Regional Hazardous Weather Advisory Centres (RHWACs)

The following outlines the criteria for the selection of RHWACs based on operational and functional requirements

1.   Basic Principles

The RHWAC must:

- Understand the safety and requirements of aviation users, such as meteorological watch offices (MWOs), airlines and air traffic management, and to the States involved in respect of en-route hazardous weather information;
- Ensure maximum operational cost-effectiveness;
- Ensure the provision of accurate and timely en-route hazardous weather information;
- Ensure sustainable operations;
- Establish effective coordination with States, within the area of responsibility (AOR), and with other RHWACs.

2.   Technical Requirements

The technical requirements and evidences which are to be considered in the selection of a RHWAC are listed below. Each RHWAC is required to meet these requirements in its AOR.

Operational Requirements	Functional Requirements	Selection Considerations	Performance Requirement (Evidence) *Note: detailed values are pending.*
2.1 Monitor the hazardous weather conditions to see if the criteria established in Annex 3 is met	**2.1.1 Data collection, processing and Analysis**		

	(1) Real-time satellite imagery, including advanced satellite enhancements: - Obtain and utilize satellite data with high spatial and temporal resolution to ensure the issuance of hazardous information has sufficient accuracy and lead time	(a) Satellite data with high spatial and temporal resolution is available and utilized for the RHWAC AOR; and	a.1 Resolution of satellite imageries - Geostationary: - Visible : < 2km - IR : 5 km - No. of channels : at least 4 Polar-orbiting: - Visible : < 2km - IR : < 2km - No. of channels : at least 4 a.2 Temporal resolution : Geostationary: at least 30 min Polar-orbiting : twice a day
		Desirable capability: *- The capability to arrange for rapid scan of satellite imageries*	*Desirable capability:* *Rapid scan : $\leqslant$ 10 min*
		(b) Products using analytically processed satellite data suitable for aviation weather forecasting are available and further developed as new technology/science becomes available.	Examples of such products: - automatic convective cloud identification; - potential turbulence area using water vapour channel; - multi-channel satellite icing product; - sand/dust identification using split channel/IDDI;

		(c) Experience with satellite data analysis for aviation weather forecasting.	
		(d) Forecasters are competent in the use of satellite data analysis, products and systems.	

	(2) Real-time Radar and lightning data:
	  - obtain and utilize radar and lightning data with high spatial and temporal resolution to ensure the issuance of hazardous information has sufficient accuracy and lead time
		(a) Radar and lightning data with high spatial and temporal resolution for its AOR, where available, is utilized; and
		
		Desirable capability:
		  - *Access to available radar and lightning data within the RHWAC AOR*
			Real-time display of radar and lightning data.

		(b) Products using analytically processed radar (in 3D) and lightning data suitable for aviation weather forecasting are available and further developed as new technology/science becomes available.	Examples of such products: - Snow band - Hydrometeor identification from polarimetric weather radar - 3D lightning location
		(c) Experience with radar and lightning data analysis for aviation weather forecasting.	
		(d) Forecasters are competent in the use of radar and lightning data analysis, products and systems.	

	(3) Surface observations (including SYNOP and METAR/SPECI): - Obtain and utilize surface observations with high spatial and temporal resolution to ensure the issuance of hazardous information has sufficient accuracy and lead time.	(a) Surface observations for its AOR, where available, is utilized; *Desirable capability:* - *Access to additional surface observations via a bilateral/sub-regional agreement*	Real-time display of internationally exchanged surface observation for its AOR including : - METAR/SPECI; - SYNOP
		(b) Experience with surface observation data analysis for aviation weather forecasting; and	
		(c) Forecasters are competent in the use of surface observation data analysis, products and systems.	
	(4) Aircraft observations such as AMDAR (including EDR and humidity if available), AIREP and Special AIREP: - Obtain and utilize aircraft observations with high spatial and temporal resolution to ensure the issuance of hazardous information has sufficient accuracy and lead time.	(a) Aircraft observations with high spatial and temporal resolution are available and utilized; *Desirable capability:* - *Access to additional aircraft observations via a bilateral/sub-regional agreement or arrangement with airlines*	Access to internationally exchanged aircraft observations within the RHWAC AOR
		(b) Experience with aircraft observation data analysis for aviation weather forecasting; and	

		(c) Forecasters are competent in the use of aircraft observation data analysis, products and systems.	
	(5) Upper air observations (including, satellite winds, wind profiler data, radiosonde and upper wind data): - Obtain and utilize upper air observations with high spatial and temporal resolution to ensure the issuance of hazardous information has sufficient accuracy and lead time	(a) Upper air observations with high spatial and temporal resolution are available and utilized; *Desirable capability:* *- Access to additional upper air observations via a bilateral/sub-regional agreement*	Access to internationally available upper air observations within the RHWAC AOR.
		(b) Experience with upper air observation data analysis for aviation weather forecasting; and	
		(c) Forecasters are competent in the use of upper air observation data analysis, products and systems.	
	(6) Routine synoptic and mesoscale analysis of latest weather (e.g. identifying the potential area of CB cloud/TS development)	(a) Visualisation of the data from the various sources listed above; *Desirable capability:* *- Integrated data display system is available to facilitate forecaster to assimilate the various data sets;*	Real-time display of the data from the various sources listed above

		(b) Routine synoptic and mesoscale analysis of latest weather are produced; and	Routine analysis : every 3 hourly
		Desirable capability: *- Rapid Update Cycle analysis is available to assimilate the various data sets;*	*Desirable capability:* *- Rapid Update Cycle analysis : every hourly;*
		(c) Experience in the development and operation of NWP products for aviation weather forecasting (e.g. Indices for clear air turbulence, such as Ellrod Index).	
2.2 Prepare the advisory	**2.2.1 Forecast the future intensity, location and extent of the hazardous weather condition**		
	(1) Climatological data within the AOR: - Forecasters understand weather characteristics and future development of weather systems	(a) Good understanding of climatological characteristics and statistical materials for weather characteristics within the AOR are available and utilized.	Availability of statistical materials for weather characteristics within the AOR

	(2) World Area Forecast Centre products (including SIGWX and GRIB2):
	  - Obtain and utilize WAFC products (including SIGWX and GRIB2)
		(a) World Area Forecast Centre products (including SIGWX and GRIB2) are available and utilized.
		
		Desirable capability:
		  - Access to both WAFC London and Washington products as backup
			a.1 Access to WAFC Provider products; and
			a.2 Display systems for the forecasters to utilize the WAFC products.

	(3) Numerical Weather Prediction (NWP) products (including global and regional NWP):
	  - Obtain and utilize highly accurate and state-of-the-art numerical weather prediction (NWP) models to ensure the issuance of RHWAs with sufficient accuracy and lead time;
		(a) Accurate and high resolution NWP model is available and utilized;	a.1 Horizontal resolution : order of 10 km
			Vertical resolution : 50 levels
			
			a.2 Initial time: 12-hourly
			
			Desirable capability: 3-hourly
			
			a.3 Accuracy :
			  - 500 hPa 24-hour forecast RMSE: < 15 gpm
			  -

		(b) Post-processing of NWP data to provide a variety of products specialized for aviation weather forecasting are available and utilized; and	Examples of such products: - EDR or turbulence indices; - Icing indices; - K, CAPE, or other thermodynamic indices
		(c) Experience in the development and operation of NWP products for aviation weather forecasting (e.g. Indices for clear air turbulence).	

	(4) Forecasting of hazardous meteorological conditions (e.g. identifying the potential area of CB cloud/TS development)	*Desirable capability:* *- Satellite and radar-based nowcasting systems to support the forecasting of future development of hazardous meteorological conditions;* *- Forecast support system to display the meteorological observations, forecasts (e.g. from NWP and nowcasting systems), as well as advisories and warnings in effect.*	
	2.2.2 Harmonize the forecast with neighbouring MWOs or advisory centers		
	(1) Coordinate with other RHWACs and MWOs within the AOR to ensure forecast consistency within the AOR and across boundaries (i.e. harmonize the location, intensity and extent of the hazardous weather):	(a) Procedures and experience of effective coordination with other centres or with MWOs within the AOR; *Desirable capability:* *- A system to assist with the harmonization of SIGMETs/Advisories across FIR or RHWAC boundaries is desirable*	Examples of such experience: - Operational experience of regional centre services such as VAAC, TCAC, RSMC, TCWC; - Involvement in regional/international MET projects; and - Multilateral arrangement to provide SIGMET for other MWOs.

		(b) Good command of language of its forecasters for communication with MWOs within the AOR and with other RHWACs; and	Examples of such competency: - all forecasters are proficient in spoken English (or other languages commonly used in the States within the AOR)
		(c) Forecast support products used for making advisories are shared to advisory users.	Example of such capability: - Good user feedback of website used to display the other aviation products;
	(2) Ensure MWOs within the AOR understand the prognostic reasoning of the advisories (e.g. provide support products for the advisories)	(a) Provision of training for MWOs in the region.	Examples of assistance for MWOs in the AOR : - Well-established training centre or training programme for MWOs in the AOR; - Involvement in guidance materials, such as pamphlets, to support MWOs in the issuance of SIGMET - Other experience and plans for technical/scientific support for other States;
	2.2.3 Encode the advisory in accordance with Annex 3 provision		

	(1) Prepare textual and digital (XML/GML) advisories	(a) Forecast preparation system to support the forecaster to prepare the textual advisories in an efficient manner;	Forecast preparation system for preparation of the textual advisories in place
		(b) Capability to encode and decode the advisory in digital (IWXXM) format; and	Examples of similar capability: - encode and decode SIGMET and or METAR/SPECI and TAF in digital (IWXXM) format
		(c) Automatic error checking to ensure the correctness of the message.	Automatic error checking system in place
	(2) Prepare graphical advisories in accordance with the textual advisories	(a) Forecast preparation system to support the forecaster to prepare the graphical advisories;	Forecast preparation system for preparation of the graphical advisories in place; *Desirable capability:* *- Forecast preparation system to automatically generate the graphical advisories based on digital advisory*
2.3 Issue the advisory	**2.3.1 Disseminate the advisory in textual format to MWOs, RODBs, WAFC Provider States…**		
		(a) System to disseminate advisories and related products via AFS; and	

		(b) Arrangement with RODB.	
	2.3.2 Disseminate the advisory in digital format to MWOs, RODB(?), WAFC Provider States…	(a) System to disseminate advisories and related products via AMHS with extended service.	System to disseminate advisories and related products via AMHS with extended service in place
	2.3.3 Provide the advisory in graphical format		
	(1) Host a webpage to display the graphical advisory messages, in compliance with the Guidelines on the Use of the Public Internet in Aeronautical Applications (ICAO Doc 9855)	(a) Capability of preparing and hosting a website to display the advisory messages graphically.	Example of such capability: - of website used to display the other aviation products;
2.4 Update the advisory	**2.4.1 Update the advisory**		

	(1) Update the advisory within appropriate time especially when special air-report is received and the phenomenon is expected to continue	(a) Facilities to assist the forecaster to analyse the meteorological conditions efficiently to decide if the phenomenon is expected to continue; and	The facilities discussed in 2.1 – 2.2 above. *Desirable capability:* *- Integrated data display system is available to facilitate forecaster to quick assess the future development of the weather systems;* *- Rapid-cycle NWP models to provide updated forecast based on new observations*
		(b) Facilities to assist the forecaster to update the hazardous meteorological information.	The facilities discussed in 2.3 above.
2.5 Verify the advisory	**2.5.1 Verify the advisories for en-route hazardous weather**		
	(1) Conduct regular objective verification, where possible, of the advisories for en-route hazardous weather	(a) The performance of the RHWA is objectively assessed on a regular basis.	Comprehensive objective verification system is available for verification of advisory using observation data (e.g. special air-reports, satellite data etc.)
	(2) Conduct validation (including regular and post-event analysis) of the advisories for en-route hazardous weather	(a) The performance of the RHWA is objectively assessed for major events; and	*Desirable capability:* *- Arrangement to obtain flight data for post-event analysis*

		(b) The performance of the RHWA is subjectively assessed on a regular basis.	Regular framework to obtain user feedback (e.g. regular coordination meeting, user forum) is in place
	(3) Publish the verification and validation results for information of users	(a) Reporting mechanism to feedback results to users.	Regular framework to feedback information to users (e.g. regular coordination meeting, user forum) is in place

3.   Institutional Requirements

Performance Requirements	Selection Considerations (Evidence)
3.1.1 Be able to provide information on a 24/7 basis	(a) Good and reliable service as MWO; (b) Backup arrangements for RHWAC; (c) Good and reliable international/regional (e.g. VAAC, TCAC, TCWC, RSMC, WAFC); (d) Demonstrable good and reliable service during future SIGMET trials;
3.1.2 Implementation of QMS	(a) Well established QMS in compliant with ICAO Annex 3 for performance monitoring and continuous improvement. *Desirable capability:* *- QMS is ISO 9001 certified.*

3.1.3	Qualification of aeronautical meteorological personnel in compliance with WMO standards and practices	(a)	Aeronautical meteorological personnel qualified to WMO standards as specified in WMO-No.49 Technical Regulations and WMO-No.1083 - Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology, in particular, competency of aeronautical meteorological personnel in satellite, radar, surface and upper-air data analysis, use of aircraft data, WAFC and NWP products.
3.1.4	Competency of aeronautical meteorological personnel in compliance with WMO standards and practices	(a) (b)	Aeronautical meteorological personnel assessed as competent to WMO competency standards as specified in WMO-No.49 Technical Regulations; Continuous training programme for aeronautical meteorological personnel to upkeep the knowledge of the aeronautical meteorological personnel
3.1.5	Sustainability of operations of the RHWAC	(a) (b)	Sufficient resources (e.g. sufficient number of qualified staff, budget and systems) for sustainable development and operation of regional centre services; Equitable cost recovery system in place (where it is implemented);

4. User-oriented Requirements

User Requirements	Selection Considerations (Evidence)
4.1.1 Cost effectiveness of the RHWAC	(a) Cost implications to downstream users (where equitable cost recovery system is implemented); e.g. minimizing cost for MWOs to provide SIGMETs using advisories.
4.1.2 Seamless information to users	(a) Simple shape of AOR to minimize difficulty in cross-boundary coordination (b) Boundaries of AOR should preferably not cut cross major high air traffic density areas; e.g. "Major Traffic Flows" in APAC Region are designated in APAC eANP.