Australian Government
Bureau of Meteorology

Review of Trend Forecast services for the aviation industry

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Authorised for release by

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Executive summary

The Bureau of Meteorology began a review of its Trend Forecast (TTF) services for the aviation industry in 2012, in response to:

- requests from the aviation industry for the Bureau to review its Trend Forecast services and investigate feasible alternative options; and
- a requirement to meet International Civil Aviation Organization (ICAO) standards.

The Bureau operates in a dynamic environment. It must review its operations on a regular basis in order to meet the changing needs of the aviation industry, while continuing to provide core functions that provide environmental intelligence to the Australian community.

The Bureau provides services in accordance with Australian Government legislation and international obligations, including the provision of aviation weather services. While the Bureau receives the majority of its funding from the Australian Government through appropriation, the Aviation Weather Service recovers the incremental cost incurred in providing aviation weather services from the aviation industry—in accordance with Department of Finance Cost Recovery Guidelines—through the Meteorological Service Charge (MSC).

In undertaking this review, the Bureau consulted with the aviation industry and the Australian Defence Force through regular consultative meetings and various industry forums. It was also necessary to establish a subject matter expert working group—the Trend Review Working Group (TRWG)—to resolve specific tasks.

The major airports affected by this review are Sydney, Melbourne, Brisbane, Perth, Adelaide, Gold Coast, Cairns, Canberra, Darwin and Hobart. The Defence aerodromes affected are those with a current TTF service.

The reasons for examining Trend Forecast services in greater detail are:

- The TTF format is unique to Australia. This unique code form presents international operators with difficulties decoding the Australian format and understanding the product's precedence over the Aerodrome Forecast (TAF). Additionally, the current format will present additional software costs to the Australian aviation industry as ICAO moves towards the digital exchange of information, including Trend, as TTF is not ICAO-compliant.
- During periods of marginal, deteriorating and/or fluctuating weather, special reports of meteorological information at an aerodrome (SPECI) can be issued many times in an hour. Each SPECI requires a TTF to be considered and appended to the observation, which can result in excessive workloads on forecasters and impact on their other duties, even though the forecast may not have changed. Tests have indicated that automated observations tend to make this situation worse with even more frequent SPECI observations issued than the current manual system.
- Although the TTF and TAF are forecasts for the same aerodrome, they convey different information concerning the probability and timing of meteorological phenomena.

- The Gold Coast airport is the sixth busiest in Australia and has no TTF service, even though the aviation industry has indicated a desire for one.
- Some airlines have no requirement for a TTF at particular locations, for certain times of the day (e.g. during curfew or low movement periods), or for specific times of the year (e.g. during the northern dry season).
- The TTF under current Bureau practices requires an aerodrome weather report to be made by a qualified meteorological observer—with associated costs. The aviation industry has indicated a desire to gain efficiencies through the further automation of observations at the major aerodromes. Automation may require changes to the current practices for issuing TTF.

In conducting the review, the TRWG regarded:

- Australia's international obligations in relation to ICAO's standards and recommended practices (SARPs) for the provision of meteorological services and products to aviation;
- current legislative and regulatory requirements governing aviation safety—including in relation to ensuring the safety, regularity and efficiency of air navigation, particularly in Australian-administered airspace—and weather services required to support this outcome;
- the approaches taken by overseas aviation weather services; and
- the requirements of the civil and military aviation sector—in terms of weather services and products for the aerodrome—to support safe and efficient aviation operations and planning.

The TRWG examined the current TTF service, developed ten principles for the automation of observations at major airports, examined alternative options to TTF and identified implementation risks that would need to be resolved.

The review has three recommendations:

Recommendation 1: The TRWG recommends that a risk assessment by an independent risk assessor be completed in order to analyse and better assess the implementation issues that need to be resolved prior to the transition to a TAF issued routinely every three hours.

This risk assessment was conducted on 12 November 2015 (summary at Appendix 12) and is the initial step towards an implementation phase that is described in Section 5. It provided confirmation on the detailed changes that will need to be made; it better identifies mitigation for identified risks (Appendix 4) and provides some information for a full implementation project timeline (Appendix 3). There were no safety implications identified in the assessment, however some risks to operational efficiencies were identified.

Recommendation 2: The TRWG recommends that subject to the implementation of appropriate risk mitigation that the TTF service be ceased and that, where appropriate, the TAF be issued routinely every three hours instead of every six hours. In addition, the TAF should be amended to provide similar responsiveness, accuracy and operational meteorological information as the current TTF.

Examples of TAF amends that create a similar effect as a TTF are at Appendices 6, 8, 9, 10 and 11.

Examples of a similar paradigm in the United States are at Appendices 5 and 7.

The timing of the transition to this option will depend on the resolution of implementation issues and risks raised at the risk assessment and any other important issues identified prior to the change.

Recommendation 3: The Bureau recommends that a TAF issued routinely every 3 hours be applied to all aerodromes where there is a specified Defence requirement and the following major airports:

- **Sydney**
- **Melbourne**
- **Brisbane**
- **Perth**
- **Adelaide**
- **Gold Coast**
- **Cairns**
- **Canberra**
- **Darwin**
- **Hobart**

The decision for the major airports was based on those airports that currently receive a TTF service and those airports that exceeded 2 million passenger movements per year in the 2012-2015 timeframe. Currently Gold Coast and Hobart have no TTF service but would receive a TAF issued routinely every 3 hours under these arrangements. There may be scope to extend this service to other aerodromes at some stage in the future.

The implementation of the recommendations in this report will result in improved services and safety for aviation stakeholders because:

- Australia will exceed ICAO requirements by providing METARs every half hour, SPECIs as required and a TAF issued routinely every 3 hours and amended as appropriate.
- There will be improvements to operational decision making because it is a simpler system.
- The TAF will have similar functionality to the TTF enabling the cessation of TTF.
- A single coded weather forecast eliminates any potential ambiguity between the TAF and TTF and offers greater simplicity for all operators. Understanding the precedence between the two different forecasts would no longer be required.

- It will eliminate alignment issues currently associated with the TAF being amended up to an hour after TTF. The TAF would be amended immediately as required.
- Reduction in forecaster workload during periods where a large number of SPECI's are issued, as forecasters will no longer be required to append TTF to each SPECI observation.
- A TAF issued routinely every 3 hours will be extended to Gold Coast and Hobart.
- A TAF issued routinely every 3 hours will operate 24/7 at Darwin and Canberra where there is currently no overnight TTF service.
- A TAF can be updated at any time. Currently the forecaster has to wait for an observation (typically half hourly) to update a TTF.
- A similar service operates in the United States and Canada.

The process to implementation is illustrated at Appendix 3 and implementation risks identified to date are at Appendix 4.

It is estimated that an implementation preparation phase of 12–18 months will be required for appropriate change management processes across the aviation industry and Defence.

Modern communication technologies combined with the additional situational awareness of weather phenomena delivered using the principles for automated observing systems will provide forecasters remotely located from the aerodrome with unprecedented information. The Bureau will continue— in consultation with the industry and regulators—to take into account opportunities to deliver services more efficiently and effectively as technology and communications improve.

1 Trend Forecast review

The Bureau provides a range of aviation weather products and services to the major airports, including the Australian Trend Forecast (TTF). All products and services delivered to the aviation industry are in accordance with the Aeronautical Services Handbook (ASH).

The TTF is a statement of meteorological conditions expected in the airspace within a radius of five nautical miles of the aerodrome reference point. It is a coded forecast appended to each aerodrome weather report (AWR) and is a concise statement of any expected significant changes of wind, visibility, weather, cloud and moderate or severe low level turbulence in the three-hour period from the time of the report.

A TTF supersedes the Aerodrome Forecast (TAF) over its period of validity and is considered the most up-to-date forecast for landing and take-off conditions[1].

1.1 Reasons for reviewing the Trend Forecast services

The review of the Trend Forecast service began in 2012 in response to:

- requests from the aviation industry for the Bureau to review its Trend Forecast services and investigate feasible alternative options; and
- a requirement to meet ICAO standards.

The review examined existing practices and technologies and evaluated whether there are alternatives that offer potential efficiencies both to the aviation industry and the Bureau, while providing improved compliance against ICAO Standard Recommended Practices and Procedures (SARPs). The following issues were examined during the review:

- During periods of marginal, deteriorating and/or fluctuating weather, special reports of meteorological information at an aerodrome (SPECI) can be issued many times in an hour. Each SPECI requires a TTF to be considered and appended to the observation, which can result in excessive workloads on forecasters and impact on their other duties, even though the forecast may not have changed. Tests have indicated that automated observations tend to make this situation worse with even more frequent SPECI observations issued than the current manual system.
- The TTF format is unique to Australia and has implications for international operators with decoding the Australian format and understanding its precedence over the TAF.

[1] AIP Book, 13 Nov 2014, GEN 3.5-5, para 3.5.3 'The TTF supersedes the TAF for its validity period and is the current forecast for pilots of aircraft whose arrival time falls within the validity period'

- ICAO is moving to XML/GML format for a range of aviation products by 2018 which will require Australia to develop unique schema at significant additional cost if the current TTF format is retained.
- Some airlines have no requirement for a Trend Forecast at specific aerodromes or only require the service at specific times during the day or year.
- TTF has priority for amendment and supersedes TAF; which can differ for up to three hours.
- TTF cannot convey probabilities less than 50 per cent, whereas TAF can convey probabilities down to 30 per cent.
- TTF is required to be appended to each METAR/SPECI. Current Bureau practice is to use a suitably competent meteorological observer, however ICAO standards and practices permit the use of automated observations. The aviation industry has indicated a desire to gain efficiencies through further automation of observations at the major aerodromes that currently have manual observations. The implementation of automated observations will require changes to current Bureau observational practices.
- If automation of observations is achieved, Bureau policies related to forecaster location and automation will be reassessed.

1.2 Terms of reference for the Trend Forecast review

The terms of reference for the review relate to the delivery of the TTF service, which in turn relates to other meteorological forecasts and observations at Australia's major airports and Defence aerodromes. The purpose of the review was to examine options for more effective and efficient delivery of services considering risks to safety, commercial risk and advances in observing and forecasting technologies. The aerodromes considered were Sydney (YSSY), Brisbane (YBBN), Melbourne (YMML), Cairns (YBCS), Darwin (YPDN), Perth (YPPH), Adelaide (YPAD), Gold Coast (YBCG), Canberra (YSCB) and relevant Defence aerodromes.

The review's terms of reference were agreed at the Major Airports Consultative Meeting on the 15 August 2012. The initial consultation with stakeholders and internal discussions revealed a need for a broader approach and the terms of reference were then modified at the Consultative Meeting on 14 February 2013 to include Defence aerodromes. The terms of reference were:

- to review the current systems, personnel requirements and costs for the provision of Trend Forecasts at Australian aerodromes;
- to compare current and proposed practices with international standards and practices;
- to analyse the risks associated with current service delivery at each aerodrome;
- to consult with industry and other stakeholders in order to examine the user requirements for forecasts at major airports;

- based on the user requirements, to examine and propose options for the delivery of Trend Forecasts, or an alternative;
- to review the infrastructure, observations and forecast product requirements at each aerodrome; and
- to provide recommendations and priorities to the Aviation Weather Services Strategic Planning Group meeting.

1.3 Trend Review Working Group

It was necessary to establish a subject matter expert working group to resolve a number of issues and provide advice on a way forward for observations and Trend Forecast practices in Australia.

The establishment of the Trend Review Working Group (TRWG) was discussed at the Consultative Meeting on 27 August 2013. The TRWG then met on three separate occasions: 12 February, 20 June and 26 August 2014. The Bureau provided a background report for the review of Trend Forecasts, chaired the meetings and provided secretariat and other administrative support. In conducting the review, the working group regarded:

- Australia's international obligations in relation to ICAO's SARPs for the provision of meteorological services and products to aviation;
- current legislative and regulatory requirements governing aviation safety—including in relation to ensuring the safety, regularity and efficiency of air navigation, particularly in Australian-administered airspace—and weather services required to support this outcome;
- approaches taken by other overseas aviation weather services providers; and
- the requirements of the civil and military aviation sector—in terms of Trend Forecast services and products—to support safe and efficient aviation operations and planning.

In developing future possible options for Trend Forecast arrangements, the TRWG specifically:

- examined whether the Trend Forecast service and manual observations should be provided for periods during curfew hours at Sydney and Adelaide airports;
- examined whether the Trend Forecast service should be provided only during the wet season months (October–April) at Darwin and Cairns;
- developed principles for automating observations at aerodromes, including references to benefit, risk and safety;
- examined feasible options for observations and forecasts at the relevant aerodromes, assessing their advantages and disadvantages and recommended a preferred option; and

- identified arrangements necessary to implement the recommended option, including agency roles and responsibilities of the Bureau and other agencies and discussed delivery timelines.

1.4 Stakeholder engagement

In undertaking this review, the Bureau consulted with the aviation industry through regular consultative meetings, various industry forums and meetings with Defence representatives. The TRWG included representatives from Qantas, Virgin Australia, Qantaslink, Skytrans, the Regional Airlines Association of Australia (RAAA), Airservices, the Australian Airline Pilots Association (AusALPA), CASA, DOIRD, Army, Royal Australian Air Force (RAAF), Royal Australian Navy (RAN) and the Bureau.

2 Aviation Weather Services

2.1 Role

The Bureau of Meteorology's Aviation Weather Service enhances the safety, regularity and efficiency of national and international aviation operations through the provision of accurate, timely and relevant forecasts, warnings and information for aerodromes and en-route operations. Aviation weather products and services are generated and delivered through the:

- Meteorological Watch Offices in each State and the Northern Territory;
- Defence Meteorological Watch Offices;
- Meteorological Offices in Sydney (SAMU), Cairns and Canberra;
- Darwin Volcanic Ash Advisory Centre (VAAC) and Darwin Tropical Cyclone Warning Centre (TCWC); and
- a Meteorological Unit at the Airservices Australia's National Operations Centre in Canberra (NOCMET).

The Bureau's role in providing services for civil aviation is established through the *Meteorology Act 1955*. Under the Convention for International Civil Aviation (the Chicago Convention) the Bureau is also the designated Meteorological Authority for Australia and must ensure that meteorological services for civil aviation in Australia are in accordance with the standards and recommended practices set out in Annex 3 to the Convention. In fulfilling this mandate, the Bureau works closely with Airservices, which is responsible for air traffic services, and the Civil Aviation Safety Authority (CASA), which is responsible for the safety regulation of civil aviation in Australia.

2.2 Consultation

The Bureau uses a range of national and international stakeholder consultation and coordination processes to ensure ongoing arrangements for improved service provision.

We are also actively involved in a number of committees, working groups and focus groups involving CASA, Airservices, Australian Transport Safety Bureau (ATSB), the Department of Defence (DOD) and the Department of Infrastructure and Regional Development (DOIRD), as well as representatives of international, domestic and regional airlines, general aviation, and other industry groups.

International consultation and coordination occur via such forums as the World Meteorological Organization (WMO) Commission for Aeronautical Meteorology (CAeM), the International Civil Aviation Organization (ICAO) Meteorology Panel (METP), the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG), and a number of other ICAO groups.

2.3 Structure

Management of the Bureau's Aviation Weather Service consists of:

- Major Airport Weather Services, overseeing services provided for the major international airports within Australia;
- Regional Aviation Weather Services, overseeing services provided to regional Australia and in low levels of airspace (including services to regional aviation, general aviation and sports aviation users);
- Upper Airspace Weather Services, overseeing all upper airspace services including aviation products supplied by the BNOC, NOCMET, TCAC and VAAC; and
- national management, which develops and manages policy, standards, practices and procedures as well as the financial management of Aviation Weather Services.

2.4 Meteorological Authority

The Meteorological Authority (MA) Office ensures that aviation weather services for Australia are provided in accordance with ICAO and provides advice to the Director of Meteorology regarding the authorisation of aviation meteorological service providers under *Civil Aviation Regulations 1988*, regulation 120.

2.5 Quality management

The Bureau's Aviation Weather Services programme and the Meteorological Authority Office maintain certification under the AS/NZS ISO 9001:2008 quality management standard. Our quality management system ensures rigorous, ongoing, independent scrutiny of the management and delivery of aviation weather services, and provides a firm basis for continuous improvement of these services to meet industry needs. The Bureau's aviation procedures are compliant with the aviation quality management system as required by ICAO.

We have implemented a centralised process for managing meteorological investigations relating to aircraft accidents and incidents, whereby all requests received by the Bureau are dealt with in a nationally coordinated and consistent manner. Meteorological investigations relating to aviation accidents and incidents help to identify any possible deficiencies in, and improvements to, aviation weather services. Consistency in such investigations allows the Bureau to identify widespread or common issues with the services more easily, and also facilitates archiving of information for future reference.

2.6 Competency

The Bureau has implemented a national aviation competency programme, whereby all forecasters performing an aviation function have been assessed and deemed competent. Following the initial competency assessments, forecasters are required to undergo routine assessments annually and major assessments every

four to five years. The Bureau is currently implementing a similar programme for aviation weather observers.

This competency training and assessment reflects what an aviation forecaster would be expected to do while exercising due care on the job, and hence provides the foundation for service-focused and operationally relevant training. It also provides a mechanism for benchmarking the required skills and knowledge.

2.7 Meteorological Service Charge

Australian Government policy requires that the Bureau recover the incremental costs incurred in providing a service to the aviation industry.

These costs are recovered by Airservices on behalf of the Bureau, via the Meteorological Service Charge (MSC). Due to the incremental cost recovery method and the impact of weather on their operations, the aviation industry maintains a strong involvement in the scoping and approval of services delivered to the industry.

3 Current TTF Service

3.1 Analysis of the current TTF Service

Comparative background information for the nine major airports is available at Table 1. Statistics for the number of revenue paying passengers in 2013–14 were used as a measure of strategic significance[2].

The four busiest airports, Sydney, Melbourne, Brisbane and Perth often have periods of air traffic congestion. Airservices has now introduced a new air traffic management system Harmony at all four airports. Harmony requires accurate weather forecast information often obtained from the TAF in order to forecast the availability of aircraft landing slots.

The TTF service is provided 24 hours a day, seven days a week, at six major airports (Sydney, Melbourne, Brisbane, Cairns, Perth and Adelaide), with Canberra and Darwin provided with a TTF for most of their operating hours. Gold Coast (50 NM south of Brisbane) has no TTF service but is the sixth busiest international airport in Australia.

Each airport has forecaster time dedicated to maintaining a continuous forecast weather watch. Full time weather observers are based at Sydney, Melbourne, Brisbane, Perth, Adelaide and Darwin—providing manual weather observations, climate observations and a radiosonde capability. The Bureau has built and currently maintains offices for personnel based at the airports, leasing the land from the airport authorities.

3.2 Resourcing

Figure 1 shows a graphical representation of the current forecasting service, compared with the number of revenue passengers through the airports between September 2013 and July 2014. The level of TTF service the Bureau provides can be considered across three distinct tiers:

Tier 1 is the service provided to Sydney airport, which has dedicated 24/7 weather forecasters (SAMU) and observers providing meteorological support. There are complex traffic management issues, with traffic flow rates sensitive to wind, cloud, visibility and other meteorological hazards. SAMU is collocated with Airservices to ensure prompt advice during challenging periods of adverse weather.

[2] Based on monthly statistics issued by the Department of Infrastructure and Transport's Bureau of Infrastructure, Transport and Regional Economics (BITRE) for August 2013 – July 2014. The statistics showed a similar comparative result for the number of aircraft movements.

Table 1: Comparison of TTF service, additional resources and weather statistics

Airport	Revenue-generating passengers (millions) August 2013 – July 2014	TTF Service (Local time)	Dedicated forecasters	Observers	Mean Thunderstorm Days per year	Mean Fog Days per year
Sydney	38.61	24/7	6	6	21.6	9.2
Melbourne	30.95	24/7	3.6[3]	6	12.8	12[4]
Brisbane	21.87	24/7	3.6	6	16.6	5.2
Perth	12.92	24/7	3.6	6	15.1	14.1
Adelaide	7.60	24/7	3.6	6	11.2	5
Gold Coast	5.79	No Service	0[5]	0	No climate data	No climate data
Cairns	4.30	24/7	6[6]	0	17.2	0.2
Canberra	2.84	0500–2030 weekdays 0630–1800 weekends	3.6	0	22.9	40.1
Darwin	2.06	0530–2159	2.4	6	80.4	2.6

[3] Fractioned because a portion of time is supported by a leave relief
[4] Melbourne has a significant number of low cloud events below Special Alternate Minimum not reflected in this statistic.
[5] A close weather watch on Gold Coast is delivered by the Brisbane RFC though there is no official resource allocated above that of a secondary airport.
[6] Manual Observations provided by forecasting staff.

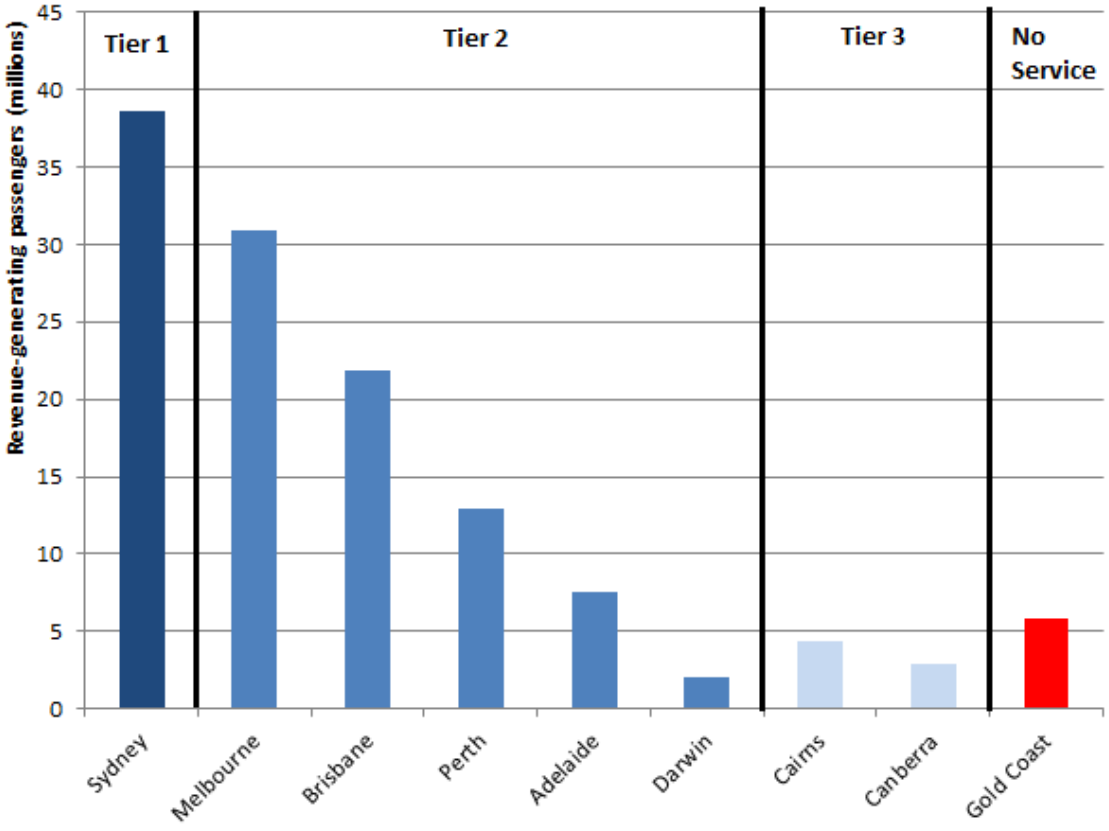

Figure 1: Statistics for revenue-generating passengers through the major airports August 2013 – July 2014 compared with the TTF Service provided by the Bureau.

Tier 2 includes Melbourne, Brisbane, Perth, Adelaide and Darwin. These airports have dedicated observers, with forecasting services provided from the aviation desks at the Regional Forecasting Centres (RFC) in those cities. The TTF service at these aerodromes is provided 24/7 with the exception of Darwin, which provides the service between 0530 and 2159 local time. Melbourne, Brisbane and Perth airports have at times capacity issues and weather-sensitive arrival rates. Adelaide and Darwin are less busy.

Tier 3 includes Cairns and Canberra. These airports both have a TTF service provided by forecasters at the airport, who issue both the observations and forecasts (TTF and TAF). The time required to perform and process an observation is approximately 15–25 minutes an hour. The forecasting role, including weather watch, is performed for the rest of the period.

Outside these tiers, Gold Coast receives a standard international TAF service with no TTF. Historically its proximity to Brisbane and the cost of running a TTF service have been the rationale for not providing an improved service at Tier 2 or Tier 3 level.

3.3 Weather considerations

Climate statistics are important when trying to balance the forecasting investment with the risk of adverse weather. Tropical cyclones occasionally affect Darwin and Cairns but are rare compared with the regular thunderstorm events that affect operations at those airports during the wet season. In order to simplify the effect of weather on each airport, only mean fog and thunderstorm days have been considered, although Melbourne has a significant number of low cloud days below Special Alternate Minimum (SAM). An analysis of the readily available climate data over a period between 1939 and 2010 was used to compare the frequency of significant weather events—see Figure 2 and Figure 3, which illustrate the total fog and thunderstorm days comparing April to September with October to March. The meteorological risk at both Cairns and Darwin appears to be low during the dry season and services will continue to align with industry requirements and seasonal conditions.

Figure 4 shows the annual mean fog and thunderstorm days. Canberra has the highest fog total and second highest thunderstorm total, which should be taken into consideration when assessing appropriate levels of forecasting service.

3.4 Curfew operations

Curfews are currently in place at Sydney, Adelaide and Gold Coast airports between 11pm and 6am[7].

The TRWG was tasked with investigating whether a Trend Forecast service and manual observations should be provided for periods during curfew hours at aerodromes. The working group took into consideration:

- night-time operations at Sydney airport;
- the requirement for TTF up to three hours prior to the end of the curfew period;
- the requirement for the major airport to be used as an emergency alternate during curfew hours; and
- the requirement for the Army to have 24/7 TTF coverage at Sydney airport.

The TRWG advised not to change the TTF service during curfew hours at Sydney and Adelaide airports at this stage.

3.5 Seasonal requirements

The TRWG was tasked with investigating whether the Trend Forecast service should be provided only during the wet season months (October–April) at Darwin and Cairns. The working group considered the following:

[7] Airport Curfew fact sheet available at www.airservicesaustralia.com/wp.../11-152FAC_Airport-curfews_WEB.pdf.

- Showers at Cairns during the dry season sometimes create below-alternate minima conditions.
- There was no significant weather at Darwin airport during the dry season.

The TRWG advised that the TTF service at Cairns should be retained at this stage, and that the TTF service in Darwin should be suspended during the dry season if a benefit to the aviation industry or the Bureau could be determined.

Later evaluation revealed that there would be no tangible benefit to the Bureau in suspending this service and no change to the base cost to industry.

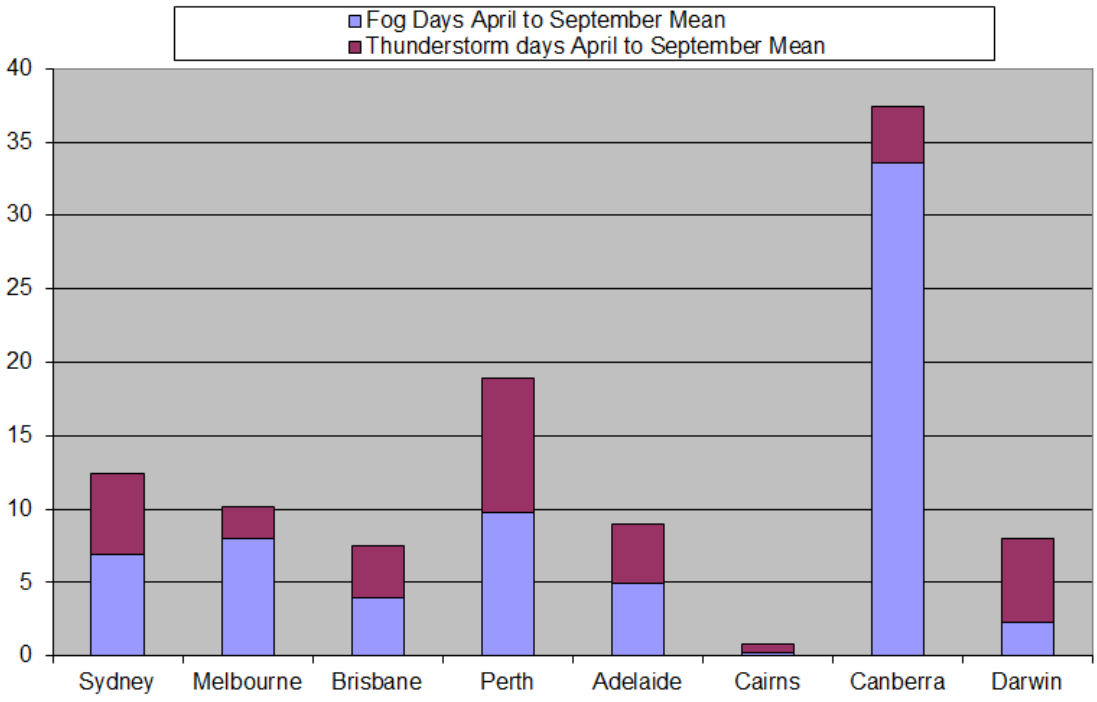

Figure 2: Weather in April–September affecting the major airports.

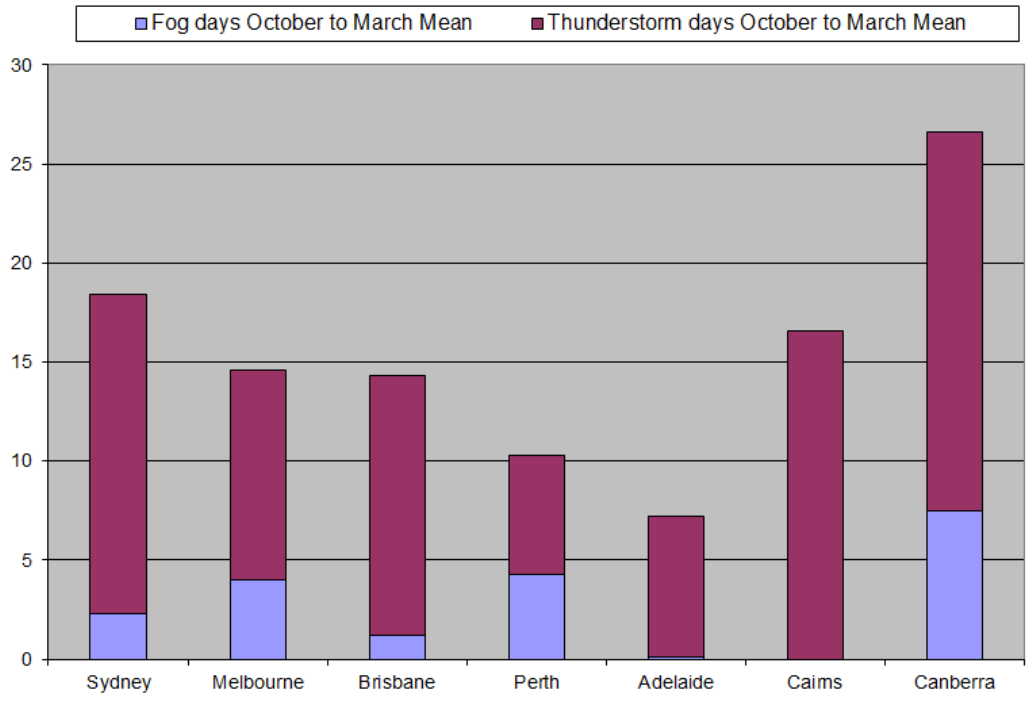

Figure 3: Weather in October–March affecting the major airports[8]

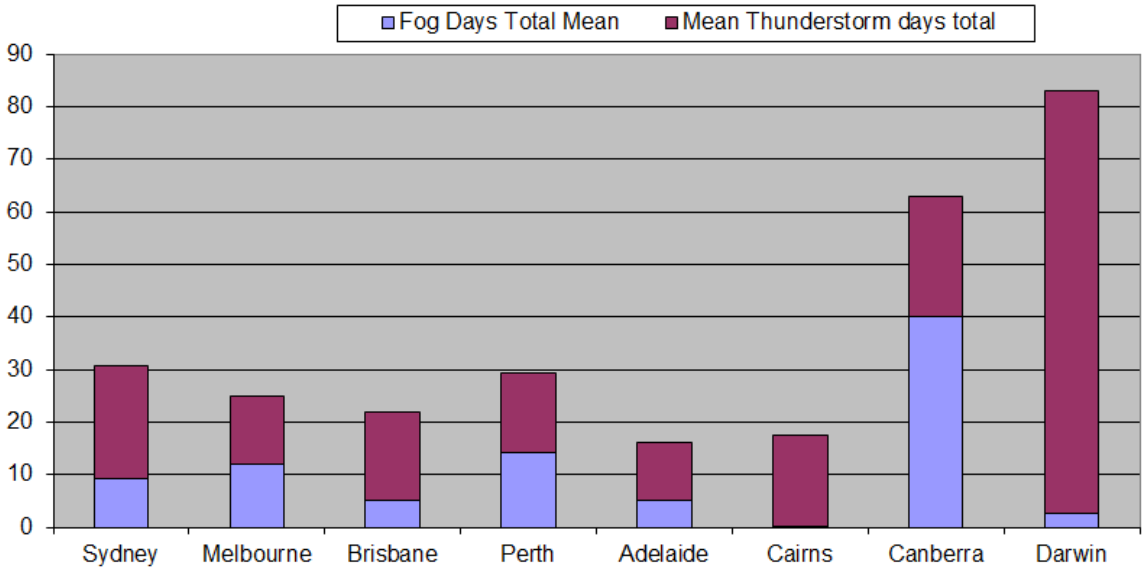

Figure 4: Weather annually affecting the major airports

[8] Darwin has 75.7 mean thunderstorm days in this period and is not shown due to scaling issues. See Figure 4.

4 Options to replace the TTF Service

4.1 Forecasts currently available

There are several forecasts available for the major airports and Defence aerodromes. Each has a purpose and precedence.

4.1.1 Airport Weather Briefings

Airport Weather Briefings (AWBs) are a one-page summary issued every six hours at Sydney and 12-hourly for many of the other major airports. They provide a complete picture of the forecast but are not routinely amended. They contain a section on the synoptic situation that provides a basis for the decisions made in the latest routine TAF, plus other possibilities that can't be articulated in the TAF or TTF.

4.1.2 Aerodrome Forecasts (TAF)

TAFs are issued routinely every six hours. For major airports, they are valid for 24 or 30 hours[9]. They conform to an internationally recognised code (with Australian variations) and are amended when the forecast changes significantly[10]. They include coding for event probabilities of 30 and 40 per cent; events above 50 per cent are included in the TAF without a probability descriptor. Only one TAF is valid at a particular time; an amended TAF will replace the previous TAF. An amended TAF could also change the entire forecast promulgated in the Airport Weather Briefing, which is not routinely amended. The TAF has a one-hour resolution for most weather changes with the exception of 'from' (FM) groups in the code, which have one-minute resolution. The TAF can only be valid from a whole hour.

4.1.3 Trend Forecasts (TTF)

TTFs have a three-hour validity period and are issued with every METAR and SPECI. They have precedence over the TAF for all purposes including short-range flight planning. TTF uses a unique but similar code to the ICAO Trend Forecast. The precedence of the TTF means there can be delays in promptly updating the TAF during busy workload periods. The ICAO Trend Forecast and TTF codes have no means to include probability events but do have up-to-the-minute resolution.

[9] The Bureau issues 24-hour TAFs for Canberra, Gold Coast and Cairns and 30-hour TAFs for the other major airports in this review.

[10] Thresholds are defined in ICAO Annex 3 and additional local thresholds apply to some airports.

4.1.4 Differences between TAF and TTF

TAF and TTF are deterministic forecasts with some significant differences between them:

- TAF can mention probabilities of 30 and 40 per cent, whereas TTF is a forecast of the most likely outcome over the next three hours. It is not inconsistent to have a PROB30 code on a TAF and no phenomena on the TTF;
- TTF has code that caters for up-to-the-minute changes, whereas the TAF has hourly granularity except for FM groups;
- TTF has a high update rate of at least every half hour, compared to at least every six hours for the TAF;
- If a short-term weather event occurs that is not on the TAF, and it is not expected to continue beyond the next hour, then a TAF amendment may not be issued; and
- TAFs can only be valid from a whole hour and amendments should take effect from the next hour when TTF is in use. When TTF is not in use the TAF amendment can take effect from the current hour.

4.2 Australian practice

4.2.1 Uses of the TTF as a landing forecast

TTF is used by most major airlines as a landing forecast for in-flight decision making. Tactical in-flight use by business jet and other charter operators frequently lacks the base operational support of the major airlines, so the pilots value the concise and targeted information in the TTF. It is particularly useful for in-flight decision-making because of its half-hourly update rate. Long-haul and extra-long-haul flights into Australia often have to make final landing decisions prior to commencing a descent. In marginal conditions near the alternate minima, TTF often provides accurate up-to-the-minute decision support—especially for potential inbound diversions.

The Aircraft Owners and Pilots Association (AOPA) has also indicated that TTF is sometimes used by smaller aircraft operating at the nearby secondary General Aviation (GA) airports such as Bankstown and Jandakot, on the basis that the TAF for those airports may not be updated and the nearby major airport's TTF can be indicative of a phenomena that could affect a wider area and potentially the secondary GA aerodrome. TTF and TAFs over an area are used to inform decisions rather than relying solely on the destination TAF. Furthermore, some flying training, air work and scenic/charter operators also monitor the primary airport TTF to plan the recommencement of flying activities following thunderstorms or fog.

There are currently meteorological broadcasts that include the TTF, made by Airservices on HF radio from Brisbane (VOLMET) and on the VHF (AERIS) service at 14 locations[11]. The AERIS METARs include TTF and are useful to aircraft to support in-flight decisions in a wide variety of circumstances. The TTF can be used effectively to ease ATC radio congestion.

Any alternative forecast arrangement would need to provide a similar tactical effect as the TTF for a diverse range of aircraft operations. There would need to be a comprehensive education and information programme, and detailed analysis of in-flight information processes.

4.2.2 TTF as a flight planning forecast

The TTF is used by many[12] of the regional airlines for flight planning purposes. The obligations related to flight planning for a Pilot in Command are described under Civil Aviation Regulations 1988, regulations 239 and 240, and include a careful study of current weather reports and forecasts for the route to be flown and at the aerodromes to be used.[13] The regulations also describe the provision for alternative courses of action, the necessary fuel and the authority for CASA to issue instructions – such as contained in AIP - in relation to flight planning. These regulations carry a strict liability under Section 6.1 of the Criminal Code.

The TTF is a short-term forecast that is valid for three hours. The AIP (Enr 1.1 – 58.2.9) allows flights, which will be completed within the validity time of the TTF may be planned wholly with reference to the destination TTF; theoretically a flight from Sydney to Melbourne could be planned solely using the latest Melbourne TTF for forecast destination weather. In addition there are added benefits in using a TTF over a TAF. When the TAF either creates an operational requirement using a 'from' (FM) or 'becoming' (BECMG) group, removes an operational requirement using a FM or BECMG group, or describes a period of intermittent (INTER—up to 30 min weather impact) or temporary (TEMPO—up to 60 min weather impact) deteriorations resulting in an operational requirement, an additional buffer of 30 min of fuel is required.[14] These 30 min buffers do not apply to the TTF resulting in a considerable fuel saving for operators whose ETA is contained within the TTF validity period.

Airservices' Aeronautical Information Package (AIP Book) states:

> 'Due to the continuous weather watch provided by TTF, the 30 minute buffers required by paras 58.2.7 and 58.2.8 do not apply. Flights which will be completed within the time of validity of the TTF may be planned wholly with reference to the destination TTF.'[15]

[11] For example Mt Canobolas, 119.85MHz, has weather for Adelaide, Alice Springs, Brisbane, Melbourne, Perth, Sydney and Williamtown.
[12] Consultation with Qantaslink, Rex, Air North, Hardy Aviation, Chartair, AOPA and the RAAA.
[13] Civil Aviation Regulations 1988, regulations 239 and 240, – www.comlaw.gov.au/Series/F1997B00935
[14] AIP Book, 13 Nov 2014, ENR 1.1, paras 58.2.7 and 58.2.8
[15] AIP Book, 13 Nov 2014, ENR 1.1, para 58.2.9

4.2.3 Australian aviation industry requirements for the solution

Industry feedback acknowledges the need for any changes to be carefully managed. In summary, the aviation industry's requirements for any change are that:

- any new option should try to achieve the same operational effect on fuel planning as the TTF;
- any new option should try to achieve the same operational effect on in-flight decision making as the TTF;
- there is a system of quality assurance for any new option to ensure that the timeliness of forecast changes and forecast accuracy are not compromised; and
- there is some certainty in long-term efficiency savings afforded by the adoption of any changes.

Additionally, the timeframes for any change would need to consider the Aeronautical Information and Regulation and Control (AIRAC) publishing cycle to ensure that operational documentation (Airservices and Jeppesen) correctly reflects the services available and includes time for pilot training and reasonable notice of a change. There are also ICAO change notification processes that will need to be completed prior to making changes.

4.2.4 Defence practice

The TTF is used by Defence aviation at a number of aerodromes. Dedicated forecasters located at the Defence aerodromes normally provide the TTF; however, some Army helicopter operations use the major airport TTF.

Similar to some industry operators, TTF is used as a critical flight planning and flight supervision tool. It was described as essential for fuel critical military aircraft. Defence apply the civil fuel buffer arrangements under ENR Para 58.2.9 for most short-duration sorties. This ensures that sorties can be flown without additional fuel right up to the forecast commencement of below-alternate conditions. Similar arrangements would need to be in place for any replacement to the TTF; otherwise a number of short-duration sorties would not be feasible—with potential impact on training and operations.

Should there be a service change from the current TTF, forecast accuracy will need to be maintained; otherwise there would be an additional impact on flying training through increased emergency diversions.

Large transport and tanker aircraft have a less critical requirement for the TTF, using it as a landing forecast only.

4.3 International practice

4.3.1 Routine meteorological observations

A routine meteorological observation (METAR)[16] is issued every half hour at the major Australian airports. ICAO requires a METAR to be issued hourly if SPECI (see below) are also issued, or half-hourly when no SPECI are issued. The Bureau has some minor registered differences with ICAO Annex 3 METAR requirements and appends a TTF to half-hourly METAR as well as SPECI, thus exceeding the international requirement.

4.3.2 Special meteorological observations

A special meteorological observation (SPECI)[17] is a non-routine meteorological observation that is reported when an element within an observation such as visibility or cloud base deteriorates below a set threshold or when there is deterioration in one element and improvement in another. An improvement above these thresholds is reported ten minutes after the event using the prevailing conditions for the ten-minute period. A TTF is appended to every SPECI and there are sometimes conditions where SPECIs are issued more than ten times in an hour. ICAO Annex 3 does not make it mandatory to issue SPECIs and a number of countries do not report SPECIs.

4.3.3 Aerodrome Forecasts

TAFs are issued routinely at the major airports and Australia has some registered differences to the international code. A TTF supersedes the TAF for its duration and amendments are not strictly required to be issued during the validity of the TTF.[18]

4.3.4 ICAO Trend Forecasts

A Trend Forecast[19] is a landing forecast intended to meet the requirements of local users and of aircraft within about one hour's flying time of the aerodrome. It is appended to the METAR or SPECI and is valid for two hours from the time of the report. Most developed countries use Trend Forecasts, with the exception of the US and Canada.

Australia has registered a difference for the TTF duration of three hours and the TTF has some unique coding and forecasting rules.

[16] AIP Book, 13 Nov 2014, GEN 3.5, sect 4.2 and ICAO Annex 3, ch 4, sect 4.3 and Appendix 3.
[17] AIP Book, 13 Nov 2014, GEN 3.5, sect 4.3 and ICAO Annex 3, ch 4, sect 4.4 and Appendix 3.
[18] AIP Book, 13 Nov 2014, GEN 3.5, sect 3.3 and ICAO Annex 3, ch 6, sect 6.2 and Appendix 5.
[19] AIP Book, 13 Nov 2014, GEN 3.5, sect 3.4 and ICAO Annex 3, ch 6, sect 6.3 and Appendix 3.

4.3.5 Approaches by other countries

Table 2 provides a summary of aerodrome observations and forecasts adopted by other countries. The US, Canada and Russia routinely issue a TAF every three hours for some aerodromes, which is a minor difference to the ICAO Recommendation[20] and provides airline operators with a more frequent update rate that effectively exceeds the standard. The US and Canada do not issue Trend Forecasts. In rapidly changing conditions the US and Canada TAFs are amended frequently to reflect important changes to forecast.

European countries, New Zealand, parts of China and many other Asian countries do not issue SPECI observations but issue METARs every half hour with an ICAO Trend. The majority of countries that use ICAO Trend Forecasts apply the ICAO Annex 3 rules without any registered differences.

Table 2: International practices for METAR, SPECI, Trend and TAF for international aerodromes with respect to ICAO Annex 3.

Country	METAR	SPECI	ICAO Trend	TAF
Australia Current	½ hourly	Yes	TTF instead	6 hourly
Australia Proposed	½ hourly	Yes	No	3 hourly
NZ	½ hourly	No	Yes	6 hourly
USA	hourly	Yes	No	3 hourly
Canada	hourly	Yes	No	3 hourly
Singapore	½ hourly	No	Yes	6 hourly
China (Hong Kong)	½ hourly	Yes	Yes	6 hourly
China (Pudong)	½ hourly	No	Yes	6 hourly
Japan	½ hourly	Yes	Yes	6 hourly
Indonesia (Jakarta)	½ hourly	No	Yes	6 hourly
Thailand	½ hourly	No	Yes	6 hourly
Philippines	hourly	Yes	Yes	6 hourly
South Africa	½ hourly	Yes	Yes	6 hourly
UAE (Dubai)	hourly	Yes	Yes	6 hourly
Russia (Moscow)	½ hourly	No	Yes	3 hourly
UK	½ hourly	No	Yes	6 hourly
Germany	½ hourly	No	Yes	6 hourly
France	½ hourly	No	Yes	6 hourly
Netherlands	½ hourly	No	Yes	6 hourly
India	½ hourly	No	Yes	6 hourly

[20] ICAO Annex 3, ch 6, para 6.2.6 "Recommendation – The period of validity of a routine TAF… and those valid for 12 to 30 hours should be issued every 6 hours."

4.4 Options for alternative forecasts

4.4.1 Observations, Trend and Aerodrome Forecasts

The Bureau proposed the following options in Table 3 for METAR, SPECI, TTF, ICAO Trend and TAF to the TRWG. The TRWG was tasked with examining these options considering their advantages, disadvantages and risks.

Table 3: Options available for coded observations and forecasts at the major airport and Defence aerodromes.

Option	METAR	SPECI	TTF Trend	ICAO Trend	TAF issued 6-hourly	TAF issued 3-hourly
1. Status quo	Yes	Yes	Yes	No	Yes	No
2. No SPECI	Yes	No	Yes	No	Yes	No
3. No Trend	Yes	Yes	No	No	Yes	No
4. No SPECI or Trend	Yes	No	No	No	Yes	No
5. ICAO Trend	Yes	Yes	No	Yes	Yes	No
6. ICAO Trend but no SPECI	Yes	No	No	Yes	Yes	No
7. TAF 3-hourly, no Trend	Yes	Yes	No	No	No	Yes
8. TAF 3-hourly, no SPECI or Trend	Yes	No	No	No	No	Yes

4.4.2 Adopting ICAO Trend

Replacing the TTF with the ICAO Trend Forecast has the advantage of aligning with international practice and would provide the major airports with a landing forecast with every METAR and SPECI. To properly align with ICAO, a Trend Forecast would be used as a landing forecast.

Options 5 and 6 replace the TTF with the compliant ICAO Trend format. These were carefully considered by the TRWG, as they would resolve most of the registered differences with ICAO. Scenarios with TTF translated into the ICAO format and examples from overseas were used during meetings to illustrate operational effect. The TRWG rejected these options because:

- the ICAO Trend Forecast Format does not allow for the code for ‘intermittent’ (INTER) to be used instead of ‘temporary’ (TEMPO) in

instances where the expected deterioration in conditions is up to half an hour. This would have a significant impact on some operations;

- during periods of marginal, deteriorating and/or fluctuating weather, SPECIs can be issued many times in an hour. Each SPECI will require a Trend to be considered and appended to the observation, which can result in excessive workloads on forecasters and impact on their other duties, even though the forecast may not have changed;
- the validity of the Trend Forecast is two hours;
- both TAF and Trend will exist for the aerodrome which will result in increased workload, delays in updates and potential confusion as the two forecasts will convey different information at times; and
- all aviation stakeholders would need to learn a new code.

4.4.3 Cancellation of SPECI Observations

If SPECI observations ceased at the major airports, METARs could still be issued every half hour with a Trend Forecast. This overcomes the problem of having a Trend Forecast attached to every SPECI observation in rapidly fluctuation weather conditions where a forecast can be repeated up to ten times in an hour. Up-to-the-minute weather information would still be available through automatic weather information systems AWIS, automatic terminal information services (ATIS) and weather reports from air traffic control. SPECIs are not used in the UK, France, Germany, New Zealand and some major airports in China.

Options 2, 4, 6 and 8 propose the elimination of SPECI observations. These options were rejected by the TRWG because:

- the aviation industry and Defence have a requirement for special conditions to be clearly alerted in the text header of the observation; and
- the aviation industry and Defence have a requirement to be notified immediately by aerodrome weather report when meteorological conditions are deteriorating or improving through SPECI thresholds.

After consideration of METAR and SPECI observations in Australia, the TRWG advised that the Bureau should continue to issue METAR every half hour with SPECIs and to issue METAR as SPECI on the half hour when appropriate. This maintains the status quo for the header of METAR/SPECI and involves writing software that changes the header from SPECI to METAR for observations issued on the half hour for international dissemination.

4.4.4 Replacement of TTF Services with responsive TAF

The remaining alternatives (Options 3 and 7) would see the current TTF service replaced with a TAF that is amended when required at interim times, to provide a similar responsiveness to that currently provided through the TTF. This would be similar to the approach adopted in the US and Canada. The TAF would use the current standard TAF code but be amended when the forecast changed in the

short term. Option 3 proposed a routine update rate of six-hourly, and was rejected by the TRWG in favour of the routine update rate of three-hourly in Option 7.

Option 7 was recommended by the TRWG, noting that there were some significant implementation issues that would need to be addressed. These issues are explained in Section 5 of this report. This was the preferred option because:

- it focuses the forecaster on one product instead of two;
- inconsistencies between the TTF and TAF are eliminated;
- the TAF is amended immediately when it is appropriate to do so (it currently has second priority to TTF and could be unchanged for up to three hours);
- the pressure on forecaster workload during high issuance rates of SPECIs is eliminated;
- all ICAO registered differences regarding the TTF can be eliminated;
- the ICAO registered differences for METAR and SPECI can be minimised or eliminated;
- Australia will be able to adopt ICAO XML schema that becomes an ICAO Recommendation in November 2016;
- there will be only one coded forecast for aerodromes in Australia, the TAF, which is understood by international operators and compliant with their operating systems; and
- the one-minute granularity of the TTF can be conveyed in the TAF using FM groups to refine the onset and cessation of weather phenomena.

Note that software to replace 'INTER' with 'TEMPO' in the TAF code will need to be written for international dissemination, thereby maintaining compliance with the ICAO TAF code, future XML schema and retaining 'INTER' for domestic use in Australia.

There are three recommendations resulting from the analysis of the TRWG:

Recommendation 1: The TRWG recommends that a risk assessment by an independent risk assessor be completed in order to analyse and better assess the implementation issues that need to be resolved prior to the transition to a TAF issued routinely every three hours.

This risk assessment was conducted on 12 November 2015 (summary at Appendix 12) and is the initial step towards an implementation phase that is described in Section 5. It provided confirmation on the detailed changes that will need to be made; it better identifies mitigation for identified risks (Appendix 4) and provides some information for a full implementation project timeline (Appendix 3). There were no safety implications identified in the assessment, however some risks to operational efficiencies were identified.

Recommendation 2: The TRWG recommends that subject to the implementation of appropriate risk mitigation that the TTF service be ceased and that, where appropriate, the TAF be issued routinely every three hours

instead of every six hours. In addition, the TAF should be amended to provide similar responsiveness, accuracy and operational meteorological information as the current TTF.

Examples of TAF amends that create the same effect as a TTF are at Appendices 6, 8, 9, 10 and 11.

Examples of a similar paradigm in the United States are at Appendices 5 and 7.

The timing of the transition to this option will depend on the resolution of implementation issues and risks raised at the working group meetings, at the risk assessment and any other important issues identified prior to the change.

Recommendation 3: The Bureau recommends that a TAF issued routinely every 3 hours be applied to all aerodromes where there is a specified Defence requirement and the following major airports:

- **Sydney**
- **Melbourne**
- **Brisbane**
- **Perth**
- **Adelaide**
- **Gold Coast**
- **Cairns**
- **Canberra**
- **Darwin**
- **Hobart**

The decision for the major airports was based on those airports that currently receive a TTF service and those airports that exceeded 2 million passenger movements per year in the 2012-2015 timeframe. Currently Gold Coast and Hobart have no TTF service but would receive a TAF issued routinely every 3 hours under these arrangements. There may be scope to extend this service to other aerodromes at some stage in the future.

The implementation of the recommendations in this report will result in improved services and safety for aviation stakeholders because:

- There will be improvements to operational decision making because it is a simpler system.
- The TAF will have similar functionality to the TTF enabling the cessation of the TTF.
- A single coded weather forecast eliminates any potential ambiguity between the TAF and TTF and offers greater simplicity for all operators.

Understanding the precedence between the two different forecasts would no longer be required.

- It will eliminate alignment issues currently associated with the TAF being amended up to an hour after TTF. The TAF would be amended immediately as required.
- Bureau forecasters will not have unnecessary workloads caused by the current requirement to append TTF/Trend to numerous SPECI observations if the forecast in the TAF is correct.
- Australia will exceed ICAO requirements by providing METARs every half hour, SPECIs as required and a three hourly TAF amended as appropriate.
- A TAF issued routinely every 3 hours be extended to Gold Coast and Hobart.
- A TAF issued routinely every 3 hours will operate 24/7 at Darwin and Canberra where there is currently no overnight TTF service.
- A TAF forecast can be updated at any time. Currently the forecaster has to wait for an observation (typically half hourly) to update using TTF.

5 Risks and Implementation

The TRWG identified the following risks associated with the introduction of a TAF issued routinely every three hours. Table 4 is an initial list that the TRWG assessed as requiring further examination through a risk assessment.

Table 4: Risks that need to be taken into consideration prior to implementation

Risk	Potential Mitigation	Owner
1. The TTF is more accurate than the TAF. Cancellation of TTF would leave the community with a lesser forecast.	The TTF may be perceived to be more accurate because it is currently the priority product and the TAF does not have to be amended immediately if the TTF covers a change of forecast. Forecasters use the same weather information to produce the TAF as they do to produce the TTF. The TAF will become the primary product delivered by forecasters. It will be monitored continuously and amended whenever the forecast changes.	Bureau of Meteorology
2. Time buffers currently removed by TTF will be applied to the TAF resulting in the carriage of additional fuel in marginal weather for operators planning short duration flights.	BoM to provide a letter of assurance to CASA that the TAF issued routinely every 3 hours will provide similar accuracy and responsiveness as TTF. Provide evidence that will demonstrate that the same meteorological information can be provided by a TAF issued routinely every 3 hours. Examine if changes to the time buffers are required given that the replacement product has the same meteorological input. Any changes to the AIP will be timed to coincide with the cessation of TTF.	Bureau of Meteorology Bureau of Meteorology Civil Aviation Safety Authority
3. Time buffers currently removed by TTF will result in unnecessary diversions for aircraft on approach to airports.	As above.	As above
4. Time buffers currently removed by TTF will result in cancelled short	As above.	As above

duration flights for Defence and civil operators.		
5. PROB30 and PROB40 forecasts in TAF currently superseded by TTF will result in significant additional fuel carriage.	Forecasters will use the FM groups where appropriate in the first three hours of the TAF to indicate onset and cessation of meteorological phenomena to a higher temporal resolution. The TAF will be amended immediately as required to convey similar meteorological information as the TTF. During periods of marginal forecast weather conditions the forecaster will look for clear weather periods in the next 3 hours and issue amendments where appropriate. Forecasters will remove a PROB requirement in the first 3 hours where appropriate through TAF amends.	Bureau of Meteorology
6. PROB30 and PROB40 forecasts in TAF currently superseded by TTF will result in unnecessary diversions for aircraft on approach to airports	As above.	As above
7. Some operators access TTF on VOLMET or AERIS.	The importance of this issue needs further assessment. An alternative means to communicate TAF information may need to be developed. There is no ICAO requirement to transmit TAF on VOLMET or AERIS.	Airservices
8. How can we ensure everyone understands the change to a 3 hourly TAF?	**During the implementation phase:** **a.** The Bureau will conduct education activities in relation to the changes brought about by a TAF issued routinely every 3 hours. **b.** There will be an update of relevant documentation including: Airservices' Aeronautical Information Package (AIP Book and ERSA), the Bureau's Aeronautical	Bureau Bureau, Airservices

	Services Handbook, pilot licencing exams, Regional Air Navigation Plan, Airservices NAIPS MET ICD, State Registered Differences and educational material. **c.** There will be articles written for various aviation magazines and bulletins.	
9. The term INTER is a registered difference with ICAO, the loss of this term could result in significant additional fuel carriage.	The term INTER will continue to be used in all domestic TAFs. Software will need to be developed to translate INTER to TEMPO for international use.	Bureau of Meteorology Airservices
10. How will international operators understand the change to a 3 hourly TAF.	All international operators should understand the ICAO TAF code. The term 'INTER' in the TAF will be visible to international operators as 'TEMPO'.	
11. Defence Bases do not have 24 hour TTF coverage. How will the change of TAF regime overnight be conveyed?	This will be examined during the implementation phase. Options for consideration are: A remark in the TAF and ERSA notes to explain when the TAF issued routinely every 3 hours is available. Alternatively the bases may receive a TAF issued routinely every 3 hours 24/7 depending on workload implications.	Bureau of Meteorology Defence

A more comprehensive set of potential mitigation actions will be completed as part of the implementation process. It is estimated that an implementation preparation phase of 12-18 months will be required for appropriate change management processes across the industry and Defence. The process to implementation is illustrated at Figure 5.

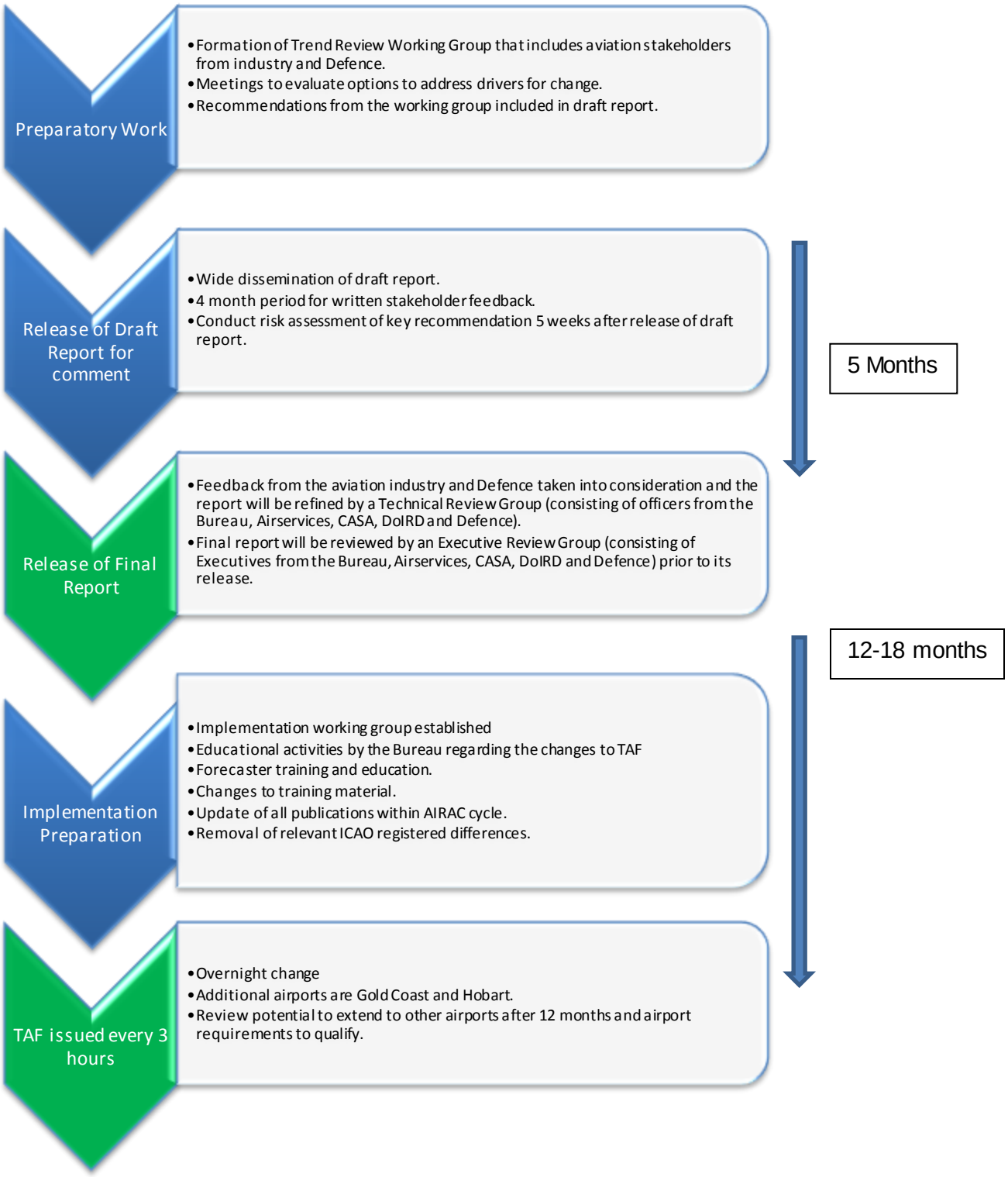

Figure 5: Diagram to illustrate report and implementation process.

6 Observations at major aerodromes

6.1 Observations at major airports and Defence aerodromes

Accurate observations are important to ensure forecast accuracy and situational awareness. The current practice for a TTF is an observation with manual input, with present weather phenomena included, provided by either qualified weather observers or (in the case of Defence aerodromes, Canberra and Cairns) forecasters with training and competence in aviation observations, based at the airport in a dual-role capacity. A manual observation uses data from automated instrumentation and the observer does have the ability to override certain parameters, such as visibility or cloud, if the instrument data are not representative of conditions at the aerodrome. Presently the Bureau's policy has the forecaster located at the aerodrome or in the same city to provide a TTF. Improved situational awareness of the weather and improved automated observation at and around the aerodrome has prompted the Bureau to consider reassessing this policy.

6.2 Situational awareness

The Bureau is implementing new technologies to improve the quality of observations over the next five years. There is potential for significant long-term cost savings if the number of manual observations could be reduced without significant detriment to the quality of the observations and forecasts.

Countries such as New Zealand and the Netherlands have adopted, or are in the process of adopting, automated observing systems at their major airports that will realise significant efficiency gains. The Bureau intends to enhance the observing capability at the major airports by installing present weather sensors to further automate the weather groups in the METAR/SPECI, along with additional ceilometers, visibility meters and webcams at each airport with a combined view of the approaches to the runways and surrounds. These webcam systems should permit a remotely located person to verify the weather affecting the instrumentation and its directional variation around an airport. We are also investigating the integration of lightning network information for inclusion of thunderstorm information into the METAR/SPECI.

High standards of observations have to be maintained and options for further improvements to enhance forecaster awareness will be examined.

The Bureau will examine the benefits of automated systems, running them in parallel with manual observations. There is potential for the restructuring of the observations programme and careful implementation of a phased reduction in personnel at the major airports. Any identified savings to industry will be promulgated in a five-year plan at the annual aviation finance meetings and would be subject to safety and service quality scrutiny. This change management process could run independently of any reforms to TAF formats and practices, but the realisation of any efficiency savings would rely on changes to forecasting practices that complement the automation of observations.

Under the current paradigm, introducing fully automated observations would increase the workload on forecasters to apply a TTF to every SPECI in rapidly fluctuating or deteriorating conditions.

The TRWG was tasked with developing principles for automated observations at each aerodrome—including reference to benefit, risk and safety. The group developed a list of ten principles for automating observations that cover safety, standards, assessment, consultation and forecaster situational awareness.

6.2.1 Principle 1: Safety

Replacement of human observers with automated systems must not compromise safety.

6.2.2 Principle 2: ICAO and WMO standards

The observing system must meet ICAO and WMO standards for an observation at an international aerodrome.

This includes the measurement of the following elements:

- mean wind speed and direction and gusts;
- horizontal visibility;
- runway visual range (for category II and III aerodromes only);
- present weather (as defined below);
- cloud amount, cloud type (CB and TCU only)[21] and cloud base height;
- air temperature and dew-point; and
- atmospheric pressure.

Present weather includes rain, drizzle, snow and freezing precipitation (including intensity), haze, mist, fog, freezing fog and thunderstorms (including thunderstorms in the vicinity, i.e. within 5–10 NM).

It should be noted that ICAO Annex 3 also recommends that the following present weather elements be measured: duststorms; sandstorms; funnel clouds; drifting or blowing dust, sand or snow; and squalls.

Benefit: The approach could be cost effectively extended to other international aerodromes in Australia that currently have either part-time or no manual observation such as Gold Coast, Broome, Port Hedland, Townsville, Alice Springs, Kalgoorlie, Avalon and Norfolk Island.

[21] The requirement to discriminate between CB and TCU is being examined further at ICAO.

6.2.3 Principle 3: Instrument siting

The siting of observing instrumentation should be representative of the aerodrome and must meet the requirements set out in WMO Pub. 8[22],ICAO Doc. 9837[23] and Bureau Spec. 2013.1[24].

6.2.4 Principle 4: Comprehensive backup

The system should incorporate a complete backup of all sensors and communications.

Benefit: Full system backup in the case of instrument failure.

6.2.5 Principle 5: Regulatory compliance and benefits and limitations

The Meteorological Authority shall be consulted prior to acquisition of equipment, to ensure that there are no regulatory impediments to transitioning to a fully automated observational platform. The fully automated system shall also be run in parallel with manual observations for a period that is suitable for assessing the benefits and limitations of the automated observations for a particular location.

Benefit: The differences in the manual and automated systems are understood.

Safety: Any impacts on safety in relation to the new system can be addressed prior to cancellation of manual observations.

6.2.6 Principle 6: Assessment report

An assessment report of the automated system, with a summary of its capability and any limitations, would be presented in the Major Airports Consultative Meeting prior to the decision to phase out human observers from any identified airport.

Benefit: All stakeholders are aware of the proposed change to observations and have the opportunity to provide reasons for keeping manual observations at the airport.

Safety: Ensures oversight of any perceived safety issues.

6.2.7 Principle 7: Improved situational awareness

Additional sensors that provide important observational data to forecasters should be installed at the airports and in surrounding areas to provide better situational awareness of local weather phenomena.

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[22] World Meteorological Organization, WMO No.8, *Guide to Meteorological Instruments and Methods of Observations*.
[23] International Civil Aviation Organization, Doc. 9837, *Manual on Automatic Meteorological Observing Systems at Aerodromes*.
[24] Bureau of Meteorology, Observations Specification 2013.1.

Benefit: This will improve short-range forecasting and refine visibility and cloud height estimates around alternate and landing minima.

6.2.8 Principle 8: Cameras at the aerodrome

Any forecaster providing forecasts for the aerodrome should have a clear visual picture of weather affecting the runway approaches during the day and in low-light situations at dawn and dusk. This will require cameras at key vantage points at the aerodrome.

Benefit: Forecasters can see if the weather affecting the instruments is representative of the aerodrome and the approaches to the runways.

Safety: Forecasters will be able to see a change in weather approaching that is not yet detected by the instruments.

6.2.9 Principle 9: Transparent charging for services at airports

The services located at airports that are required by the aviation industry through the MSC are supported by regular and transparent reviews of pricing.

6.2.10 Principle 10: Maintenance of observational equipment

The Bureau should maintain all observational equipment owned by the Bureau and replace the equipment capability when beyond economical repair or at the end of its operational lifetime.

6.3 Delivery of forecast services from a remote location

Modern communication technologies combined with the additional situational awareness of weather phenomena delivered using principles 7 and 8 will provide forecasters remotely located from the aerodrome with unprecedented information. The Bureau will continue, in consultation with the industry and regulators, to take into account opportunities to deliver services more efficiently and effectively as technology and communications improve.

Appendix 1 – Summary of recommendations

Recommendation 1: The TRWG recommends that a risk assessment by an independent risk assessor be completed in order to analyse and better assess the implementation issues that need to be resolved prior to the transition to a TAF issued routinely every three hours.

This risk assessment was conducted on 12 November 2015 (summary at Appendix 12) and is the initial step towards an implementation phase that is described in Section 5. It provided confirmation on the detailed changes that will need to be made; it better identifies mitigation for identified risks (Appendix 4) and provides some information for a full implementation project timeline (Appendix 3). There were no safety implications identified in the assessment, however some risks to operational efficiencies were identified.

Recommendation 2: The TRWG recommends that subject to the implementation of appropriate risk mitigation that the TTF service be ceased and that, where appropriate, the TAF be issued routinely every three hours instead of every six hours. In addition, the TAF should be amended to provide similar responsiveness, accuracy and operational meteorological information as the current TTF.

The timing of the transition to this option will depend on the resolution of implementation issues and risks raised at the working group meetings and any other important issues identified prior to the change.

Recommendation 3: The Bureau recommends that a TAF routinely issued every 3 hours be applied to all aerodromes where there is a specified Defence requirement and the following major airports:

- **Sydney**
- **Melbourne**
- **Brisbane**
- **Perth**
- **Adelaide**
- **Gold Coast**
- **Cairns**
- **Canberra**
- **Darwin**
- **Hobart**

The decision for the major airports was based on those airports that currently receive a TTF service and those airports that exceeded 2 million passenger movements per year in the 2012-2015 timeframe. Currently Gold Coast and Hobart have no TTF service but would receive a TAF routinely issued every 3

hours under these arrangements. There may be scope to extend this service to other aerodromes at some stage in the future.

Appendix 2 – Glossary of terms, abbreviations and acronyms

AIRAC: Aeronautical Information and Regulation and Control

AIRSERVICES: Airservices Australia

ASH: Aeronautical Services Handbook

ATC: Air Traffic Control

ATSB: Australian Transport Safety Bureau

AWR: Aerodrome Weather Report

BECMG: Change indicator 'becoming' in the TAF Code

BNOC: Bureau's National Operational Centre

CAA: Civil Aviation Authority

CASA: Civil Aviation Safety Authority

DOD: Department of defence

DOIRD: Department of Infrastructure and Regional Development

DIR: Director of the Bureau of Meteorology

ERSA: En-Route Supplement

FM: change indicator 'from' in the TAF and TTF code.

ICAO: International Civil Aviation Organization

INTER: Unique Australian code (TAF and TTF) for 'intermittent' meaning frequent or infrequent temporary fluctuations in meteorological conditions which reach or pass specified threshold values and last for a period of less than 30 min.

MA: Meteorological Authority

METAR: Meteorological report from an aerodrome at a routine time (half-hourly) when conditions are better than specified thresholds—this is the primary format in aeronautical meteorology for reports of surface meteorological information at an aerodrome

METP: ICAO Meteorology Panel

MSC: Meteorological Service Charge

NOC: National Operations Centre

NOCMET: Meteorological Unit at the Airservices National Operations Centre (NOC)

PRECIPITATION: In meteorology, any product of the condensation of atmospheric water vapour that falls under gravity (e.g. rain, hail, snow)

RAAF: Royal Australian Airforce

RTS: Raise, Train and Sustain

RAN: Royal Australian Navy

RFC: Regional Forecasting Centre

RVR: Runway Visual Range – a visibility meter located near the runway provides RVR.

SAMU: Sydney Airport Meteorological Unit

SARPs: ICAO's standards and recommended practices

SPECI: A special report of surface meteorological information at an aerodrome, only issued when specific criteria are met. Has the same format as a METAR, except for the name

TAF: Aerodrome Forecast (originally Terminal Aerodrome Forecast)

TCAC: Tropical Cyclone Advisory Centre

TEMPO: ICAO TAF and Trend Code: Used to describe frequent or infrequent fluctuations in meteorological conditions which reach or pass specified threshold values and last for a period of less than an hour.[25] Australian TAF and TTF Code: Used to describe frequent or infrequent fluctuations in meteorological conditions which reach or pass specified threshold values and last for a period of 30–60 minutes.

ToR: Terms of Reference

TRWG: Trend Review Working Group

TTF: Australian Trend Forecast (Originally Trend Type Forecast)

UTC: UNIVERSAL TIME COORDINATED - The primary time standard by which the world regulates clocks and time—signified in aviation forecasts and reports by the letter **Z**

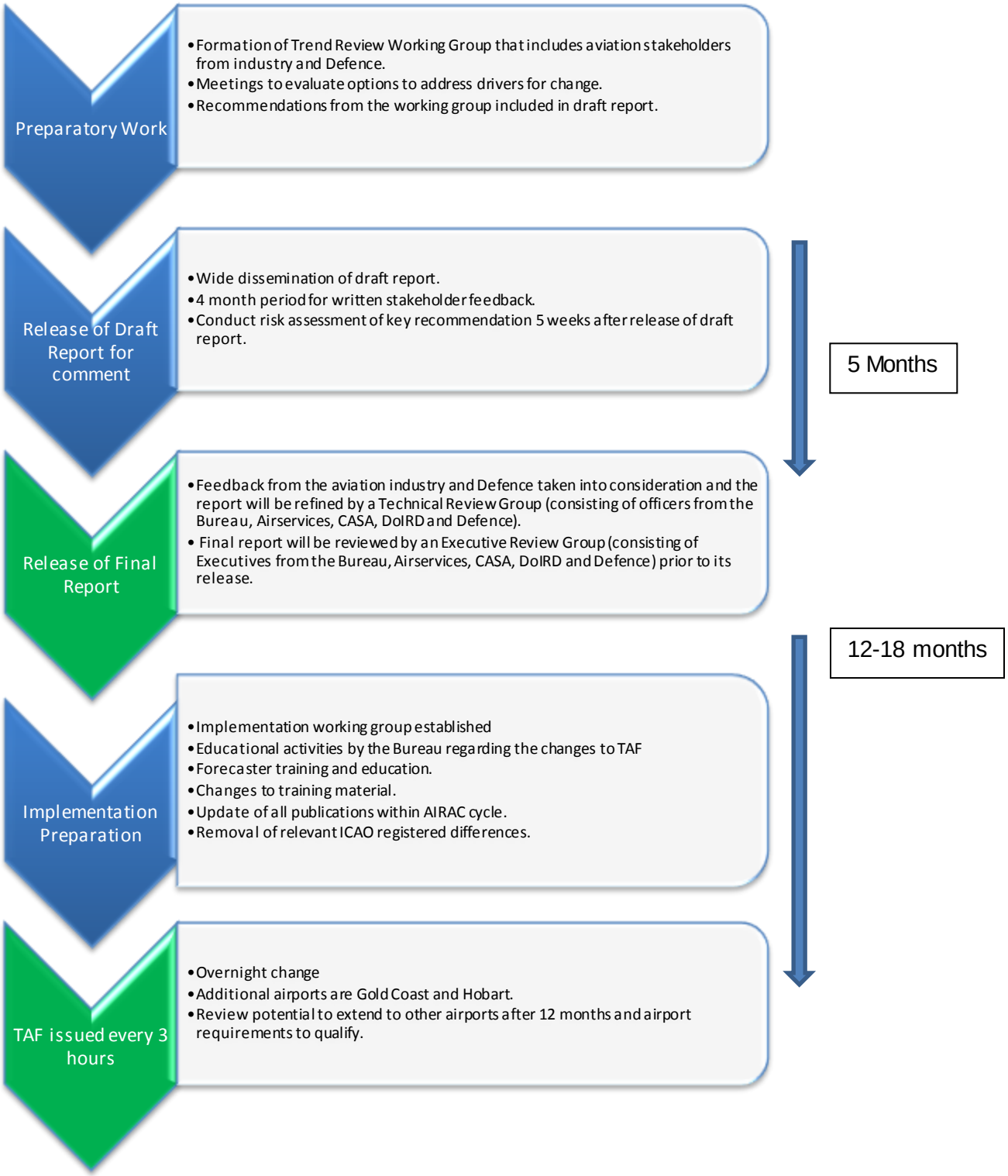
VAAC: Volcanic Ash Advisory Centre

WMO: World Meteorological Organization

XML: Extended Mark-up Language

[25] ICAO Annex 3, APP 5–4, 1.3.5

Appendix 3 – Report and implementation process



Appendix 4 – Implementation risks

Risk	Potential Mitigation	Owner
1. The TTF is more accurate than the TAF. Cancellation of TTF would leave the community with a lesser forecast.	The TTF may be perceived to be more accurate because it is currently the priority product and the TAF does not have to be amended immediately if the TTF covers a change of forecast. Forecasters use the same weather information to produce the TAF as they do to produce the TTF. The TAF will become the primary product delivered by forecasters. It will be monitored continuously and amended whenever the forecast changes.	Bureau of Meteorology
2. Time buffers currently removed by TTF will be applied to the TAF resulting in the carriage of additional fuel in marginal weather for operators planning short duration flights.	BoM to provide assurance to CASA that the TAF issued routinely every 3 hours will provide similar accuracy and responsiveness as TTF. Provide evidence that will demonstrate that the same meteorological information can be provided by a TAF issued routinely every 3 hours. Examine if changes to the time buffers are required given that the replacement product has the same meteorological input. Any changes to the AIP will be timed to coincide with the cessation of TTF.	Bureau of Meteorology Bureau of Meteorology Civil Aviation Safety Authority
3. Time buffers currently removed by TTF will result in unnecessary diversions for aircraft on approach to airports.	As above.	As above
4. Time buffers currently removed by TTF will result in cancelled short duration flights for Defence and civil operators.	As above.	As above
5. PROB30 and PROB40 forecasts	Forecasters will use the FM groups where appropriate in the first three hours of the TAF	Bureau of

in TAF currently superseded by TTF will result in significant additional fuel carriage.	to indicate onset and cessation of meteorological phenomena to a higher temporal resolution. The TAF will be amended immediately as required to convey similar meteorological information as the TTF. During periods of marginal forecast weather conditions the forecaster will look for clear weather periods in the next 3 hours and issue amendments where appropriate. Forecasters will remove a PROB requirement in the first 3 hours where possible through appropriate TAF amends.	Meteorology
6. PROB30 and PROB40 forecasts in TAF currently superseded by TTF will result in unnecessary diversions for aircraft on approach to airports	As above.	As above
7. Some operators access TTF on VOLMET or AERIS.	The importance of this issue needs further assessment. An alternative means to communicate TAF information may need to be developed. There is no ICAO requirement to transmit TAF on VOLMET or AERIS.	Airservices
8. How can we ensure everyone understands the change to a 3 hourly TAF?	**During the implementation phase:** **a.** The Bureau will conduct education activities in relation to the changes brought about by the TAF issued routinely every 3 hours. **b.** There will be an update of relevant documentation including: Airservices' Aeronautical Information Package (AIP Book and ERSA), the Bureau's Aeronautical Services Handbook, pilot licencing exams, Regional Air Navigation Plan, Airservices NAIPS MET ICD, State Registered Difference and educational material. **c.** There will be articles written for various aviation magazines and bulletins.	Bureau Bureau, Airservices

9. The term INTER is a registered difference with ICAO, the loss of this term could result in significant additional fuel carriage.	The term INTER will continue to be used in all domestic TAFs. Software will need to be developed to translate INTER to TEMPO for international use.	Bureau of Meteorology Airservices
10. How will international operators understand the change to a 3 hourly TAF.	All international operators should understand the ICAO TAF code. The term 'INTER' in the TAF will be visible to international operators as 'TEMPO'.	
11. Defence Bases do not have 24 hour TTF coverage. How will the change of TAF regime overnight be conveyed?	This will be examined during the implementation phase. Options for consideration are: A remark in the TAF and ERSA notes to explain when the TAF issued routinely every 3 hours is available. Alternatively the bases may receive a 3 hourly TAF 24/7 depending on workload implications.	Bureau of Meteorology Defence

Appendix 5 – Example of a fog event at Los Angeles airport

Objective: To illustrate how the a TAF issued routinely every 3 hours is used in the United States to provide a similar forecast effect to TTF.

- The table is a sequence of METAR/SPECI and TAFs as issued on the 10 April 2014.
- There are no Trend or TTF forecasts in the US.
- 12 TAFs were issued 00-15Z to create a similar effect to TAF and TTF.
- Yellow highlights the change to the previous forecast. Each amend demonstrates a change in forecast.
- The United States issues METARs on the hour only and SPECIs at other times. Every hourly METAR is called a METAR even if the observation is in SPECI conditions. In Australia if the conditions on the hour or half hour are SPECI then the observation is issued as a SPECI.

METAR/SPECI	TAF	Explanatory Notes
	TAF KLAX 092336Z 1000/1106 26012KT P6SM SCT250 FM100200 27008KT P6SM SCT250 FM100500 VRB03KT 2SM BR OVC004 FM101300 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26011KT 6SM HZ SKC FM110300 25009KT 5SM BR SCT250=	Low stratus and reduced vis forecast 0500-1800Z
METAR KLAX 100253Z 24009KT 10SM FEW150 SCT200 16/11 A2996 RMK AO2 SLP143 T01560106 55004=	TAF AMD KLAX 100300Z 1003/1106 24009KT P6SM FEW150 SCT200 FM100500 VRB03KT 2SM BR OVC004 FM101300 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26011KT 6SM HZ SKC FM110300 25009KT 5SM BR SCT250=	Routine 3 hourly TAF.
METAR KLAX 100353Z VRB06KT 10SM FEW200 15/11 A2997 RMK AO2 SLP148 T01500106=	TAF AMD KLAX 100408Z 1004/1106 24006KT P6SM FEW150 SCT200	The forecast onset of low stratus now 2 hours later than

	FM100700 VRB03KT 2SM BR OVC004 FM101300 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26011KT 6SM HZ SKC FM110300 25009KT 5SM BR SCT250=	previous forecast – rolled right.
METAR KLAX 100453Z 26005KT 10SM FEW250 14/11 A2999 RMK AO2 SLP153 T01440106=	TAF KLAX 100526Z 1006/1112 24006KT P6SM FEW150 SCT200 FM100800 VRB03KT 2SM BR OVC004 FM101600 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26012KT P6SM SKC FM110300 25008KT 5SM BR SCT250 FM110700 VRB03KT 3SM BR OVC006=	Rolled right again to 1 hour later and second mist period rolled right by 3 hours.
METAR KLAX 100553Z 24006KT 10SM FEW005 14/11 A2999 RMK AO2 SLP152 T01440106 10189 20144 10189 20144 FREE 51010=		
SPECI KLAX 100617Z 27006KT 1SM R25R/P6000FT BCFG BR BKN002 14/11 A2999 RMK AO2 VIS 1/2V2 FG BKN002 ASOS VIS 9=	TAF AMD KLAX 100622Z 1006/1112 24006KT 1SM BCFG BR OVC002 FM101000 VRB03KT 2SM BR OVC004 FM101600 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26012KT P6SM SKC FM110300 25008KT 5SM BR SCT250 FM110700 VRB03KT 3SM BR OVC006=	Fog evident and visibility dropped worse than original forecast. TAF amended immediately.
SPECI KLAX 100650Z 27003KT 3/4SM R25R/2000VP6000FT BCFG BR BKN002 12/11 A3000 RMK AO2 VIS 1/4V1 1/4 FG BKN002 ASOS VIS 1 3/4=		
METAR KLAX 100653Z 26003KT 3/4SM R25R/2000VP6000FT BCFG BR BKN002 12/11 A3000 RMK AO2 SLP154 VIS 1/4V1 1/4 FG BKN002 T01220111=		
SPECI KLAX 100713Z 00000KT 1SM R25R/P6000FT BCFG BR BKN002 12/11 A3000 RMK AO2 VIS 1/4V1 1/4 FG BKN002 ASOS VIS 2=		
SPECI KLAX 100740Z 00000KT 1/2SM R25R/P6000FT FG BKN002 13/11 A3000 RMK AO2 VIS 1/4V1 FG BKN002 ASOS VIS 3=		
METAR KLAX 100753Z 00000KT 1/2SM R25R/6000VP6000FT FG VV002 12/12 A3000 RMK AO2 SLP156 VIS 1/4V1 ASOS VIS 3 T01220117 402440122=		
SPECI KLAX 100810Z 20004KT 1/4SM R25R/1600V2800FT FG VV002 12/12 A3000 RMK AO2 VIS 1/4V3/4=	TAF AMD KLAX 100816Z 1008/1112 24006KT 1/4SM FG VV002	TAF amend now reflects Fog and the marginal improvement also

	FM101400 VRB03KT 2SM BR OVC004 FM101600 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26012KT P6SM SKC FM110300 25008KT 5SM BR SCT250 FM110700 VRB03KT 3SM BR OVC006=	moves to later time.
	TAF AMD KLAX 100840Z 1009/1112 24006KT 1/4SM FG VV002 FM101400 VRB03KT 2SM BR OVC004 FM101600 VRB03KT 3SM BR OVC006 FM101800 26006KT 5SM HZ SCT008 FM102000 26012KT P6SM SKC FM110300 25008KT 5SM BR SCT250 FM110700 VRB03KT 3SM BR OVC006=	This is the routine 3 hourly TAF.
METAR KLAX 100853Z 21003KT 1/16SM R25R/1600VP6000FT FG VV002 12/11 A2999 RMK AO2 SLP152 ASOS VIS 1/2 T01220111 58001 $=		Continuous fog
METAR KLAX 100953Z 28003KT 1/16SM R25R/2600VP6000FT FG VV002 12/11 A2998 RMK AO2 SLP148 ASOS VIS 1 1/2 T01220111 $=		Continuous fog
METAR KLAX 101053Z 21004KT 1/16SM R25R/1200VP6000FT FG VV002 12/11 A2997 RMK AO2 SLP146 ASOS VIS 1 T01170111 $=	TAF KLAX 101128Z 1012/1118 VRB03KT 1SM BR OVC002 FM101400 VRB03KT 2SM BR OVC004 FM101600 24006KT 3SM BR BKN006 FM101800 27008KT 6SM HZ SCT006 BKN250 FM102000 27012KT P6SM BKN250 FM110400 VRB03KT P6SM BKN250 FM110600 VRB03KT 5SM BR OVC007=	This is the routine 3 hourly TAF. No change to previous forecast.
METAR KLAX 101153Z 00000KT 1/16SM R25R/2000V5000FT FG VV002 12/11 A2996 RMK AO2 SLP143 ASOS VIS 1/2 T01170111 10144 20117 56010 $=		
METAR KLAX 101253Z 00000KT 1/4SM R25R/4000VP6000FT FG VV002 12/11 A2996 RMK AO2 SLP142 VIS E 1/2 ASOS VIS 1/2 T01170111 $=		
SPECI KLAX 101335Z 18003KT 1/4SM R25R/P6000FT FG SCT001 BKN150 BKN250 12/11 A2997 RMK AO2 VIS SE 1 FG SCT001 SCT V BKN ASOS VIS 2 1/2 $=	TAF AMD KLAX 101340Z 1014/1118 VRB03KT 1/4SM FG VV002 FM101400 VRB03KT 1SM BR OVC004	Observed conditions slightly worse and change to 1 statute mile visibility from 1400Z.

	FM101600 24006KT 3SM BR BKN006 FM101800 27008KT 6SM HZ SCT006 BKN250 FM102000 27012KT P6SM BKN250 FM110400 VRB03KT P6SM BKN250 FM110600 VRB03KT 5SM BR OVC007=	
SPECI KLAX 101349Z 21003KT 1/8SM R25R/P6000FT FG BKN002 12/11 A2998 RMK AO2 VIS SE 1 CIG 001V003 FG BKN002 BKN V SCT ASOS VIS 2 $=		
METAR KLAX 101353Z 21003KT 1/8SM R25R/4000VP6000FT FG BKN002 12/11 A2998 RMK AO2 SLP150 CIG 001V003 FG BKN002 BKN V SCT ASOS VIS 2 T01170111 $=	TAF AMD KLAX 101357Z 1014/1118 VRB03KT 1SM BR BKN002 FM101500 VRB03KT 1SM BR OVC004 FM101700 27006KT 6SM HZ SCT006 BKN250 FM102000 27012KT P6SM BKN250 FM110400 VRB03KT P6SM BKN250 FM110600 VRB03KT 5SM BR OVC007=	Lifting to OVC004 now forecast for later at 1500Z though more improved conditions forecast earlier 1700Z.
	TAF AMD KLAX 101424Z 1014/1118 VRB03KT 1SM BR BKN002 FM101700 27006KT 6SM HZ SCT006 BKN250 FM102000 27012KT P6SM BKN250 FM110400 VRB03KT P6SM BKN250 FM110600 VRB03KT 5SM BR OVC007=	The improvement forecast for 1500Z now cancelled.
	TAF AMD KLAX 101435Z 1015/1118 VRB03KT 1/2SM FG BKN002 FM101700 27006KT 6SM HZ SCT006 BKN250 FM102000 27012KT P6SM BKN250 FM110400 VRB03KT P6SM BKN250 FM110600 VRB03KT 5SM BR OVC007=	Routine 3 hourly TAF.
METAR KLAX 101453Z 25004KT 1/4SM R25R/1400V2200FT FG BKN002 12/11 A2998 RMK AO2 SLP152 CIG 001V003 FG BKN002 ASOS VIS 1/2 T01170106 53008 $=		

SPECI KLAX 101512Z 25004KT 1/2SM R25R/1400V2200FT FG BKN002 12/11 A2998 RMK AO2 CIG 001V003 FG BKN002 ASOS VIS 1 1/2 $=		
SPECI KLAX 101539Z COR 25004KT 1/2SM R25R/P6000FT FG SCT003 BKN140 13/11 A2998 RMK AO2 VIS 1/4V1 VIS NE 1 FG SCT003 SCT V BKN ASOS VIS 4 $=		
METAR KLAX 101553Z COR 25003KT 3/4SM R25R/P6000FT BCFG BR SCT003 BKN140 13/11 A2998 RMK AO2 SLP151 VIS 1/2V1 1/2 VIS NE-E 2 ASOS VIS 4 T01330111 $=		
SPECI KLAX 101608Z 00000KT 3SM BCFG BR SCT003 BKN140 14/11 A2998 RMK AO2 VIS S-NW 1 $=		
METAR KLAX 101653Z 00000KT 5SM BR FEW003 SCT140 17/11 A2999 RMK AO2 SLP153 VIS S-NW 1 1/2 T01720106 $=	TAF KLAX 101721Z 1018/1124 27006KT 5SM HZ SCT006 BKN250 FM101900 27012KT P6SM BKN250 FM110400 VRB03KT 3SM BR OVC005 FM111000 VRB03KT 6SM BR OVC012 FM111900 25010KT 6SM HZ SCT015 BKN250=	Routine 3 hourly TAF issued.
METAR KLAX 101753Z 27008KT 7SM BCFG FEW005 SCT160 16/11 A3000 RMK AO2 SLP158 VIS SW-W 1 1/2 T01610106 10183 20117 53006 $=		

Appendix 6 – Scenario 1: Fog event at Sydney Airport 10 July 2012

Objective: To compare current TTF and a future TAF issued routinely every 3 hours.

- Non-highlighted TAFs were issued on the date of this event.
- Yellow highlights TTF and change in TAF that would occur if there was no TTF.
- Additional TAFs in green.
- 3 TAFs in original forecast sequence becomes 9 TAFs when TTF removed.

METAR/SPECI	TAF (actual for date)	Explanatory Notes
	TAF AMD YSSY 091004Z 0912/1018 30008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 TEMPO 1010/1018 4000 RA SCT015 BKN025 PROB30 0919/0923 0500 FG	
METAR YSSY 091600Z 36004KT CAVOK 10/09 Q1026 NOSIG=	TAF YSSY 091400Z 0915/1021 30008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 TEMPO 1010/1018 4000 RA SCT015 BKN025 PROB30 0919/0923 0500 FG	Routine 3 hourly TAF update issued at 1400Z. No change to forecast.
METAR YSSY 091630Z 33004KT CAVOK 10/09 Q1026 FM1900 33005KT 0500 FG=	TAF YSSY 091637Z 0918/1024 33008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 33012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025 PROB30 0919/0923 0500 FG	Fog event appears for the first time on the TTF at 1630Z.

METAR YSSY 091700Z 32004KT CAVOK 10/09 Q1025 FM1900 33005KT 0500 FG=		
METAR YSSY 091730Z 33005KT 9000 FEW090 10/08 Q1025 RMK FU FM1930 33005KT 0500 FG=	TAF AMD YSSY 091730Z 0918/1024 33005KT 9000 FU FEW025 FM091930 33005KT 0500 FG FM092300 33005KT 9999 FEW035 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 33012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025	TTF message now explicit in TAF. Fog event rolled to later time. Note that the TAF Amend can be issued at any time and not necessarily have to wait for the next METAR observation.
METAR YSSY 091800Z 01004KT 9000 FEW090 09/08 Q1025 FM2000 33005KT 0500 FG=	TAF AMD YSSY 091800Z 0918/1024 33005KT 9000 FU FEW025 FM092000 33005KT 0500 FG FM092300 33005KT 9999 FEW035 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 33012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025	Same message as TTF in TAF. Later onset forecast.
METAR YSSY 091830Z 34006KT 9000 FEW090 10/08 Q1025 RMK FU FM2000 33005KT 0500 FG=		
METAR YSSY 091900Z 35007KT CAVOK 09/08 Q1025 RMK FU FM2030 33005KT 0500 FG=	TAF AMD YSSY 091900Z 0919/1024 33005KT 9000 FU FEW025 FM092030 33005KT 0500 FG FM092300 33005KT 9999 FEW035 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 33012KT 9999 FEW035 TEMPO 1010/1022 4000 RA	New TAF indicates later onset of fog in TTF.
METAR YSSY 091930Z 32007KT CAVOK 09/07 Q1025 RMK FU FM2030 33005KT 0500 FG=		
SPECI YSSY 091958Z 35007KT 7000 VCFG 09/07 Q1025 FM2030 33005KT 0500 FG=		

SPECI YSSY 092000Z 35007KT 6000 VCFG FEW002 09/07 Q1025 RMK VIS REDUCED TO NORTH FM2030 33005KT 0500 FG=	TAF YSSY 092000Z 0921/1103 35005KT 0500 FG FM092300 33005KT 9999 HZ FEW035 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 33012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025	This is the next routine 3 hourly TAF. It assumes the TAF start time will be in fog. No AMD means the forecast is the same as the previous TAF
SPECI YSSY 092017Z 34005KT 4000 BCFG FEW002 09/07 Q1025 RMK FOG PATCHES TO N NW FM2030 33005KT 0500 FG=		
SPECI YSSY 092030Z 35006KT 8000 4000N PRFG FEW002 09/07 Q1026 RMK FOG BANK TO N NW FM2030 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092043Z 33006KT 6000 2000N PRFG FEW002 09/07 Q1026 FM2043 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		Even though the observation is mist the forecast remains for imminent fog. No update issued.
SPECI YSSY 092047Z 33006KT 5000 1500N PRFG BR FEW002 09/07 Q1026 FM2047 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092054Z 34006KT 4000 1000NE PRFG BR FEW002 09/07 Q1026 RMK FOG BANK TO N/E FM2054 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092100Z 34005KT 4000 1500N PRFG BR 09/08 Q1026 FM2100 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092109Z 34005KT 2500 0800W FG 08/07 Q1026 FM2109 33005KT 0500 FG FM2300 33008KT 9999 HZ FEW025=		No change to forecast.
SPECI YSSY 092124Z 34006KT 0700 FG VV002 09/07 Q1026 FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092130Z 34006KT 1800 0800W BCFG 09/07 Q1026 FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092142Z 34005KT 0900 FG VV200 09/07 Q1027 FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092200Z 33005KT 2500 0900NW BCFG 09/08 Q1026 FM2300 33008KT 9999 HZ FEW025=		Forecast clearance time remains 2300.
SPECI YSSY 092230Z 33006KT 2000 0900N BCFG BKN200 10/08 Q1026 RMK FOG TO N AND W FM2300 33008KT 9999 HZ FEW025=		

SPECI YSSY 092246Z 33006KT 4000 1500N PRFG BKN200 10/08 Q1026 RMK FOG TO N AND W FM2300 33008KT 9999 HZ FEW025=	TAF YSSY 092241Z 1000/1106 33008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 3012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025 RMK=	
SPECI YSSY 092300Z 31005KT 6000 2500N PRFG BKN200 11/08 Q1026 RMK FOG TO NORTH FM2300 33008KT 9999 HZ FEW025=		
SPECI YSSY 092330Z 32006KT 5000 2500N PRFG BKN200 11/09 Q1026 RMK FOG TO NORTH FM0000 33008KT 9999 FEW025=		
SPECI YSSY 092353Z 34005KT 7000 3000N PRFG FEW003 BKN210 13/09 Q1026 RMK FOG TO N FM0000 33008KT 9999 FEW025=		
SPECI YSSY 100000Z 34005KT 7000 4000N VCFG BKN210 12/09 Q1026 RMK BR FOG TO NW FM0030 33008KT 9999 FEW025=	TAF AMD YSSY 100000Z 1000/1106 34005KT 4000 BR FEW025 FM0030 33008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 FM102200 3012KT 9999 FEW035 TEMPO 1010/1022 4000 RA SCT015 BKN025 RMK=	This TAF amend reflects the later 0030Z clearance to 9999 FEW025.
SPECI YSSY 100014Z 35005KT 8000 5000NW BR FEW005 BKN210 13/10 Q1026 FM0030 33008KT 9999 FEW025=		
SPECI YSSY 100030Z 29006KT 8000 FEW015 SCT210 BKN300 13/10 Q1025 RMK BR FM0130 02015KT 9999 FEW035=		

Appendix 7 – Example of a thunderstorm event at New York JFK airport 13 June 2014

Objective: To illustrate how a TAF issued routinely every 3 hours is used in the United States to provide a similar forecast effect to TTF.

- There are no Trend or TTF forecasts in the US.
- 3 TAFs were issued 2050Z - 2323Z
- Yellow highlights the forecast for the event. Each amend illustrates a change in forecast
- The United States issues METARs on the hour only and SPECIs at other times. Every hourly METAR is called a METAR even if the observation is in SPECI conditions. In Australia if the conditions on the hour or half hour are SPECI then the observation is issued as a SPECI.
- Yellow highlights the change to the previous forecast.

Observations	TAF	Explanatory Notes
SPECI KJFK 132136Z 12005KT 6SM HZ BKN004 BKN027 BKN100 BKN250 22/19 A2976 RMK AO2 BKN004 V SCT $=	TAF AMD KJFK 132050Z 1321/1424 18008KT 1SM BR VCSH OVC003 TEMPO 1322/1401 2SM -TSRA BR BKN015CB OVC030 FM140600 24007KT 3SM BR VCSH SCT015 BKN030	TEMPO -TSRA 2200Z-0100Z introduced.
SPECI KJFK 132148Z 13005KT 7SM SCT004 BKN033 BKN100 BKN250 22/19 A2976 RMK AO2 $=		
METAR KJFK 132151Z 14006KT 7SM SCT004 BKN033 BKN100 BKN250 22/19 A2976 RMK AO2 SLP077 T02170194 $=		
SPECI KJFK 132227Z 23003KT 10SM TS FEW004 SCT019 BKN029CB BKN250 22/20 A2979 RMK AO2 TSB27 OCNL LTGICCG SW-NW TS SW-NW MOV NE VCSH	TAF AMD KJFK 132246Z 1323/1424 18008KT P6SM VCSH SCT004 BKN025 TEMPO 1323/1324 2SM TSRA BR BKN015CB OVC030	TAF amended to show earlier clearance of thunderstorms from 0100Z to 2400Z.

SW-NW $=	FM140000 16008KT P6SM VCSH SCT004 BKN035	
METAR KJFK 132251Z 27009KT 6SM - TSRA FEW013 OVC029CB 23/19 A2982 RMK AO2 TSB27RAB42 PRESRR SLP096 FRQ LTGICCG S-N TS S-N MOV NE P0001 T02280189 $=		
SPECI KJFK 132300Z 25011G24KT 1/4SM R04R/2800VP6000FT +TSRA BR SCT013 BKN029CB OVC042 21/19 A2980 RMK AO2 SFC VIS 2 FRQ LTGICCG ALQDS TS ALQDS MOV NE P0012 $=		
SPECI KJFK 132313Z 17005KT 3SM R04R/3000VP6000FT +TSRA BR FEW007 BKN021CB OVC042 20/18 A2980 RMK AO2 SFC VIS 4 FRQ LTGICCG OHD AND N-S TS OHD AND N-S MOV NE P0053 $=		
SPECI KJFK 132345Z 16006KT 7SM - TSRA FEW019 SCT029CB OVC075 21/18 A2980 RMK AO2 OCNL LTGIC NE-SE TS NE-SE MOV NE P0069 $=	TAF KJFK 132323Z 1400/1506 16008KT P6SM VCSH SCT007 BKN035 TEMPO 1400/1404 5SM BR SCT007 BKN010	Routine TAF with new TEMPO group
METAR KJFK 132351Z 15007KT 7SM TSRA FEW019 SCT029CB OVC075 21/18 A2980 RMK AO2 SLP092 OCNL LTGIC NE-SE TS ...		Thunderstorms cease in accordance with forecast.
SPECI KJFK 140001Z 12006KT 5SM RA BR FEW007 SCT038 OVC090 21/18 A2980 RMK AO2 TSE00 P0003 $=		No need to amend TAF – forecast correct
METAR KJFK 140051Z 12006KT 10SM - RA FEW065 BKN100 OVC140 21/19 A2979 RMK AO2 TSE00 SLP089 P0007 T02060189 $=		

Appendix 8 – Scenario 2: Thunderstorm event at Sydney airport on 8 January 2012

Objective: To compare current TTF with a future TAF routinely issued every 3 hours.

- Non-highlighted TAFs were issued on the date of this event.
- Yellow highlights TTF and change in TAF that would occur if there was no TTF.
- Additional TAFs in green.
- 3 TAFs in the original forecast sequence becomes 11 TAFs when TTF removed.

METAR/SPECI	TAF	Explanatory Notes
	TAF YSSY 072330Z 0800/0906 03018KT 9999 FEW035 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 PROB30 TEMPO 0805/0812 VRB20G35KT 3000 TSRA BKN015 SCT035CB	
METAR YSSY 080400Z 04017KT 9999 FEW040 SCT100 BKN140 27/18 Q1003 NOSIG=	TAF YSSY 080230Z 0803/0906 03018KT 9999 FEW035 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 PROB30 TEMPO 0807/0812 VRB20G35KT 3000 TSRA BKN015 SCT035CB	Routine 3 hourly TAF update. No change to forecast.
METAR YSSY 080430Z 03018KT 9999 FEW040 BKN140 26/19 Q1002 INTER 0700/0730 VRB20G30KT 3000 TSRA SCT015 SCT030CB=	TAF AMD YSSY 080430Z 0805/0906 03018KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 INTER 0807/0808 VRB20G30KT 3000 TSRA SCT015 SCT030CB PROB30 TEMPO 0808/0812 VRB20G30KT 3000 TSRA BKN015 SCT035CB	The INTER thunderstorms now forecast for 0700Z. PROB30 TEMPO moves to later time. Greater certainty in first 3 hours of the TAF.

METAR YSSY 080500Z 03018KT 9999 FEW040 BKN140 26/19 Q1002 INTER 0700/0800 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
METAR YSSY 080530Z 02018KT CAVOK 27/20 Q1001 RMK DISTANT CB TOPS TO S 6AC140 INTER 0700/0830 VRB20G30KT 3000 TSRA SCT015 SCT030CB=	TAF AMD YSSY 080530Z 0806/0912 03018KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 INTER 0807/0810 VRB20G30KT 3000 TSRA SCT015 SCT030CB PROB30 TEMPO 0810/0812 VRB20G30KT 3000 TSRA BKN015 SCT035CB	Routine TAF INTER to 1000Z PROB30 TEMPO forecast to start later at 1000Z.
METAR YSSY 080600Z 02019KT 9999 FEW040 BKN140 28/20 Q1001 WS RWY34L RMK TCU TOPS TO SW INTER 0700/0900 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
METAR YSSY 080630Z 02012KT 9999 VCSH FEW040 SCT080 BKN140 27/20 Q1001 RMK TCU TOPS TO W INTER 0700/0930 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
METAR YSSY 080700Z 05013KT 9999 -SHRA FEW030TCU SCT070 BKN100 25/21 Q1001 INTER 0700/1000 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
SPECI YSSY 080718Z 05008KT 9999 TS SCT030 BKN100 FEW040CB 24/21 Q1002 FM0718 05008KT 9999 -SHRA FEW010 SCT035 INTER 0718/1018 VRB20G30KT 3000 TSRA SCT015 SCT030CB=	TAF AMD YSSY 080725Z 0807/0912 05008KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 INTER 0807/0811 VRB20G30KT 3000 TSRA SCT015 SCT030CB PROB30 TEMPO 0811/0812 VRB20G30KT 3000 TSRA BKN015 SCT035CB	INTER period now extends a further hour with smaller forecast PROB30 TEMPO period.

SPECI YSSY 080730Z 01005KT 6000 TSRA SCT030 BKN070 SCT040CB 24/21 Q1002 FM0730 02008KT 9999 -SHRA FEW010 SCT035 INTER 0730/1030 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
SPECI YSSY 080738Z 28005KT 3000 TSRA SCT017 BKN070 SCT030CB 24/21 Q1002 WS RWY34R FM0738 02008KT 9999 -SHRA FEW010 SCT035 INTER 0738/1038 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
SPECI YSSY 080755Z 06006KT 7000 TSRA SCT017 SCT030CB BKN070 23/22 Q1001 FM0755 02008KT 9999 -SHRA FEW010 SCT035 INTER 0755/1055 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
SPECI YSSY 080800Z 09005KT 7000 TSRA FEW014 SCT020 BKN070 SCT030CB 23/21 Q1002 FM0800 02008KT 9999 -SHRA FEW010 SCT035 INTER 0800/1100 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
SPECI YSSY 080813Z 08006KT 9999 TS FEW009 BKN070 BKN100 FEW040CB 23/22 Q1002 FM0813 02008KT 9999 -SHRA FEW010 SCT035 INTER 0813/1113 VRB20G30KT 3000 TSRA SCT015 SCT030CB=	TAF AMD YSSY 080830Z 0809/0912 03018KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 INTER 0809/0812 VRB20G30KT 3000 TSRA SCT015 SCT030CB	Routine 3 hourly TAF. Note the change of TEMPO to INTER in the last hour 1100Z from previous TAF.
SPECI YSSY 080830Z 08005KT 9999 VCSH FEW008 SCT030 BKN100 24/22 Q1002 INTER 0830/1130 VRB20G30KT 3000 TSRA SCT015 SCT030CB=		
METAR YSSY 080900Z 07009KT 9999 VCSH FEW011 SCT030 OVC120 23/22 Q1002 INTER 0900/1000 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 1000/1200 VRB20G30KT 3000 TSRA SCT010 SCT030CB=	TAF AMD YSSY 080900Z 0809/0912 03018KT 9999 FEW040 FM081000 34010KT9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 INTER 0809/0810 VRB20G30KT 3000 TSRA SCT015 SCT030CB TEMPO 0810/0812 VRB20G30KT 3000 TSRA SCT010 SCT030CB=	This amend reflects a change of policy to TEMPO 1000-1200Z from INTER in previous TAF.

SPECI YSSY 080921Z 13008KT 9999 TS FEW015 SCT030 OVC100 FEW040CB 24/22 Q1002 FM0921 07008KT 9999 -SHRA FEW010 SCT030 INTER 0921/1000 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 1000/1200 VRB20G30KT 3000 TSRA SCT010 SCT030CB=		
SPECI YSSY 080930Z 14007KT 9000 TSRA SCT030 BKN060 OVC100 SCT040CB 23/22 Q1002 FM0930 07008KT 9999 -SHRA FEW010 SCT030 INTER 0930/1000 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 1000/1200 VRB20G30KT 3000 TSRA SCT010 SCT030CB=		
SPECI YSSY 081000Z 14006KT 7000 TSRA SCT030 SCT050 OVC110 FEW040CB 23/22 Q1003 FM1000 07008KT 9999 -SHRA FEW010 SCT030 TEMPO 1000/1200 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 1200/1300 5000 SHRA BKN010=	TAF AMD YSSY 081000Z 0810/0915 03018KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 TEMPO 0810/0812 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 0812/0815 5000 SHRA BKN010==	New TEMPO for showers introduced to forecast 1200-1500Z.
SPECI YSSY 081030Z 15007KT 6000 TSRA FEW010 BKN030 OVC100 FEW040CB 23/22 Q1004 FM1030 07008KT 8000 -SHRA FEW010 SCT030 TEMPO 1030/1200 VRB20G30KT 3000 TSRA SCT010 SCT030CB TEMPO 1200/1330 5000 SHRA BKN010=		
SPECI YSSY 081100Z 15007KT 7000 TSRA FEW010 SCT040CB OVC100 23/22 Q1004 FM1100 07008KT 8000 -SHRA FEW010 SCT030 TEMPO 1100/1400 VRB15G30KT 3000 TSRA SCT010 SCT030CB=	TAF AMD YSSY 081100Z 0811/0915 03018KT 9999 FEW040 FM081000 34010KT 9999 -SHRA SCT035 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 TEMPO 0811/0815 VRB20G30KT 3000 TSRA SCT010 SCT030CB	Change of forecast. TEMPO TSRA until 1500.

SPECI YSSY 081130Z 03007KT 5000 TSRA FEW014 SCT040CB BKN060 23/22 Q1004 FM1130 01008KT 8000 -SHRA FEW010 SCT030 TEMPO 1130/1430 VRB15G30KT 3000 TSRA SCT010 SCT030CB=	TAF YSSY 081130Z 0812/0918 34010KT 9999 -SHRA FEW015 SCT030 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 FM090900 08008KT 9999 SCT025 TEMPO 0812/0815 VRB15G30KT 3000 TSRA BKN010 SCT040CB=	Routine TAF.
SPECI YSSY 081200Z 32008KT 7000 -SHRA FEW005 BKN010 BKN070 23/22 Q1004 FM1210 01008KT 8000 -SHRA FEW010 SCT030 TEMPO 1210/1500 VRB15G30KT 3000 TSRA BKN010 SCT030CB=		
METAR YSSY 081230Z 31007KT 9999 FEW005 SCT030 OVC110 23/22 Q1004 TEMPO 1230/1330 8000 -SHRA BKN010 TEMPO 1330/1500 4000 TSRA BKN010 SCT030CB=		
METAR YSSY 081300Z 28006KT 9999 FEW030 BKN110 23/22 Q1003 TEMPO 1300/1400 8000 -SHRA BKN010 TEMPO 1400/1500 4000 TSRA BKN010 SCT030CB=		
METAR YSSY 081330Z 31007KT 9999 FEW030 BKN110 23/22 Q1003 TEMPO 1330/1500 8000 -SHRA BKN010=	TAF AMD YSSY 081330Z 0813/0918 34010KT 9999-SHRA FEW015 SCT030 FM081800 21015G25KT 9999 -SHRA FEW015 SCT025 FM090000 15015KT 9999 FEW030 FM090900 08008KT 9999 SCT025 TEMPO 0813/0815 8000-SHRA BKN010=	Forecaster changes policy to remove thunderstorms from TAF. TEMPO Showers remain with BKN010

Appendix 9 – Scenario 3: Thunderstorm and shower event at Cairns airport on 10 March 2015

Objective: To compare current TTF with a future TAF issued routinely every 3 hours.

- Non-highlighted TAFs were issued on the date of this event.
- Yellow highlights TTF and change in TAF that would occur if there was no TTF.
- Additional TAFs in green.
- 2 TAFs in the original forecast sequence becomes 7 TAFs when TTF removed.

METAR/SPECI	TAF	Explanatory Notes
	TAF YBCS 100545Z 1006/1106 13017KT 9999 SCT028 SCT045 BKN180 FM100800 16012KT 9999 -SHRA SCT023 SCT040 FM110000 15020KT 9999 -SHRA SCT028 SCT045 INTER 1006/1012 3000 SHRA BKN020 TEMPO 1012/1106 3000 SHRA BKN020 PROB30 INTER 1006/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	Routine TAF.
METAR YBCS 100700Z 13014KT 9999 VCSH FEW030 SCT070 BKN300 31/23 Q1003 INTER 0700/1000 3000 SHRA BKN020 INTER 0800/1000 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.0	TAF AMD YBCS 100705Z 1007/1106 13017KT 9999 SCT028 SCT045 BKN180 FM100800 16012KT 9999 -SHRA SCT023 SCT040 FM110000 15020KT 9999 -SHRA SCT028 SCT045 INTER 1007/1012 3000 SHRA BKN020 TEMPO 1012/1106 3000 SHRA BKN020 INTER 1008/1011 VRB15G25KT 1000 TSRA BKN005 FEW025CB PROB30 INTER 1011/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	The certainty in the TTF is conveyed in a TAF amend. The forecaster may have confidence beyond the 3 hour TTF limit. In this example the confidence of INTER TSRA is to 4 hours.

SPECI YBCS 100737Z 13017G28KT 6000 -SHRA FEW025 SCT048 BKN030 28/25 Q1004 FM0737 13015KT 9999 -SHRA FEW025 BKN070 INTER 0737/1037 3000 SHRA BKN020 INTER 0800/1037 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.0		
SPECI YBCS 100800Z 13018KT 6000 -SHRA FEW030 SCT060 BKN300 27/25 Q1004 FM0800 13015KT 9999 -SHRA FEW025 BKN070 INTER 0800/1100 3000 SHRA BKN020 INTER 0900/1100 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.0 VIS 15KM TO S	TAF AMD YBCS 100805Z 1008/1106 13015KT 9999 -SHRA FEW025 BKN070 FM110000 15020KT 9999 -SHRA SCT028 SCT045 INTER 1008/1012 3000 SHRA BKN020 TEMPO 1012/1106 3000 SHRA BKN020 INTER 1009/1011 VRB15G25KT 1000 TSRA BKN005 FEW025CB PROB30 INTER 1011/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	This amend creates a 55 minute window to the next likely thunderstorm.
SPECI YBCS 100830Z 18008KT 9999 FEW027 SCT060 BKN300 26/24 Q1005 INTER 0830/1130 3000 SHRA BKN020 INTER 1000/1130 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.4	TAF AMD YBCS 100835Z 1009/1106 13015KT 9999 -SHRA FEW025 BKN070 FM110000 15020KT 9999 -SHRA SCT028 SCT045 INTER 1009/1012 3000 SHRA BKN020 TEMPO 1012/1106 3000 SHRA BKN020 INTER 1010/1012 VRB15G25KT 1000 TSRA BKN005 FEW025CB PROB30 INTER 1012/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	Routine TAF that extends the no thunderstorm window time of issue to 1000Z.
METAR YBCS 100900Z 17008KT 9000 -SHRA SCT024 SCT060 OVC300 27/24 Q1006 INTER 0900/1200 3000 SHRA BKN020 INTER 1000/1200 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.6		

METAR YBCS 100930Z 17009KT 9000 -SHRA FEW012 SCT024 BKN060 26/24 Q1006 INTER 0930/1100 3000 SHRA BKN020 TEMPO 1100/1230 2000 SHRA SCT012 BKN018 INTER 1100/1230 VRB15G25KT 1000 TSRA BKN005 FEW025CB RMK RF00.0/000.8	TAF AMD YBCS 100935Z 1009/1106 17015KT 9999 -SHRA FEW025 BKN070 FM110000 15020KT 9999 -SHRA SCT028 SCT045 INTER 1009/1011 3000 SHRA BKN020 TEMPO 1011/1106 2000 SHRA BKN018 INTER 1011/1013 VRB15G25KT 1000 TSRA BKN005 FEW025CB PROB30 INTER 1013/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	Timings in TAF amend match TTF.
SPECI YBCS 100948Z 18008KT 9000 4000S VCTS -SHRA FEW010 SCT020 BKN060 FEW022CB 26/24 Q1006 FM0948 18012KT 9000 -SHRA FEW012 BKN022 TEMPO 0948/1248 2000 SHRA SCT010 BKN018 INTER 0948/1248 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.2/001.0 CB 8KN TO S	TAF AMD YBCS 100950Z 1009/1106 18012KT 9999 -SHRA FEW025 BKN1070 FM110000 15018KT 9999 -SHRA SCT022 BKN035 TEMPO 1009/1106 2000 SHRA BKN020 INTER 1009/1013 15018KT 1000 TSRA SCT010 BKN018 FEW022CB PROB30 INTER 1013/1106 VRB15G25KT 1000 TSRA BKN005 FEW025CB	
SPECI YBCS 100953Z 14017KT 4000 VCTS SHRA FEW010 SCT018 BKN040 FEW022CB 26/25 Q1007 FM0953 18012KT 9000 -SHRA FEW012 BKN022 TEMPO 0953/1253 2000 SHRA SCT010 BKN018 INTER 0953/1253 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF02.2/003.2 CB 7NM TO S		
SPECI YBCS 101000Z 13019KT 5000 SHRA FEW012 SCT018 OVC050 25/24 Q1007 FM1000 18012KT 9000 -SHRA FEW012 BKN022 TEMPO 1000/1300 2000 SHRA SCT010 BKN018 INTER 1000/1300 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF02.4/004.6	TAF AMD YBCS 101005Z 1010/1112 18012KT 9000 -SHRA FEW012 BKN022 FM110000 15018KT 9999 -SHRA SCT022 BKN035 TEMPO 1010/1112 2000 SHRA SCT010 BKN018 INTER 1010/1016 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB PROB40 INTER 1016/1112 VRB18G28KT 1000 TSRA SCT008 BKN015 FEW022CB	

SPECI YBCS 101016Z 16013KT 7000 -SHRA FEW012 SCT024 BKN050 25/24 Q1007 FM1016 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1016/1316 2000 SHRA SCT010 BKN018 INTER 1016/1316 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.8/006.8		
METAR YBCS 101030Z 19010KT 9999 -SHRA FEW008 SCT020 BKN050 25/24 Q1007 FM1030 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1030/1330 2000 SHRA SCT010 BKN018 INTER 1030/1330 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.2/007.2		
METAR YBCS 101100Z 19009KT 9999 -SHRA FEW008 SCT026 BKN050 25/24 Q1007 FM1100 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1100/1400 2000 SHRA SCT010 BKN018 INTER 1130/1400 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.4/008.2 LIGHTNING TO SE		
METAR YBCS 101130Z 17011KT 9999 VCSH SCT020 BKN050 26/24 Q1007 FM1130 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1130/1430 2000 SHRA SCT010 BKN018 INTER 1200/1430 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.0/008.2		
METAR YBCS 101200Z 17010KT 9999 VCSH FEW010 SCT020 BKN050 26/24 Q1007 FM1200 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1200/1500 2000 SHRA SCT010 BKN018 INTER 1200/1500 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.0/009.0		No change to forecast
SPECI YBCS 101218Z 19011KT 4000 SHRA FEW010 SCT018 BKN050 25/24 Q1007 FM1218 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1218/1518 2000 SHRA SCT010 BKN018 INTER 1218/1518 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.0/009.0		

SPECI YBCS 101230Z 19009KT 9999 VCSH FEW008 BKN018 BKN050 25/24 Q1007 FM1230 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1230/1530 2000 SHRA SCT010 BKN018 INTER 1230/1530 15018G28KT 1000 TSRA SCT010 BKN018 FEW022CB RMK RF00.8/010.6		
SPECI YBCS 101300Z 16008KT 9999 -RA FEW008 SCT020 BKN050 25/24 Q1007 FM1300 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1300/1600 2000 SHRA SCT010 BKN018 RMK RF00.4/011.8	TAF AMD YBCS 101305Z 1013/1112 16010KT 9000 -SHRA FEW012 BKN022 FM110000 15018KT 9999 -SHRA SCT022 BKN035 TEMPO 1013/1112 2000 SHRA SCT010 BKN018 PROB40 INTER 1016/1112 VRB18G28KT 1000 TSRA SCT008 BKN015 FEW022CB	Thunderstorms Removed from first 4 hours of TAF. The confidence of the TTF is conveyed in the TAF amend.
METAR YBCS 101330Z 15009KT 9999 VCSH FEW008 SCT020 BKN050 25/24 Q1007 FM1330 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1330/1630 2000 SHRA SCT010 BKN018 RMK RF00.4/013.0		
SPECI YBCS 101346Z 18011KT 2000 SHRA FEW008 BKN018 BKN050 25/24 Q1007 FM1346 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1346/1646 2000 SHRA SCT010 BKN018 RMK RF00.0/013.0		
SPECI YBCS 101400Z 18012KT 9999 VCSH FEW008 BKN020 BKN050 25/24 Q1007 RESHRA FM1400 16012KT 9000 -SHRA FEW012 BKN022 TEMPO 1400/1700 2000 SHRA SCT010 BKN018 RMK RF02.6/019.0	TAF AMD YBCS 101405Z 1014/1112 18010KT 9000 -SHRA FEW012 BKN022 FM110000 15018KT 9999 -SHRA SCT022 BKN035 TEMPO 1014/1112 2000 SHRA SCT010 BKN018 PROB40 INTER 1017/1112 VRB18G28KT 1000 TSRA SCT008 BKN015 FEW022CB	Further hour of thunderstorms removed from TAF.
SPECI YBCS 101430Z 17009KT 9999 -SHRA FEW005 BKN020 BKN050 25/24 Q1006 TEMPO 1500/1800 2000 SHRA SCT010 BKN018 RMK RF00.0/019.0		
SPECI YBCS 101500Z 18011KT 9999 VCSH FEW005 BKN022 BKN050 25/24 Q1006 TEMPO 1515/1800 2000 SHRA SCT010 BKN018 RMK RF00.0/019.4		

Appendix 10 – Scenario 4: Thunderstorm event at Darwin on 9 January 2015

Objective: To compare current TTF with a future TAF issued routinely every 3 hours.

- Non-highlighted TAFs were issued on the date of this event.
- Yellow highlights TTF and change in TAF that would occur if there was no TTF.
- Additional TAFs in green.
- 1 TAF in the original forecast sequence becomes 4 TAFs when TTF removed.

METAR/SPECI	TAF	Explanatory Notes
	TAF AMD YPDN 090609Z 0906/1012 32016G26KT 9999 -SHRA SCT025 FM091000 31014KT 9999 -SHRA FEW012 SCT020 FM100000 29019G29KT 9999 -SHRA FEW015 SCT025 FM101000 29014KT 9999 -SHRA FEW015 SCT020 PROB30 INTER 0906/1002 29030G50KT 1000 TSRA BKN005 SCT018CB	Routine TAF as issued on the date in question.
METAR YPDN 090700Z 34017KT 9999 FEW020 BKN250 FEW020TCU 30/25 Q1002 INTER 0900/1000 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.0 SHRA TO S	TAF AMD YPDN 090705Z 0907/1012 32016G26KT 9999 -SHRA SCT025 FM091000 31014KT 9999 -SHRA FEW012 SCT020 FM100000 29019G29KT 9999 -SHRA FEW015 SCT025 FM101000 29014KT 9999 -SHRA FEW015 SCT020 INTER 0909/0910 VRB30G50KT 1000 TSRA BKN010 SCT020CB PROB30 INTER 0910/1002 29030G50KT 1000 TSRA BKN005 SCT018CB	Clear weather slot conveyed in the TTF is now conveyed through a TAF amend. 2 hours of clear weather in this example.

METAR YPDN 090730Z 33017KT 9999 -SHRA FEW020 BKN250 29/26 Q1002 INTER 0830/1030 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.2	TAF AMD YPDN 090735Z 0907/1012 32016G26KT 9999 -SHRA SCT025 FM090830 VRB30G50KT 1000 TSRA BKN010 SCT020CB FM090900 32016G26KT 9999 -SHRA SCT025 FM091000 31014KT 9999 -SHRA FEW012 SCT020 FM100000 29019G29KT 9999 -SHRA FEW015 SCT025 FM101000 29014KT 9999 -SHRA FEW015 SCT020 INTER 0909/0911 VRB30G50KT 1000 TSRA BKN010 SCT020CB PROB30 INTER 0911/1002 29030G50KT 1000 TSRA BKN005 SCT018CB	This sequence of coding in the TAF provides the same effect as the ½ hourly TTF.
METAR YPDN 090800Z 33016KT 9999 FEW020 BKN250 FEW020TCU 30/25 Q1002 INTER 0830/1100 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.2 SHRAS TO SW		
METAR YPDN 090830Z 31015KT 9999 FEW010 SCT020 BKN250 FEW020TCU 30/25 Q1003 INTER 0845/1130 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.2 SHRA'S TO SW/S	TAF YPDN 090835Z 0909/1012 32016G26KT 9999 -SHRA SCT025 FM091000 31014KT 9999 -SHRA FEW012 SCT020 FM100000 29019G29KT 9999 -SHRA FEW015 SCT025 FM101000 29014KT 9999 -SHRA FEW015 SCT020 INTER 0909/0913 VRB30G50KT 1000 TSRA BKN010 SCT020CB PROB30 INTER 0913/1002 29030G50KT 1000 TSRA BKN005 SCT018CB	Routine TAF This conveys confidence in INTER TSRA for next 4 hours.
SPECI YPDN 090839Z 25021KT 9999 5000SW VCTS FEW010 SCT020 BKN250 FEW020CB 27/23 Q1003 FM0900 31014KT 9999 -SHRA FEW012 SCT020 INTER 0839/1139 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.2		
SPECI YPDN 090843Z 25018KT 2000 TSRA FEW010 SCT020 BKN250 FEW020CB 26/23 Q1004 FM0900 31014KT 9999 -SHRA FEW012 SCT020 INTER 0843/1143 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/000.2		

SPECI YPDN 090902Z 27018G41KT 9999 3000NW TSRA FEW006 SCT015 BKN250 FEW015CB 25/24 Q1004 FM0920 31014KT 9999 -SHRA FEW012 SCT020 INTER 0902/1202 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.2/009.2		
SPECI YPDN 090916Z 31015KT 9999 VCTS FEW010 BKN250 FEW015CB 25/25 Q1004 FM0920 31014KT 9999 -SHRA FEW012 SCT020 INTER 0916/1216 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/009.4		No change to forecast
SPECI YPDN 090919Z 31016G26KT 9999 VCTS FEW010 BKN250 FEW015CB 26/25 Q1004 FM0925 31014KT 9999 -SHRA FEW012 SCT020 INTER 0919/1219 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.2/009.6		
SPECI YPDN 090934Z 30017G27KT 9999 -RA FEW015 SCT057 BKN150 26/24 Q1004 FM0940 31014KT 9999 -SHRA FEW012 SCT020 INTER 0934/1234 VRB30G50KT 1000 TSRA BKN010 SCT020CB RMK RF00.0/009.6		

Appendix 11 – Scenarios: Fog and thunderstorm events where PROB30 is used in the first three hours of the TAF.

Objective: To illustrate examples where PROB30 could be used in the first 3 hours of the TAF.

Note: Forecasters will be trained and encouraged to minimise the use of PROB30 or PROB40 in the first 3 hours, however there will be circumstances where the use of PROB30 or PROB40 in the first 3 hours is unavoidable.

Example 1: Fog event at Sydney Airport.

METAR/SPECI	Proposed 3 hourly TAFs	Explanatory Note
METAR YSSY 091600Z 36004KT CAVOK 10/09 Q1026 RMK RF00.0/000.0	TAF YSSY 091400Z 0915/1021 30008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 TEMPO 1010/1018 4000 RA SCT015 BKN025 PROB30 0917/0919 0500 FG	Routine 3 hourly TAF issued at 1400Z indicates PROB30 of fog between 1700 and 1900Z. This is where the forecaster still thinks there is probability of 30% of fog happening at YSSY but less than 50% chance.
METAR YSSY 091630Z 33004KT CAVOK 10/09 Q1026 RMK RF00.0/000.0		TAF has PROB30 between 1700 and 1900Z.
METAR YSSY 091700Z 32004KT 9000 FEW090 10/09 Q1025 RMK RF00.0/000.0		TAF has PROB30 between 1700 and 1900Z.
METAR YSSY 091730Z 33005KT 9000 FEW090 10/09 Q1025 RMK RF00.0/000.0	TAF AMD YSSY 091710Z 0917/1024 30008KT 9999 FEW025 FM100200 02015KT 9999 FEW035 FM101000 36012KT 9999 -RA SCT025 BKN035 TEMPO 1010/1018 4000 RA SCT015 BKN025	At 1710Z, amended TAF issued to remove PROB30 as likelihood of fog diminished below 30% threshold.

Example 2: Thunderstorm event at Darwin Airport.

METAR/SPECI with current TTF	Proposed 3 hourly TAFs	Explanatory Note
METAR YPDN 120000Z 28012/16KT 9999 CAVOK 30/24 Q1008 RMK RF00.0/000.2	TAF YPDN 112334Z 1200/1306 26014KT 9999 -SHRA SCT025 PROB30 TEMPO 1202/1212 25025G35KT 1000 TSRA BKN010 SCT025CB	Routine 3 hourly TAF issued at 2330Z indicates PROB30 of thunderstorm between 0200Z and 1200Z. This is where the forecaster still thinks there is probability of 30% of thunderstorm happening at YPDN but less than 50% chance.
METAR YPDN 120030Z 26014/19KT 9999 SCT023 30/25 Q1007 RMK RF00.0/000.0		TAF has PROB30 between 0200 and 1200Z.
TTF METAR YPDN 120100Z 27016/20KT 9999 FEW023 31/26 Q1007 RMK RF00.0/000.0		TAF has PROB30 between 0200 and 1200Z.
METAR YPDN 120130Z 24014/17KT 9999 SCT025 31/26 Q1007 RMK RF00.0/000.0	TAF AMD YPDN 120110Z 1201/1306 26013KT 9999 -SHRA SCT025 PROB30 TEMPO 1205/1209 22020G35KT 1000 TSRA BKN010 SCT020CB	At 0110Z, amended TAF issued to delay PROB30 as forecaster was confident that the thunderstorm risk could be delayed to 0500Z.

Appendix 12 – Trend Review Risk Assessment – Record of Workshop

12 November 2015 at 10am
Main Conference Room, Bureau of Meteorology
Level 15, 300 Elizabeth Street, Surry Hills

Attendees

Chair - Andrew McCrindell (Bureau of Meteorology)
Independent Risk Assessor - Warren Williams (Airservices Australia)
Ashwin Naidu (Bureau of Meteorology)
John Darnley (Meteorological Authority, Bureau of Meteorology)
LCDR Sam Dale (Royal Australian Navy)
Graham Rennie (Qantas)
William Tidmarsh (Qantas)
Glenn Warwick (CASA)
Richard Hesseon (CASA)
Adrian Slootjes (Virgin Australia)
Anthony Sturgess (Virgin Australia)
LCDR Barbra Parker (Royal Australian Navy, METOC) (from 10.30am)
Captain Brian J Greeves (AusALPA)

Minutes – Gillian Davenport (SelectRight)

1. Introduction and Welcome

The Chair, Andrew McCrindell, welcomed all attendees to the workshop and acknowledged the traditional owners of the land.

He explained that the workshop was being held as recommended in the draft report of the Trend Review Working Group (TRWG):

> **Recommendation 1**: The TRWG recommends that a risk assessment by an independent risk assessor be completed in order to analyse and better assess the implementation issues that need to be resolved prior to the transition to a TAF issued routinely every three hours.

and its purpose was to conduct an independent risk assessment of another key recommendation of the TRWG, namely:

> **Recommendation 2**: The TRWG recommends that subject to the implementation of appropriate risk mitigation that the TTF service be ceased and that, where appropriate, the TAF be routinely issued every three hours instead of every six hours. In addition, the TAF should be amended to provide similar responsiveness, accuracy and operational meteorological information as the current TTF.

The Chair outlined the agenda for the day and introduced Warren Williams from Airservices Australia who conducted the independent risk assessment.

The meeting noted that RAAA, AOPA and smaller operators were not in attendance, despite being invited to participate. Brian Greeves of AusALPA informed the meeting he had some feedback from a recent Trend Review workshop with pilots (REX, Sunstate-Qantaslink, Virgin Australia, General Aviation, Cobham-Qantaslink (B717), Qantas) discussing the issues, focusing on what the present system does, what the new system will do and any identifying any gaps. He would share the concerns raised on their behalf during this workshop.

The outcomes of this assessment will be written up and distributed for all attendees for comment and then be placed on website on 1 December for public reference when preparing responses to draft review report.

2. Agree Terms of Reference

Draft terms of reference had been circulated prior to the risk assessment. The Chair clarified that the meeting was to risk assess replacing TTF with a TAF routinely issued every 3 hours. He briefly went through the ToR document, highlighting the timelines. The deadline to be compliant with international (ICAO) standard is November 2018, but the Bureau intends to make the change by November 2016. It will be an overnight change.

In response to a query from CASA regarding italicized text in Appendix A (ref page 4, ICAO Annex 3, Clause 6.3.1), the Chair clarified that he had added this text. Landing forecasts are optional but this clause in Annex 3 is relevant if landing forecasts are prepared. Australia has a list of registered differences on landing forecasts with ICAO because the code for TTF is different. The option to use a landing forecast as a mitigation strategy against removal of TTF was considered by the TRWG and reasons for not pursuing it are outlined in the draft report.

It was raised that AIP Book has been updated since the ToR was written so the first reference in Appendix A should now be to clause 3.6.3 and the dates in the references to AIP Book in the first and third points should be updated to 12 November 2015 as the most recent edition.

All in attendance agreed to the Terms of Reference, with the amendment above. The finalised Terms of Reference are in Attachment 1.

3. Background Presentation

The Chair gave a brief presentation (Attachment 2) to provide background and an overview of the Trend Review process. He went through the list of relevant rules for flight planning that apply to this change as identified in the draft report and asked for comments about any other relevant rules that should be considered. Participants raised additional concerns regarding:

- Inconsistency between AIP and CASA regulations part 91 and part 121. As Part 91 allows an exemption for time buffers based on TTF, how will this apply when TTF is removed? Operators need certainty about how CASA will apply this clause and the requirement for buffers when TTF is removed but the regulations still refer to TTF.
- General misunderstanding amongst pilots of the relationship between TAF and TTF, such as when there could be a 30% risk in TAF that is not conveyed in TTF because risks in TTF are coded for 50% probability or more. Many pilots believe TTF is the most reliable product and use the TAFas a secondary product for forecasts beyond the TTF timeframe. CASA clarified that there is no regulatory requirement for pilots to consider the TAF for decisions within the timeframe of the TTF because the TTF supercedes the TAF. Some operators such as Virgin Australia apply procedures to use the most restrictive of TTF and TAF, even though legal requirement is for TTF only.
- Forecasters focus on the TTF and the TAF is the secondary forecast, the TAF may not be updated to reflect some short term changes in TTF - currently forecasters spend a lot of time preparing TTF during significant weather events.

LCDR Barbra Parker joined the workshop at 10.30am.

In response to queries from participants about the benefits identified by the TRWG, the Chair clarified:

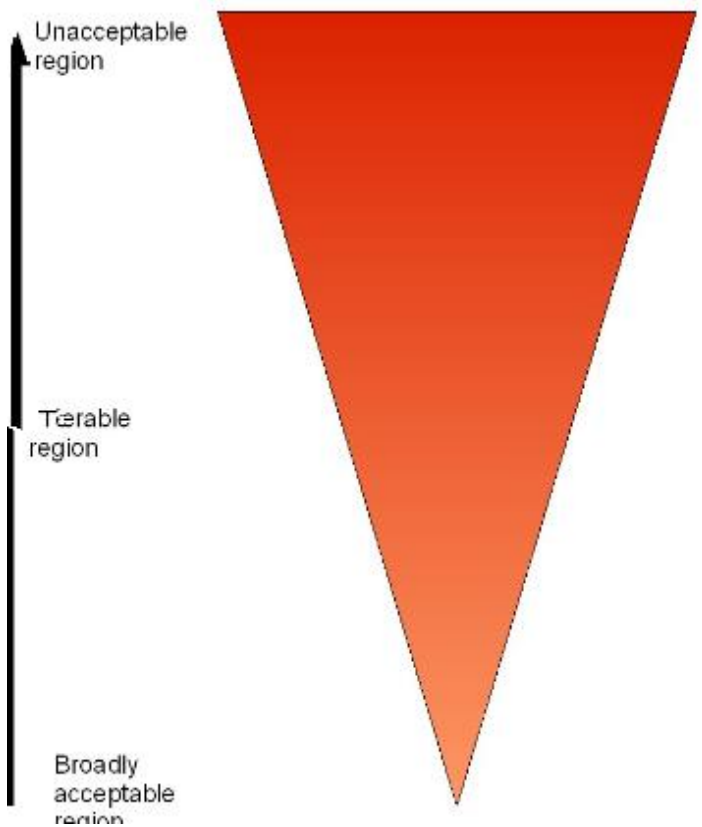
- Australia will register a difference to keep the code SPECI for METAR observations on the half hour that are in SPECI conditions – TRWG identified a need to retain this difference and means a retention of the status quo for observation codes SPECI and METAR in Australia. It is not a problem as both coding systems are accepted by ICAO.
- There is no difficulty going to a 3hr TAF in terms of ICAO compliance as it exceeds the international requirement for routine TAF update. In places where a TTF is currently issued, the TAF will be routinely issued every 3 hours, with amends as required. Similar to regional airport TAFs, when an amendment is required for the current hour the TAF AMD will commence from the previous hour.

In relation to the issues raised by the TRWG, the following additional points were raised:

- Point 5 regarding PROB30 and PRB40 forecasts resulting in diversions could also be seen as a benefit if it allows better decision making.
- Installation of superior observation equipment in airports where there are currently no observers present may present an issue for meeting the November 2016 deadline. The Bureau confirmed this process was underway at Coolangatta.
- There is currently no plan to broadcast the 3 hourly TAF over VOLMET but this has not been ruled out.

4. Agreement on the ASNS 31000 Risk Procedure

Warren Williams outlined the process for the risk assessment to be conducted in accordance with the ASNZ 31000 Risk Management Process and the ALARP diagram.



Warren explained that he would take the group through discussing the current situation, identifying the risks the current system addresses, how the future system will address those risks and identify any emerging risks. Through the discussions the group will determine where the current and future system leads the industry to sit on a level of risk tolerability.

It was clarified that the change to a 3 hourly TAF relates only to sites that currently have TTF, plus other sites identified by the Review. Sites that currently do not have TTF will continue to have 6 hourly TAF.

5. Risk Assessment

Warren asked the meeting to focus on defining the risk the TTF is managing and to determine if participants perceive industry is currently in a tolerable area of risk. He posed as the key questions: What is the current risk that TTF is managing? Was it implemented in response to anything?

In discussing these questions, participants gave examples to show how forecast products are used in flight planning to achieve operational efficiency and how removal of the TTF may affect efficiency. Brian Greeves from AusALPA presented the issues and perspectives raised in a preceding workshop with pilots from major airlines, regional airlines and General Aviation. Points raised included:

- Perception amongst pilots that the TTF gives a more accurate forecast and allows fine-tuning of operations, in particular how much fuel to carry. By having accurate information, operators can mitigate risks and operate more efficiently.
- The TTF was introduced to address an operational issue and allows some flexibility to operators in determining the need for an alternate and use of TTF negates the requirement for time buffers. It is used for PNR decision-making and anticipated runways during flights, in effect being used as a landing forecast in some situations and a flight planning forecast in others.
- Efficiency gains through use of the TTF are relatively more important for short haul flights (one hour or less) that fall wholly within the forecast period of the TTF. For those flights, TTF may be the only forecast referred to and there is a perception that TAF cannot provide the required accuracy of information.
- Decisions about fuel load and diversion are made with reference to regulatory requirements, operator policy and captain's discretion. While regulations apply to all, individual operators have different levels of risk tolerability, and there are different requirements for short and long haul flights so no generalised rule can be made about how TTF, TAF and other information are used in flight planning currently, except to say that generally operators take a conservative approach in the flight planning stage. Information used in-flight can be highly variable between operators and circumstances, from sole reliance on TTF to use of a wide range of information.
- The impact on operational efficiency is likely to have a greater impact on smaller operators using short range/duration aircraft as a greater proportion of their operations are within the forecast period of the TTF and there is a heavier reliance on the exemption from time buffers enabled by the TTF. Removal of the TTF will have the greatest effect on those who rely most heavily on it.
- Operators flying to a series of regional airports can currently use the TTF when returning to a major airport on the last leg of the day. As it is less restrictive than TAF that may be the difference between them being able to make their final flight. Removal of the TTF could be seen as managing the risk for them, or could be seen as a penalty.
- TTF has served Australia well and is seen as very accurate. The replacement TAF needs to be seen as being as accurate. Bureau confirmed both forecasts have the same level of accuracy, with the difference that the TTF is updated more frequently. Industry has developed this perception over time that TTF is more accurate.
- TAF at major airports is currently not amended promptly for changes that occur within TTF duration. The new paradigm will see TAFs amended to adjust for changes in short range forecasts. Forecasters are currently busy preparing and issuing TTF during adverse weather events.

- Use of the TTF is different for short haul and long haul flights. There is regulatory backing to adjust time buffers if flight is within forecast period. It is an existing risk that over-reliance on TTF could be problematic if TTF is not accurate. Its perceived accuracy could be causing operators to underestimate risk. While the likelihood for the risk is low, there would be a high consequence due to little room for maneuvering in-flight when time buffers have been relaxed.
- CASA stated that the TTF, while useful, is not necessary. If it ceased to be issued immediately, safety functions would still be met. The TTF provides for operational efficiency over the current TAF.

It was determined that there was a difference between what TTF is used for, and what risk it is managing. Its use has changed over time so some of the risks identified are existing risks rather than related to the change.

In summary, participants agreed:

- The worst credible outcome for having no TTF was an aircraft landing with less than mandated fuel reserves (less than 30 minutes fuel). Replacement of the TTF with a 3 hourly TAF will manage this risk to the same level, but is likely to result in a reduction in operational efficiency.
- The main use of TTF it to allow operational efficiencies. It also allows better tactical decision making during a flight as it can be used to validation of TAF due to it being updated more frequently.
- Most operators are conservative in the strategic planning stage before departure but cannot generalize about how operators make tactical decisions to address risk during flights. Operators have different approach to risk in flight, with some operators requiring pilots to use all available information in flight, with other operators using only TTF once airborne.

Break at 11.50am for lunch.

On resumption, participants assessed that currently industry sits at just above lower tolerability limit.

Warren guided discussion to developing an assessment of where industry would be in risk tolerability after the change. To focus the discussion, he summarised the change being assessed as:

- removal of TTF with METAR/SPECI issued at the same frequency as today.
- TAF changes to 3 hourly routine issue in locations specified.
- TAFs to use more amendments to reflect changes to forecasts in the first 3 hours.
- More TAF amendments with triggers to amend TAF the same as currently in TTF.
- The TAF can be amended immediately a forecast change is noticed. Currently TTF has to wait for the next observation.

Based on the current uses of the TTF, participants identified risks or potential consequences resulting from cessation the TTF:

- Perception that this change will decrease usefulness of information. However, this assumption is based on misconception that TTF is more accurate than TAF.
- Removal of the TTF would reduce operational efficiency. Time buffers would be applied as required by TAF assessments so operators would

have to reduce flying times, or increase fuel load. For some smaller operators complying with these changes may not be viable.

- Need to make sure that TAF provides same level of accurate information as TTF and is perceived as providing equivalent information to deliver operational solutions. The perception that TAF is too conservative may lead to the revised TAF still being considered inferior to the current TTF. Transition to the 3hrly TAF gives an opportunity to consider additional improvements to the TAF.
- Change to TAF could result in an increase in diversion activity. Diversions at end of long haul flights are a risk in themselves. Currently TTF gives better information than TAF because it is updated and it gives a high level of confidence.
- Increased fuel requirements due to stricter buffer requirements of TAF. Until aviation regulations are changed (part 91 and Part 121), references to the non-existent TTF may result in pilots misinterpreting buffer applicability if they consider that the concessions for TTF can be applied to the 3 hour TAF.
- Risk associated with a change in rules between 3 hourly and 6 hourly TAF. How does an operator know which TAF rules apply given that the codes are the same.
- Reduced availability of information for some operators if there is no replacement product on VOLMET/AERIS.
- Need for education about assessing risks for smaller operators.

It was acknowledged that some of the scenarios or risks identified exist under the current system – removal of the TTF is highlighting these risks even though they are being managed currently and will remain under the change but are not caused by the change.

Although the focus of the risk assessment is on safety issues, the potential for additional regulatory burden must be considered. If the TTF removal triggers changes to CASA regulations, any additional financial burden will need to be considered as an impact before changes to regulations will be approved. A clear consequence of the removal of TTF without regulatory change is that all aircraft will be required to carry more fuel. This could be a safety risk as some operators may be pushed to act outside the regulations.

Participants initiated discussion about impending changes in the Bureau and how these may affect aviation forecasts. Although not a result of the TTF/TAF change being considered, participants felt these should be considered in this context and how they may interplay with and affect the implementation of the change to removing TTF. Changes of concern include:

- Proposed centralisation of forecasters and potential for loss of local knowledge.
- Introduction of Remote Automatic Weather Stations.
- Ongoing BoM resources in 6 hour TAF locations.
- Forecaster workload, accuracy and timing of TAF.

The Chair responded that these risks can be added to the list of issues to be considered, but this change must be pursued regardless of the outcome of the Bureau organizational changes. He referred to the resourcing table in the draft report showing staffing allocations at aerodromes. While acknowledging that future changes in the Bureau may affect staffing levels or focus, these changes will be managed by Bureau and the removal of the TTF will not in and of itself have an effect on staffing levels. The changes should lead to a workload reduction for the forecaster, as currently they have to constantly update the TTF forecast with the issue of SPECI; after the change the forecaster will be able to focus on monitoring TAF and amending when it is needed. Examples of a similar effect of amended TAF are in the appendices of the draft Trend Review

Report.

Participants highlighted that some broader issues arise when consider a change to the forecast product including:

- Are we trying to improve on the TTF with the replacement product?
- Is it an opportunity to review fuel buffer rules? The biggest issue discussed during the workshop has been the change to buffer requirements when the TTF is removed so this may indicate an opportunity to review buffer rules - what is their basis and are they being managed in the most appropriate way?

6. Develop controls

Having identified the risks above, participants suggested treatments to address the risks:

- Education and training for all stakeholders will be essential in implementation of this change, as in any change process. Training will be required for pilots, operators and forecasters to ensure understanding of change.
- Mandated buffers in regulations should be changed to reflect the change to a 3 hourly TAF or there will be a potential for excessive fuel carriage. There is a risk of a transition period when the Regulations do not reflect the forecast products available. CASA would need assurance that TAF reliability and accuracy is similar or better than the TTF to inform any evaluation of potential regulation changes. The process to commence regulatory change is at the request of industry after finalisation of the report.
- Consider if this change should be used as an opportunity to review the application of fuel buffer levels for every TAF.
- Convey to industry and operators that the new TAF is no less accurate than the TTF. Need to allay concerns that the TTF is being replaced by an inferior product and promote confidence in the accuracy of the system.
- Provide assurance that BoM forecasters will have ability to apply attention to TAF and issue amendments as required to enhance its currency.
- Consider having a 'ghosting' period where TTF and 3 hour TAF are prepared together in the lead up to cut over date to give assurance of the accuracy of TAF.
- Need to examine the impact of information being removed from VOLMET/AIRES before deciding if it needs to be replaced. In many situations there were other sources, so the impact needs to be assessed and a proportional response implemented.

Risks arising from these treatments were also identified:

- Applying different rules and time buffers around the 3 hourly TAF with the intent of creating similar efficiencies to TTF could create confusion with 6 hourly TAFs because the code is the same.
- Consider whether education and training can be undertaken before November 2016 given potential changes within the Bureau associated with the Review of Aviation Weather Services.
- Timelines for installation of new equipment at Hobart and Gold Coast required for the changeover.

Some risks identified do exist currently so they already have mitigation strategies. For example:

- Risk that people start treating 6 hour TAF and 3 hour TAF in the same way. This risk is already managed in an international context as pilots

deal with different length TAFs in other countries. Each operator is responsible for training and educating their staff.

- If current system is maintained, an education program would be needed anyway. There would be a big cost to industry to code Australian exceptions to international schema.
- Reliance on 6 hourly TAF instead of TTF can happen today. For example if a forecaster is sick at Canberra airport, no TTF is issued, and TAF is used instead. If TTF is not available at any major airport today for whatever reason, the latest TAF becomes the primary forecast.

7. Summary of assessment outcome and next steps

Overall, the majority of participants agreed that the safety risk profile would not be changed as a result of implementing a 3 hourly TAF there being a tolerable level of safety risk after the TTF is removed. Virgin Australia stated that it has begun mitigating for the worse conditions in either TTF or TAF, this change would improve the risk profile for their operation. AusALPA assessed that the change will result in an improvement to the safety risk profile, but operator efficiency will decrease if the fuel buffer rules were still in place.

Participants acknowledged there will be a transition period as operators adjust to any new operating arrangements resulting from removal of the TTF. Qantas stated its requirement for a parallel process to ensure amendment to buffer regulations at same time as TTF removal.

Participants discussed the process following this workshop:

- Bureau will receive submissions on the draft Trend Review report by the end of January 2016. A technical and executive group, comprising representatives from the Bureau, Airservices, DOIRD, Defence and CASA will evaluate submissions prior to release of the final report.
- After the final report is released, this group will appoint a lead to coordinate implementation of the change across the industry. Although Bureau is responsible for implementing the change to forecasts, it is anticipated an implementation group will be formed to oversee implementation of change across all stakeholders.
- It was proposed that Airservices Australia could record the risks identified in the final report on its risk register.
- The Bureau will take responsibility for the quality assurance of TAF forecast product during the change.
- Operators will assume the risk of interpreting and using the new forecast product.

Immediate actions arising from this workshop:

- Notes from the risk assessment will be sent to all participants and to REX and RAAA for comment before being posted to the Bureau website.
- Glenn Warwick would begin preparation of an internal discussion paper for CASA on options for regulation change.

8. Other business

Barbra Parker asked why the Defence aerodromes were not stated at Recommendation 3. The Chair responded that Defence can determine the aerodromes and he would discuss this issue further with RAN METOC, RAAF and Army outside of the workshop to explore where 3 hour TAF was

required and for what periods to ensure there was no reduction in service.

9. Close

The workshop closed at 2.50pm.