided in Appendix 3 of Annex 3 to the Convention on International Civil Aviation — *Meteorological Service for International Air Navigation* as follows.

Deterioration

3.1.3 A SPECI representing a deterioration in conditions shall be disseminated immediately after the observation. (Standard)

3.2.2 Local special reports shall be transmitted to local air traffic services units as soon as the specified conditions occur. (Standard)

Improvement

3.1.4 A SPECI representing an improvement in conditions should be disseminated only after the improvement has been maintained for 10 minutes. (Recommended practice)

3.2.2 Local special reports shall be transmitted to local air traffic services units as soon as the specified conditions occur. (Standard)

In Japan, JMA issues local special reports and SPECI at the same time based on the same observations as outlined below.

Deterioration

Local special reports and SPECI are issued immediately after observation.

Improvement

Local special reports and SPECI are issued, in principle, after improvement in weather conditions continues for 10 minutes. If improvement can be expected to continue for 10 minutes, local special reports and SPECI are issued immediately rather than after 10 minutes.

For example, if no standby time is set, when visibility (VIS) or ceiling (CLG) falls momentarily below the minimum allowable for approach/take-off and improves soon after, users would probably not receive an immediately issued automated SPECI reporting the deterioration until after the condition had already improved, and would also receive a subsequent untimely SPECI reporting the improvement. While it would technically be possible to issue automated SPECI for every minor deterioration (up to one a minute), this would clearly be excessive and redundant. There would also be numerous cases in which actual weather conditions would differ from those reported in automated SPECI by the time users receive the information, which is not an appropriate reporting situation.

In manned (visual) observation, although monitoring is immediately conducted in relation to visibility or ceiling deterioration, the output of manned SPECI can be suspended if the deterioration is only momentary and improvement is seen before issuance, as observation data entry and SPECI production take a couple of minutes.

For this reason, JMA applies a standby time for automated SPECI issuance relating to visibility and ceiling changes.

To support safety in landing and take-off, JMA maintains an ongoing policy of reporting deterioration immediately after observation (i.e., within around 2 minutes to avoid excessive automated SPECI issuance).

As it is difficult in automated observation (unlike in manned observation) to predict whether meteorological condition improvement will continue for 10 minutes, JMA instead applies an optimal standby time of around 5 minutes so that automated SPECI can be issued with appropriate frequency.

Automated SPECI issuance for changes in present weather are not as frequent as those for visibility and ceiling changes due to the limited numbers and types of SPECI criteria. However, in consideration of standby time settings for automated SPECI issuance relating to visibility and ceiling changes, JMA also applies a standby time for automated SPECI issuance relating to changes in present weather.

JMA does not apply standby times for other elements prescribed in SPECI criteria for the reasons outlined below.

<u>Surface wind direction/speed and air temperature</u>

The likelihood of overly frequent automated SPECI issuance is extremely low, as SPECI criteria for these elements are based on differences from the last reported values.

<u>Runway visual range (RVR)</u>

Changes in RVR can be reported every minute even in manned SPECI.

Tables 1 and 2 compare numbers of automated and manned SPECI for Kansai International Airport. From 16 May to 15 June 2016, automated SPECI were issued in line with the criteria and conditions outlined below based on possible standby times for automated SPECI issuance regarding visibility and ceiling changes. (These conditions were not applied to changes in other elements such as wind direction and speed; rather, regular SPECI criteria for manned observation and reporting were applied for automated SPECI issuance (up to once a minute)).

<u>SPECI criteria for visibility change</u>

5,000 m, 3,200 m, 2,400 m, 1,600 m, 1,500 m, 600 m and 200 m

<u>SPECI criteria for ceiling changes</u>

1,500 ft, 1,000 ft, 600 ft, 400 ft, 300 ft, 200 ft and 100 ft

<u>Conditions regarding possible standby times for automated SPECI issuance regarding visibility and ceiling changes</u>:

- around 2 minutes for deterioration
- around 2, 5 and 10 minutes for improvement

Notes

- Visibility and ceiling are calculated every 15 seconds.
- The standby time of around 2 minutes for deterioration means that automated SPECI is issued when deterioration to a level below the relevant SPECI criterion continues into a second minute

($HH^hMM^m00^s$). (The time from when the criterion is met to automated SPECI issuance is a little less than 2 minutes at most.)

Example 1) If visibility/ceiling deteriorates and the SPECI criterion is met at $09^h00^m30^s$, an automated SPECI is issued when the value remains below the criterion level until $09^h02^m00^s$ (see **Figure 1**).

Example 2) If visibility/ceiling deteriorates and the SPECI criterion is met at $09^h01^m00^s$, an automated SPECI is also issued when the value remains below the criterion level until $09^h02^m00^s$.

- The standby time of around 5 minutes for improvement means that automated SPECI is issued when improvement to a level above the relevant SPECI condition continues into a fifth minute ($HH^hMM^m00^s$). (The time from when the criterion is met to automated SPECI issuance is a little less than 5 minutes at most.)

Example 1) If visibility/ceiling improves and the SPECI criterion is met at $09^h00^m30^s$, an automated SPECI is issued when the value remains above the criterion level until $09^h05^m00^s$ (see **Figure 2**).

Example 2) If visibility/ceiling improves and the SPECI criterion is met at $09^h01^m00^s$, an automated SPECI is also issued when the value remains above the criterion level until $09^h05^m00^s$.

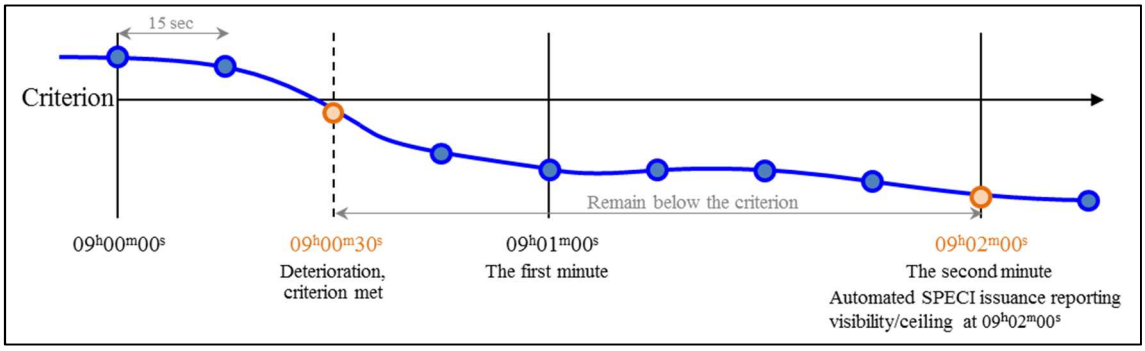


Figure 1 Issuance timing with a standby time of around 2 minutes for deterioration

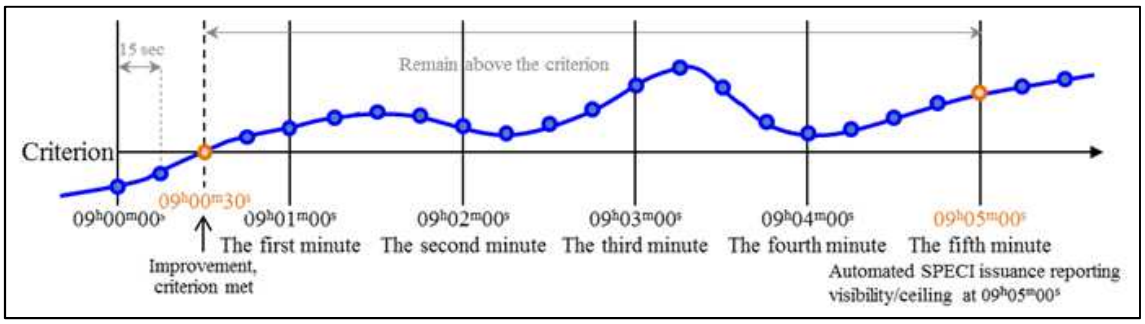


Figure 2 Issuance timing with a standby time of around 5 minutes for improvement

Table 1 shows maximum numbers of manned/automated SPECI issuances within the 30 minutes between each METAR in a day. On a certain day, the maximum is seven.

With a standby time of around 2 minutes for improvements, up to 11 SPECI can be issued within these 30 minutes. With standby times of around 5 and 10 minutes, the maximum numbers are 8 and 8, respectively, which is similar to the maximum numbers for manned SPECI issuance.

Table 2 shows the number of cases per day in which the average number of manned/automated SPECI issuances within the 30 minutes between each METAR is five or more (i.e., every 5 minutes or less on average).

With a standby time of 2 minutes for improvement, there were up to 2 cases per day in manned SPECI and 11 in automated SPECI, which is considerably frequent. With standby times of around 5 and 10 minutes there were 3 and 2 cases per day, respectively. These values are comparable to or the same as those of manned SPECI.

Figure 3 profiles visibility and ceiling values reported in manned and automated METAR/SPECI from 03:00 to 06:00 JST on 30 May 2016.

Summary

With a standby time of 2 minutes for deterioration:

- If the standby time for improvement is around 2 minutes, the number of automated SPECI issuances per unit time will increase and frequent reporting will occur very often.
- If the standby time for improvement is around 5 or 10 minutes, the number of automated SPECI issuances per unit time and the maximum number of occurrences of frequent reporting per day will be comparable to those of manned SPECI.
- If the standby time for improvement is around 10 minutes, automated SPECI issuance may be delayed by several tens of minutes compared to that of shorter times (around 2 or 5 minutes).

Accordingly, JMA sets standby times for automated SPECI issuance regarding visibility and ceiling changes at around 2 minutes for deterioration and around 5 minutes for improvement. Corresponding times for changes in present weather are the same.

Table 1 Maximum numbers of manned/automated SPECI issuances within the 30 minutes between each METAR in a day (Kansai International Airport)

Year and month			May 2016																July 2016															Max
Date			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Manned SPECI			4	2	0	0	0	1	0	0	0	0	4	7	2	2	2	0	0	1	0	1	5	0	1	0	0	0	0	5	2	0	1	7
Auto-mated SPECI	2	2	8	6	0	0	0	1	0	0	0	0	11	11	6	8	7	0	0	1	0	3	8	0	5	0	0	0	0	9	7	0	1	11
	2	5	6	6	0	0	0	1	0	0	0	0	7	7	4	5	6	0	0	1	0	2	5	0	4	0	0	0	0	8	5	0	1	8
	2	10	4	5	0	0	0	1	0	0	0	0	5	6	3	5	5	0	0	1	0	2	4	0	3	0	0	0	0	8	3	0	1	8
	Deterioration	Improvement																																
	Standby times																																	

Table 2 Number of cases (per day) in which the average number of manned/automated SPECI issuances within the 30 minutes between each METAR is five or more (Kansai International Airport)

Year and month			May 2016																July 2016															Max
Date			16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Manned SPECI			0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	2
Auto-mated SPECI	2	2	6	5	0	0	0	0	0	0	0	0	8	6	3	8	11	0	0	0	0	0	5	0	1	0	0	0	0	3	4	0	0	11
	2	5	1	3	0	0	0	0	0	0	0	0	2	2	0	2	3	0	0	0	0	0	1	0	0	0	0	0	0	2	2	0	0	3
	2	10	1	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
	Deterioration	Improvement																																
	Standby times																																	

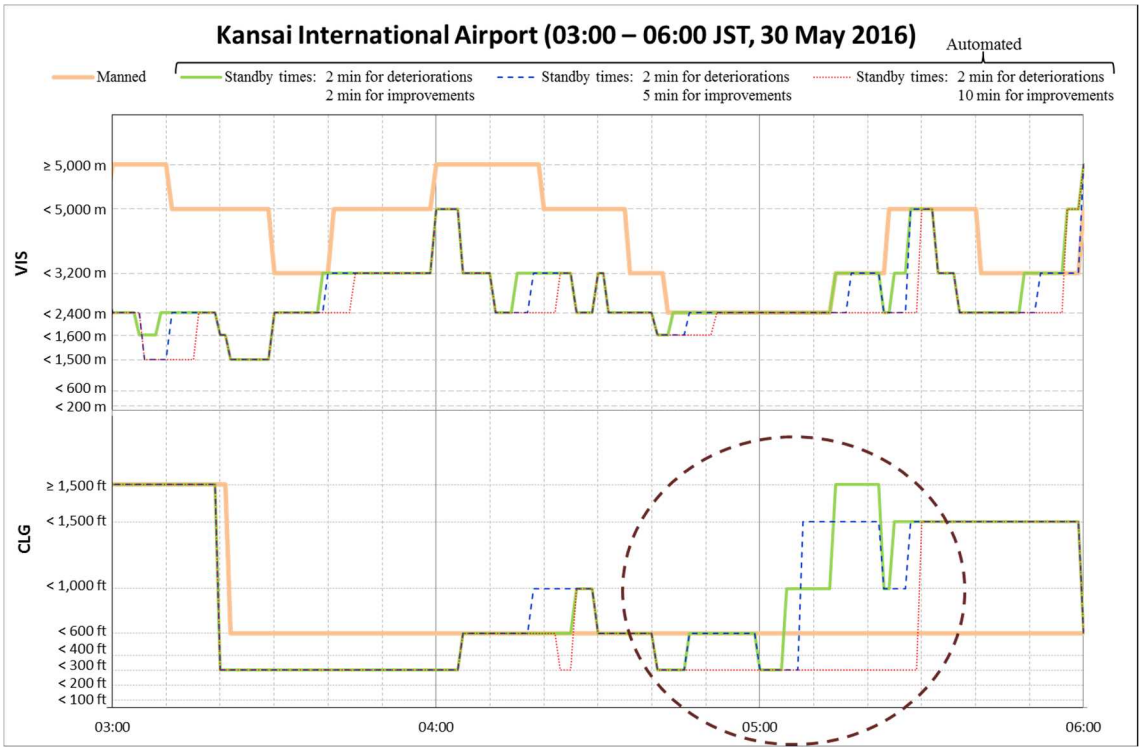


Figure 3 Visibility (VIS) and ceiling (CLG) values reported in manned and automated METAR/SPECI (03:00 – 06:00 JST, 30 May 2016, Kansai International Airport)

Notes

- In **Figure 3**, reported visibility (VIS) and ceiling (CLG) values are classified by the SPECI criteria thresholds. For example, visibility of 2,000 m and 2,100 m are both classified as < 2400 m.
- At around 05:00 JST (shown in the dashed circle), the red dotted line (showing a standby time of around 10 minutes for improvement) denotes a ceiling remaining at less than 300 ft and delayed issuance of automated SPECI for ceiling improvement (by several tens of minutes) as compared to those of shorter standby times (2 or 5 minutes).

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Appendix A2-2 Comparison of visibility (VIS) and cloud base height (CLG) in automated and manned METAR/SPECI

The Japan Meteorological Agency (JMA) conducted research on the characteristics of automated observation and reporting for six aerodromes in Japan (Sendai, Fukuoka, Kagoshima, Hachijojima, Izumo and Amami) for the periods from 1 October 2014 to 31 January 2015 (cool season) and from 16 July to 30 September 2015 (warm season).

The tables below compare reported visibility (VIS) and cloud base height or ceiling (CLG) in automated and manned METAR/SPECI (or SCAN for Hachijojima Airport).

Table 1 Comparison of reported visibility (VIS) in automated and manned METAR/SPECI (total for the six aerodromes)

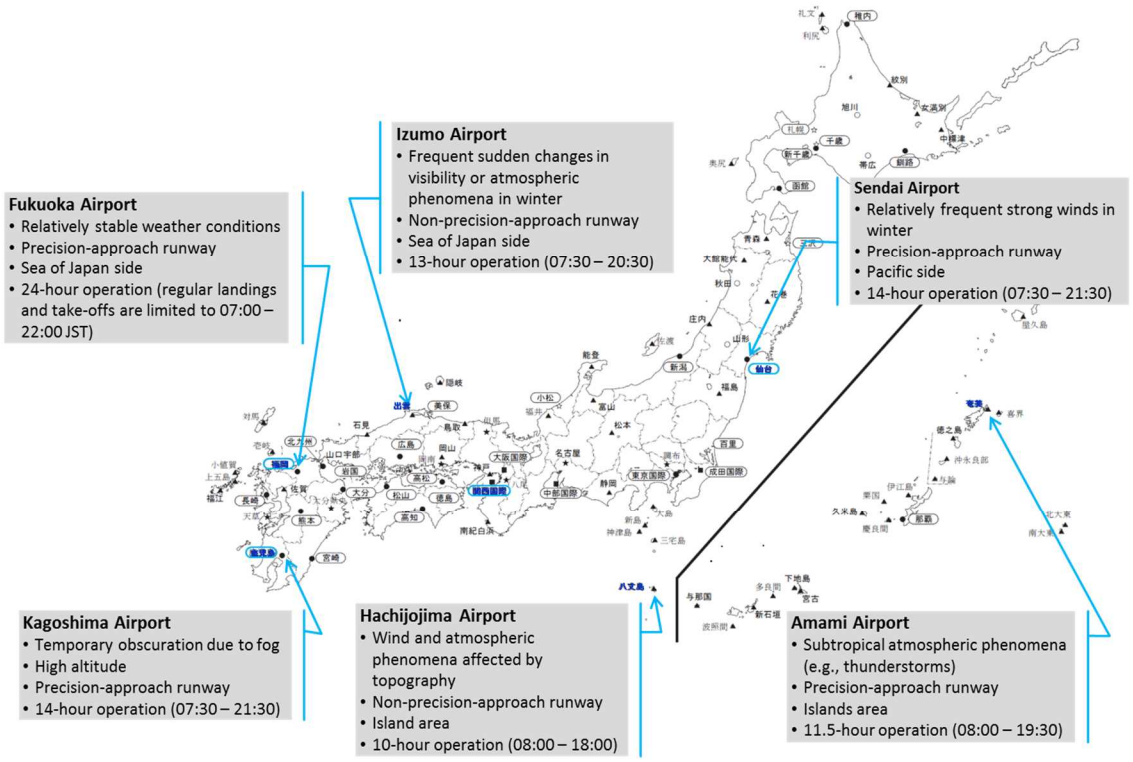
Visibility		**Automated METAR** [m]								
	72.8%	< 0200	< 0400	< 0600	< 0800	< 1600	< 3200	< 5000	≥ 5000	Missing
Manned METAR [m]	< 0200	1	0	0	0	0	0	0	0	0
	< 0400	6	1	2	0	1	0	1	0	0
	< 0600	7	5	2	0	0	0	0	0	0
	< 0800	0	2	2	3	3	0	0	0	0
	< 1600	2	7	7	6	28	10	2	1	0
	< 3200	1	4	8	17	83	168	34	7	0
	< 5000	0	1	5	8	41	149	121	54	0
	≥ 5000	3	6	3	5	42	242	503	22758	16

Table 2 Comparison of reported cloud base height or ceiling (CLG) in automated and manned METAR/SPECI (total for the six aerodromes)

Cloud base height		**Automated METAR** [ft]							
	83.0%	< 0100	< 0200	< 0600	< 1000	< 1500	< 3000	≥ 3000	Missing
Manned METAR [ft]	< 0100	0	0	0	0	0	0	0	0
	< 0200	4	2	0	0	0	1	1	0
	< 0600	2	18	95	16	3	3	6	0
	< 1000	0	0	59	99	50	16	14	0
	< 1500	0	3	22	87	162	60	18	1
	< 3000	1	5	34	103	357	612	288	7
	≥ 3000	12	6	48	79	284	1140	20338	22

Notes

The six target aerodromes were selected in consideration of variations in climatological conditions, geographical characteristics, airport operation type and other factors.

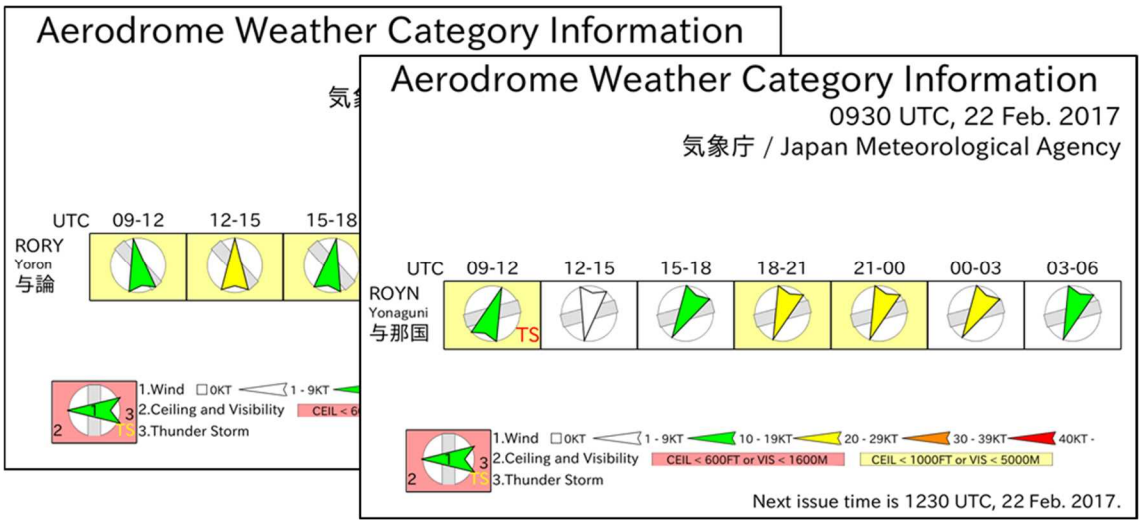


- In the research, JMA selected automated METAR reports issued every 10 minutes whose reporting time matched those of manned METAR/SPECI or SCAN for comparison.
- In the comparison, reported visibility and cloud base height or ceiling were classified using the threshold values for aerodrome forecast (TAF) and landing forecast (TREND) reports. Automated/manned report values in the same or adjacent categories were counted as matching. The reports in the grey cells of the tables were not used for concordance calculation.
- Visibility/cloud base height (or ceiling) differences between automated and manned METAR are chiefly attributable to differences in observation methods and locations (see **Examples 1 – 4**). When weather conditions change moment by moment, even slight differences in observation timing may cause such discrepancies.
- Visibility in the automated METAR data used for this research was the smaller of 1-minute or 10-minute mean values of MOR. In the operational phase of automated observation, visibility in operational automated METAR is expected to be slightly higher (i.e., with greater concordance), since operational automated METAR reports 1-minute mean values of MOR.

Appendix Aerodrome Weather Category Information

The Japan Meteorological Agency (JMA) provides Aerodrome Weather Category Information for aerodromes where full automation is implemented. Details of the information are as below.

- Target aerodromes:Iki, Kikai, Tokunoshima, Yoron, Minamidaito, Kitadaito, Tarama and Yonaguni
- The information is automatically issued eight times a day (at 0030, 0330, 0630, 0930, 1230, 1530, 1830 and 2130 UTC) and provided on JMA's dedicated MetAir website for aeronautical users.
- The information consists of forecasts issued every 3 hours for the following elements up to 21 hours ahead:
  - Maximum speed and direction of surface wind
  - Weather category based on a combination of ceiling and visibility
  - Presence or absence of thunderstorms (TS)



Color legend

1. Surface wind speed

White:	1 – 9 kt
Green:	10 – 19 kt
Yellow:	20 – 29 kt
Orange:	30 – 39 kt
Red:	40 kt or more

2. Ceiling (CEIL) and visibility (VIS)

White:	VMC		
Yellow:	CIG < 1000 ft	or	VIS < 5000 m
Pink:	CIG < 600 ft	or	VIS < 1600 m