Graphical Area Forecast (GAF)

Post Implementation Review

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Aviation Meteorological Services

Graphical Area Forecast Working Group (GAF WG) Members

Bureau – Industry Regional Aviation Weather Services Consultative Group

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1 Executive Summary

The Bureau of Meteorology implemented the Graphical Area Forecast (GAF) project on 9 November 2017, replacing text-based Area Forecasts with graphical products.

Following the implementation of the GAF project, a Post Implementation Review (PIR) was conducted with the following objectives:

- evaluate whether the Graphical Area Forecast (GAF) project objectives were met;
- determine how effectively the GAF project was run, including the relevant documentation;
- review whether the expected benefits were realised; and
- document lessons learned and make recommendations for future improvements.

This report summarises the post implementation review process, project achievements and the action plan for outstanding issues as well as various recommendations for consideration in future reviews of aviation meteorological products and services.

2 Introduction

2.1 Purpose of the post implementation review

The Bureau of Meteorology implemented Graphical Area Forecasts (GAFs) on 9 November 2017 to replace text-based Area Forecasts (ARFORs). The text based ARFOR was replaced by two new products, known as the Graphical Area Forecast (GAF) and the Grid Point Wind and Temperature (GPWT) Forecast.

In addition, Airservices Australia's National Information Processing System (NAIPS) and associated systems were upgraded to move from the distribution of text-based area forecasts to graphical-based area forecasts.

Following the implementation of the GAF and GPWT, a wide range of aviation industry customers were invited to provide feedback and comments on the GAF and GPWT products and the implementation process. In addition, a GAF Post Implementation Review (GAF PIR) was held with GAF Working Group members to review the process.

The key objectives of the GAF PIR were to:

- o evaluate whether the Graphical Area Forecast (GAF) project objectives were met;
- o determine how effectively the GAF project was run, including the relevant documentation;
- o review whether the expected benefits were realised; and
- o document lessons learned and make recommendation for future improvements.

This report summarises the post implementation review to ensure the lessons learned and recommendations are considered in future reviews of aviation meteorological products and services.

2.2 Methodology

The review methodologies used to evaluate the GAF project as part of the GAF PIR were as follows:

- Feedback and comments were obtained from a wide range of aviation industry customers via an evaluation questionnaire;
- a GAF PIR meeting was held with GAF Working Group members on 19 February 2018; and
- general feedback and comments collated via various industry forums, such as RAPAC (Regional Airspace and Procedures Advisory Committee), RAAA (Regional Aviation Association of Australia), Bureau of Meteorology/Aviation Industry Consultative Meetings, etc.

3   GAF Project Summary

3.1   Background

Prior to 9 November 2017, the Bureau of Meteorology (Bureau) was producing Area Forecasts (ARFORs) for 28 areas across Australia. These ARFORs were provided in a text format to pilots to plan flights in the airspace below 20,000 feet. In addition, the format of Australian ARFORs did not comply with International Civil Aviation Organization (ICAO) Annex 3 specifications.

In response to aviation industry requests for more graphical products and to make practices more compliant with ICAO requirements, the Bureau officially commenced a project called Graphical Area Forecasts (GAFs) in February 2014 to review the requirements to support the implementation of a GAF.

To ensure that industry requirements were met, a Graphical Area Forecast Working Group (GAF WG) consisting of representatives from Australia and International Pilots Association (AIPA), Airservices Australia, Air Sport Australia Confederation (ASAC), Aircraft Owners and Pilots Association (AOPA), Civil Aviation Safety Authority (CASA), Defence, Glider Federation of Australia (GFA), Honourable Company of Air Pilots Australia (HCAPA), Qantas, Qantas Link, Regional Aviation Association of Australia (RAAA), Rex Airlines, Sharp Airlines, Virgin Australia Regional Airlines (VARA), Virgin Australia, Data Service Providers (OzRunways and AvPlan) and the Bureau (Aviation Meteorological Services and Meteorological Authority) met on various occasions to make decisions on the format and the requirements. In addition to this, the Bureau met separately on a few occasions with Airservices Australia, CASA and the Data Service Providers (which included participants from Ozrunways, AvPlan, Avsoft, Champagne, Command Software, PocketFMS, Sentient Software and Jeppesen) to discuss the proposed changes and the potential impact on the systems and users of general aviation flight planning application vendors.

In preparation for the implementation, the Bureau in coordination with GAF WG members finalised detailed requirements, a concept of operations (ConOps), a number of plans, including Implementation and Communication Plans and user education strategies to ensure the project was delivered effectively and efficiently. The implementation plan also included a reduction to the vertical extent of ARFORs from FL200 to 10,000FT and distribution of ICAO compliant AIRMETs into pilot briefing services (via NAIPS).

3.2   Objectives of GAF project

The objectives and expected benefits of the GAF project were as follows:

1. The 28 forecast areas used in ARFORs to be amalgamated into ten larger GAF - domains. These larger domains will allow pilots to access multiple area forecasts for flight planning easily and simplifying the flight planning process;

2. GAF will provide information on weather, cloud, visibility, icing, turbulence and freezing levels in a graphical layout with supporting text;

3. The image section of the GAF outlines the boundaries of different weather areas, allowing greater flexibility when distinguishing between weather boundaries. This will present information in a more accessible format, with less reliance on plotting complex location descriptions in long text strings;

4. More frequent and higher resolution wind information will be provided in a separate forecast product, Low-level Grid Point Wind and Temperature (GPWT) Forecasts. GPWT Forecasts will include wind speed and direction and temperature forecasts at specified heights above mean sea level, presented in a gridded format;

5. The GAF and GPWT Forecasts will be more user friendly, and quicker and considerably easier to interpret;

6. Production of Extensible Markup Language (XML) product variants which will allow integration of data into general aviation flight planning application to ensure meteorological forecast information can be overlayed on other pilot datasets (aircraft position, flight path, aerodrome information, etc.); and

7. Reduction in the number of Australia's Registered Differences to ICAO Annex 3.

3.3   Status

On 9 November 2017, the Bureau replaced ARFORs with two new separate products, GAFs and GPWT Forecasts nationally. Based on the decisions made by GAF WG the following were delivered:

- Ten GAF domains, named NSW-E, NSW-W, NT, QLD-N, QLD-S, SA, TAS, VIC, WA-S, WA-N broadly based on states.
- GAFs for each domain providing information on weather, cloud, visibility, icing, turbulence and freezing levels in a graphical layout with supporting text for the airspace between the surface and 10,000 feet;
- Nine GPWT forecast domains covering GAF areas as well as a specific Timor Sea area, named AUS, NSW, NT, QLD-N, QLD-S, SA, TIMS, VT (VIC/TAS), WA-S and, WA-N
- GPWT forecasts for each domain providing information on wind speed and direction and temperature at specified heights above mean sea level, presented in a gridded format;
- An upgrade to Airservices Australia NAIPS area briefings to enable delivery of GAFs and GPWT Forecasts;
- Modified area QNH areas (previously also used for Area Forecasts) to align with GAF domain boundaries;
- Portable Network Graphics (PNG) and Portable Document Format (PDF) and XML formats of GAFs and GPWT Forecasts.

At the time of writing, the Bureau (and Airservices) were undertaking further product and system developments based on aviation industry feedback. These are presented in the Action Plan (Table 4).

4   Assessment of GAF Project Achievement

4.1   Project Outcomes

Table 1 below summarises the project outcomes and achievements.

Project Outcomes	Achievement	Reasons for deviations (where relevant)
Project objectives	GAF project was delivered within scope and budget as per the original Business Case. However, there was a slight variation in delivery timelines. The cumbersome and antiquated text-based Area Forecast (ARFOR) was replaced with a user friendly graphical and digital global ICAO standard products, GAFs and GPWT Forecasts.	The initial plan was to deliver the GAF project in November 2016, however, after consultation with the GAF WG and Airservices, it was deemed necessary to delay implementation of the project to November 2017 to ensure Airservices and the Bureau's systems were ready and able to deliver the objectives effectively and efficiently.
Benefits	Most of the expected benefits were realised upon implementation of the project. The graphical products provided a weather overview that is considerably easier to interpret and use, and more comprehensive than ARFOR, while improving safety and efficiency of all general aviation pilots.	

	In addition to the graphical products, greater value came through the provision of the forecasts in digital XML format. The provision of digital data has greatly improved pilot situational awareness by allowing the overlay of meteorological forecast information on other pilot datasets such as their aircraft position, flight path, position of other aircraft, aerodrome information and other relevant details. The GAF is the first aviation area forecast produced in XML format worldwide and has received significant praise in Australia and internationally.
User Satisfaction	The Bureau has been reaching out to the aviation industry on several occasions in numerous forums seeking feedback and ensuring that pilots were fully aware of the change. The GAF project received a considerable amount of positive feedback from customers. The new graphical products have been identified to be easily interpreted by pilots and as a great step forward for aviators around Australia. In addition, the Bureau received some constructive feedback which allowed for further enhancement of products to meet user requirements.

Table 1: Summary of the project outcomes and achievements

4.2   Process and Decision Making

4.2.1   Establishment of a Process and Timeline

The GAF project officially started in February 2014 at the Bureau-Industry Regional Weather Services Consultative Group meeting where it was decided that a working group (GAF WG) should be formed to discuss the various details of GAFs to ensure industry requirements were met, safety implications considered and to help progress the project through to implementation.

The Bureau worked very closely with GAF WG members to achieve major deliverables throughout the project. The timeline below provides a snapshot of the major deliverables.
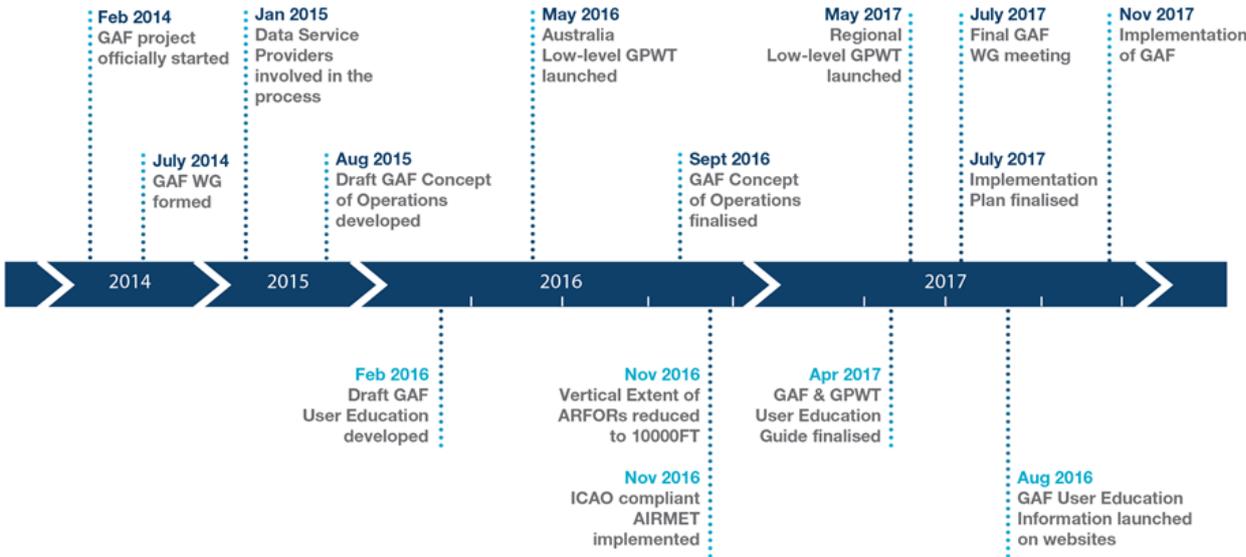
Graphical Area Forecast (GAF) Timeline

Feb 2014
GAF project officially started

July 2014
GAF WG formed

Jan 2015
Data Service Providers involved in the process

Aug 2015
Draft GAF Concept of Operations developed

Feb 2016
Draft GAF User Education developed

May 2016
Australia Low-level GPWT launched

Nov 2016
Vertical Extent of ARFORs reduced to 10000FT

Nov 2016
ICAO compliant AIRMET implemented

Sept 2016
GAF Concept of Operations finalised

Apr 2017
GAF & GPWT User Education Guide finalised

May 2017
Regional Low-level GPWT launched

Aug 2016
GAF User Education Information launched on websites

July 2017
Final GAF WG meeting

July 2017
Implementation Plan finalised

Nov 2017
Implementation of GAF

2014   2015   2016   2017

Figure 1: GAF Timeline

4.3   GAF Budgets and Resources

The GAF Project was delivered within the allocated budget and resources, including the cost associated with the travel requirements for the user education process.

4.4 Communication, Implementation & Customer Engagement

To successfully achieve implementation of the GAF project, the Bureau in close coordination with GAF Working Group, developed a detailed communication and implementation plan, which included educating aviation users and forecasters about the new GAF and GPWT products.

The Bureau reached out to the aviation industry throughout the development of GAFs to ensure that users were not only aware of the change but also prepared for its implementation (Table 2). In addition, the Bureau in conjunction with Airservices Australia and CASA conducted a comprehensive education campaign to provide ongoing updates to the aviation industry. Specific details on the Bureau's user education strategies can be obtained at http://www.bom.gov.au/aviation/gaf/index.shtml.

A Concept of Operations (ConOps) plan was developed between the Bureau and Airservices Australia to define the GAF and GPWT capabilities and the functional requirements in relation to the NAIPS briefing services. Airservices Australia extensively upgraded the capability of NAIPS and associated systems to support the delivery of GAF and GPWT products.

The Table 2 below provides a summary of the processes and strategies established for GAF project implementation.

Processes and Plans	Methodology or application tools
Process	Endorsement from BoM/Industry Consultative Meeting to commence the project.
	Formation of GAF WG.
	GAF WG Meetings on regular basis to capture and finalise the requirements; assess safety implications and progress through to implementation.
	Regular meetings with Airservices regarding system and process changes.
	Ad-Hoc meetings with sub-group members, including Airservices AusALPA, CASA and Data Service Providers to finalise some of the additional requirements.
	Updates provided to various fora, including Consultative Meetings, RAAA TWG, RAPAC etc. on regular basis.
Documentation	A Business Case and Project Plan
	A Concept of Operations (ConOps) developed with Airservices Australia, regularly reviewed and updated as required.
	GAF requirements documents for IBL Software Engineering to ensure the GAF product was developed to the required specifications.
	Implementation Plan, including user education strategies as outlined below.
	Documentation made available to GAF WG members via the Bureau's webpage, e-mails and meeting invitations, including various actions and decisions.
	Changes to aeronautical documents, including Aeronautical Information Package (AIP), En route Supplement Australia (ERSA), Designated Airspace Handbook (DAH), CASA examinations.

	Communication Plans, including internal and external communication strategies.
	Changes to internal operational documents relevant to Airservices and Bureau.
	Transition and Changeover Plan
System(s) and software	Upgrades to Airservices Australia system NAIPS (National Aeronautical Information Processing System) based on the ConOps.
	Upgrades to the Bureau's Visual Weather program to enable production of GAF. GPWT Forecasts.
	GAF/GPWT XML Schema was developed by Airservices and distributed to all Data Services providers (DSP) prior to implementation to ensure DSPs could ingest data within their system.
Communication	Communication to customers via various fora, including • GAF WG Meetings; • BoM Consultative Meetings; • RAAA TWG Meetings; • RAPAC Meetings; • BoM/Airservices Technical Group Meetings; and • Defence fora.
	Communication to customers by publishing and promoting information on various webpages and publications: • Industry publications – various magazines, including Flight Safety Magazine; • Web pages – BoM webpage, NAIPS front Page, CASA webpage, Data Service Provides Webpage etc.
	Communication via various social media channels, such as Facebook and Twitter.
User Education Strategy	Various user education strategies were established by various organisations prior to the implementation of GAF as outlined below. The Bureau: • made various brochures available under the Bureau's Aviation Knowledge Centre; • produced GAF (and AIRMET) user education guide; • produced a GAF Video; • produced GAF FAQ document; and • ensured training and competency assessment of the Bureau forecasters; • delivered presentations on an ongoing basis at various fora, including RAAA; Aero Clubs, Flight Training Schools; safety seminars, RAAF bases and training schools. • produced articles for various industry publications. CASA assisted by including a GAF campaign in their CASA Safety Seminars nationally. In addition, CASA made various articles available via CASA Flight Safety Australia Magazines.
	Airservices assisted with training at Airservices Academy and School of Air Traffic Control.

Table 2: Summary of processes and strategies established for the project

4.5 GAF Project Highlights and Customer Satisfaction

The new graphical and digital GAF has proven to be easily interpreted by pilots and has achieved the key objective of successfully replacing the cumbersome and antiquated text-based Area Forecast (ARFOR).

The highlight of this project was the close collaboration between the Bureau, Airservices Australia, CASA and the other members of the GAF WG to develop detailed requirements, concept of operations, communication and implementation plans, including user education strategies to implement a project that enhances the safety and efficiency of the flight planning process. The GAF is a pioneer, being the first area forecast available in XML format worldwide. It has received significant praise by its users and other meteorological agencies around the globe. The success of this project can be attributed to the dedication and expertise of those involved.

In addition, the Bureau and Airservices Australia implemented significant changes to their IT systems, including a major enhancement to the NAIPS system within a very challenging timeline.

Upon implementation of the GAF project, the aviation industry were invited to provide their feedback on the GAF and GPWT products, as well as the implementation process. The GAF project received a considerable amount of feedback from customers, both positive and constructive. The constructive feedback allowed for further product development such as implementation of reference products to assist in interpretation of GPWT forecast charts, the provision of more detailed information in the User Guide and improvements to the NAIPS system to make it more user-friendly and responsive.

5   Lessons Learned & Recommendations

5.1   Summary of Lesson Learned

The key lessons:

- The GAF project was a major change for the aviation industry, especially for General Aviation (GA) pilots, and changes of this magnitude require additional consultation and education processes to ensure more customers become aware of the change.

- Whilst all the required outcomes of the project were delivered, it took an extended length of time to implement the project. The project commenced at a slow pace thus consideration should be given allowing more agility in the timeframe of such a substantial change. It became evident late in the project that a major delay was likely due to the amount of changes required to NAIPS.

- NAIPS briefing service was required to be updated to move from the distribution of text- based products to graphical based products for the first time ever. Whilst the development, testing and cutover was completed in accordance with the plans and to schedule, NAIPS performance slowed-down significantly just after implementation, and users could not access NAIPS for several hours. Thorough end-to-end testing should have been undertaken well in advance to understand any pertaining issues.

- Some aspects of the GAF and GPWT products were not fully understood by the customers. More clarity and thorough education process is required on products before any major change to products like this.

- The table below provides a list of other lessons learned from the post implementation review that can be applied more broadly to other changes, specifically, for large change management processes.

Title	Issue/Recommendation
Process	GAF WG membership did not include any representative from helicopter operations. **Recommendation:** It is recommended that Australian Helicopter Association is included in the working group for future changes affecting low-level operations especially for a change of this magnitude.
	The Defence Air Traffic Controllers were not involved in the working group or in any initial consultation process. **Recommendation:** It is recommended that both Air Navigation Service Providers (Airservices Australia and Defence) are considered and represented in the working group.
	Whilst some of the Data Service Providers (DSPs) were involved in the GAF WG, the relevant members were not included until well into the process. **Recommendation:** DSP should be involved from the outset for a change affecting low-level operations, as they distribute most of the aeronautical information in agreement with Airservices Australia.

	The full requirements and scope of NAIPS changes were underestimated.
	Recommendation: To ensure the system changes, such as NAIPS, are captured fully it is recommended that a specific ongoing project meeting between the Bureau and Airservices should be scheduled in future for a large-scale change. The meeting between the Bureau and Airservices should be based on the project agenda and tracked action items managed via the project schedule.
	The work and demand required for a substantial change of this nature was underestimated.
	Recommendation: It is recommended that an agreed implementation plan is in place well in advance and the management of work is thoroughly scoped and planned.
Documentation	Several documents were required to be updated/changed for this project. However, not all documents were identified in advance.
	Recommendation: It is recommended that all the relevant documents that require amendments are identified well in advance and are incorporated into the implementation plan.
	Several changes were required in AIP. The changes were either not fully scoped initially or were submitted late. In addition, there was some confusion on how the documentation changes were managed between various organisations, such as Airservices Australia, the Bureau and CASA.
	Recommendation: It is recommended that the documentation (including AIP) amendments for a change of this magnitude should be drafted by the relevant organisation well in advance and the changes are managed and finalised by various organisations well and truly before the cut over date.
	The earlier version of the Implementation Plan did not include the user education plan.
	Recommendation: It is recommended that the Implementation Plan should include user education plans and strategies from the outset.
	While the GAF User Education Guide was very comprehensive and circulated widely, the document was not made available to various users well in advance. Earlier awareness is critical and therefore sections of education material should have been made available to the users in advance.
	Recommendation: It is recommended that the User Guide for a change of this nature be finalised well in advance. If the final and detailed version of the document cannot be made available, sections with essential elements of education material should be finalised and made available to the users in advance.
System/Software Changes	NAIPS performance had significant issues soon after the cutover to GAF due to additional load issues on NAIPs. This problem was not detected in the formal acceptance testing phase as there was limited availability of test products for end-to-end testing. In addition, the testing was not fully performed between Airservices and Data Service Providers (DSPs).

Recommendations: It is recommended to

- do a thorough end-to-end testing between the Bureau and Airservices to ensure any issues and impact related to larger file size of the graphical products can be understood and rectified earlier.
- develop a joint transition plan in consultation with the Industry Working Group (including representation from the customers and industry partners such as DSPs). In addition, this plan should be developed earlier in the project and should be discussed with the industry.

Customer feedback highlighted that the order of the products within the NAIPS briefing page was not consistent with customer expectations. In addition, the NAIPS Web User interface was identified as less than intuitive.

Recommendations: It is recommended that

- the project should consult with the working group to develop and/or verify user requirements and expectations throughout the design process;
- develop mock-ups and provide to the working group for review.
- update NAIPS configuration to ensure customer feedback is captured and user interface design is intuitive (See various actions under Action Plan).

The Bureau's Aviation Webpage was not updated with GAF products during the cutover.

Recommendation: It is recommended that the Bureau's webpage be updated a day before the cutover otherwise a support person should be available to rectify any issues related to the webpage for any major changes of this nature.

Communication	Some customers felt that they were not adequately consulted or communicated which resulted in lack of awareness of GAF changes. **Recommendation:** All members of the working group should ensure the information about the changes are adequately communicated and all the relevant customers are adequately consulted early during the change lifecycle.
User Education Strategy	The Bureau made the GAF FAQ (Frequently Asked Questions) document available on the GAF webpage, however, this was not well advertised. **Recommendation:** It is recommended that educations material is developed and made available well in advance.
Products	GAF WG Post Implementation Review and customer feedback highlighted difficulties in understanding the following: • use of sub-areas in GAFs; • lack of reference in GPWT Forecasts; • using GPWT Forecasts. **Recommendation**: It is recommended to update the GAF User Guide to include more detail on sub areas and to create GPWT/PCA reference charts for all low-level regional domains (refer to various actions under Action Plan)

Table 3: Summary of lessons learned ad recommendations

6   Action Plan

The GAF WG PIR identified a number of Action Items to ensure that issues identified with the GAF Implementation are resolved and that recommendations from lessons learned are implemented in an effective manner. The Action Items are outlined in Table 4 below.

A brief report on the PIR was presented to industry for comment at the Bureau-Industry Regional Aviation Weather Services Consultative meeting in February 2018. Since then, the Bureau and Airservices have completed the majority of the Action Items as outlined in the status column of the Table.

Most of the pending Action Items are related to NAIPS changes. These items will be actioned as part of the BoM/Airservices Technical Sub-Group (BoM/AsA TSG) meetings and reported on at future Bureau-Industry Regional Aviation Weather Services Consultative meetings.

6.1   Action Items from the GAF PIR Meeting

Action Items

Reference	Action Item	Organisation Responsible	Status
PIR-1	Airservices to change default validity of area briefing in NAIPS to 6 hours	Airservices Australia	Complete
PIR-2	Airservices to change default chart variant in NAIPS area briefing to hi-res PNG	Airservices Australia	Complete
PIR-3	Bureau to investigate why PDF is a larger file size than the PNG	Bureau of Meteorology	Complete
PIR-4	Airservices to remove the sub menu and direct display PDF charts	Airservices Australia	Complete
PIR-5	Airservices to make GPWT XML available to data service providers beyond 24 hours	Airservices Australia	Complete
PIR-6	Airservices to alter information presented in the chart directory as per the presentation	Airservices Australia	Partially Complete
PIR-7	Airservices to change the order of charts as presented in briefing	Airservices Australia	In progress
PIR-8	Airservices to form a technical working group to discuss changes to NAIPS briefing page, including displaying GAF and GPWT Charts with OPMET	Airservices Australia	This is now handled by BoM/AsA TSG Meeting
PIR-9	Bureau to create GPWT/PCA reference charts for all low level regional domains	Bureau of Meteorology	Complete

PIR-10	Bureau to publish GPWT/PCA reference charts on Bureau website, GAF User Guide and ERSA	Bureau of Meteorology	Complete
PIR-11	Airservices to include GPWT/PCA reference charts in NAIPS chart directory	Airservices Australia	Complete
PIR-12	Bureau to update Metro briefings to include GAF and GPWT	Bureau of Meteorology	Complete
PIR-13	Bureau and Airservices to investigate resolution of GAF images (check clarity of PCA locations)	Airservices Australia and Bureau of Meteorology	Complete
PIR-14	Bureau to update GAF FAQ's to include NCC as the first point of contact for NAIPS issues	Bureau of Meteorology	Pending
PIR-15	Bureau to update GAF User Guide with the suggested changes	Bureau of Meteorology	Complete
PIR-16	Refer any GAF related changes to NAIPS to BoM/Airservices Technical Sub group Meeting	Airservices Australia and Bureau of Meteorology	Referred
PIR-17	Refer any further enhancement(s) to GAF and other related products to BoM/Industry Consultative Meeting	Bureau of Meteorology	Referred

Table 4: Action Items from GAF PIR