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 economic benefits to aviation users, such as meteorological watch offices (MWOs), airlines and air traffic management, and to the States involved;
- Ensure maximum operational cost-effectiveness;
- Ensure the provision of accurate and timely advisory 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 (Evidence)
2.1	**Data collection, processing and Analysis**		
2.1.1	Real-time satellite imagery, including advanced satellite enhancements	(a) Obtain and utilize satellite data with high spatial and temporal resolution to ensure the issuance of advisory information has sufficient accuracy and lead time; and (b) Experience with satellite data analysis for	(a) Satellite data with high spatial and temporal resolution is available and utilized (i.e. Access to high resolution satellite multi-channels imageries for the RHWAC AOR with an update rate of 30 minutes or less; (b) Products using analytically processed satellite

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	aviation weather forecasting.	data suitable for aviation weather forecasting are available and further developed as new technology/science becomes available, including advanced products such as automatic convective cloud, cloud top, and hot tower detection; and (c) Forecasters are competent in the use of satellite data analysis, products and systems. *Desirable Option:* *- The capability to arrange for rapid scan of satellite imageries*
2.1.2 Radar and lightning data	(a) Obtain and utilize radar and lightning data with high spatial and temporal resolution to ensure the issuance of advisory information has sufficient accuracy and lead time; and (b) Experience with radar and lightning data analysis for aviation weather forecasting.	(a) Radar and lightning data is available and utilized; (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; and (c) Forecasters are competent in the use of radar and lightning data analysis, products and systems. *Desirable Option:* *- Radar and lightning data with high spatial and temporal resolution* *- Access to radar and lightning data within the RHWAC AOR*
2.1.3 Surface observations (including SYNOP and METAR/SPECI)	(a) Obtain and utilize surface observations with high spatial and temporal resolution to ensure the issuance of advisory information has sufficient accuracy and	(a) Surface observations are available and utilized; (b) Access to internationally available surface observations, as a minimum METAR/SPECI and SYNOP; and

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Operational Requirements	Functional Requirements	Selection Considerations (Evidence)
	lead time; and (b) Experience with surface observation data analysis for aviation weather forecasting.	(c) Forecasters are competent in the use of surface observation analysis, products and systems. *Desirable Option:* *- Surface observations with high spatial and temporal resolution* *- Access to additional surface observations via a bilateral/sub-regional agreement*
2.1.4 Aircraft observations (AIREP and Special AIREP)	(a) Obtain and utilize aircraft observations with high spatial and temporal resolution to ensure the issuance of advisory information has sufficient accuracy and lead time; and (b) Experience with aircraft observation data analysis for aviation weather forecasting.	(a) Aircraft observations with high spatial and temporal resolution are available and utilized; (b) Access to internationally available aircraft observations within the RHWAC AOR); and (c) Forecasters are competent in the use of aircraft observation analysis, products and systems.
2.1.5 Upper air observations (including AMDAR (including EDR and humidity if available), satellite winds, wind profiler data, radiosonde and upper wind data)	(a) Obtain and utilize upper air observations with high spatial and temporal resolution to ensure the issuance of advisory information has sufficient accuracy and lead time; and (b) Experience with upper air observation data analysis for aviation weather forecasting.	(a) Upper air observations with high spatial and temporal resolution are available and utilized; (b) Access to internationally available upper air observations within the RHWAC AOR; and (c) Forecasters are competent in the use of upper air observation analysis, products and systems. *Desirable Option:* *- Access to additional upper air observations via a bilateral/sub-regional agreement*
2.1.6 Numerical Weather Prediction (NWP) products (including global and regional NWP)	(a) Obtain and utilize high accurate and state-of-the-art numerical weather prediction (NWP) models to ensure the issuance of RHWAs with sufficient	(a) Accurate and high resolution NWP model is utilized for AOR; (b) Variety of NWP products specialized for aviation weather forecasting are operational and/or being

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Operational Requirements	Functional Requirements	Selection Considerations (Evidence)
	accuracy and lead time; and (b) Experience in the development and operation of NWP products for aviation weather forecasting (e.g. Indices for clear air turbulence, such as Ellrod Index).	developed; and (c) Forecasters can utilize the products using NWP display system.
2.1.7 World Area Forecast Centre products (including SIGWX and GRIB2)	(a) Obtain and utilize WAFC products (including SIGWX and GRIB2).	(a) Display systems for the forecasters to utilize the WAFC products (including SIGWX and GRIB2) with using display system. (b) Forecasters are competent in the use of WAFS products.
2.1.8 Climatological data within the AOR	(a) Forecasters understand weather characteristics.	(a) Statistical materials for weather characteristics within the AOR; and (b) Forecasters can utilize the statistical materials.
2.2 Forecasting		
2.2.1 The ability to monitor and analyse the meteorological observations, forecasts and warnings	(a) Ingestion and visualisation of meteorological observations, forecasts and warnings in real-time.	(a) Forecast support system to display the meteorological observations, forecasts and warnings; and (b) Routine synoptic and mesoscale analysis of latest weather (e.g. identifying the potential area of CB cloud/TS development).
2.2.2 The ability to produce both textual and graphical advisories	(a) Prepare textual advisories; (b) Generate graphical advisories in accordance with the textual advisories; (c) Issue advisories in appropriate timing.	(a) Forecast support system to prepare the textual advisories and generate the graphical advisories in timely manner; (b) Error checking system in place.
2.2.3 High resolution, well developed and accurate forecast capability for selected en-route hazardous weather	(a) Monitor and analyze observational data (e.g. satellite imageries, radar and lightning data) and NWP model outputs in a timely manner;	(a) Areas based on satellite imageries and NWP outputs; (b) Access to and real-time visualization of SIGMETs and Advisories

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Operational Requirements	Functional Requirements	Selection Considerations (Evidence)
phenomena using a range of techniques and integrated systems (i.e. NWP, satellite, radar)	(b) Monitor related SIGMETs/Advisories from FIRs within the area of responsibility of the regional centre or advisory centres; (c) Provide forecast at pre-defined time interval; (d) Update forecast if there is a significant change of the situation; and (e) Maintain weather watch.	(c) Climatology of weather phenomena in the area of responsibility; (d) Development and operation of highly accurate high resolution NWP model; (e) Availability of satellite and radar-based nowcasting systems; (f) Guidance and manual for forecast / analysis are developed *(g)* Expert system to support the monitoring of change; and (h) Guidance and manual for forecast / analysis are developed. *Desirable Option:* *- Availability of EPS NWP probabilistic forecast* *- Probabilistic objective guidance (e.g. exceedance likelihood of icing indices) based on mesoscale EPS output* *- Rapid-cycle NWP models to provide updated forecast based on new observations*
2.2.4 International collaboration and coordination with States within the AOR and with other RHWACs	(a) 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); and (b) Ensure MWOs within the AOR understand the prognostic reasoning of the advisories (e.g. provide support products for the	(a) Procedures and experience of effective coordination with other centres or with MWOs within the AOR (e.g. Operational experience of regional centre services such as VAAC, TCAC, TCWC, RSMC); (b) Good command of language of its forecasters for communication with States within the region and with other RHWACs; (c) Forecast support products used for making

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		advisories).	advisories are shared to advisory users; and (d) Involvement in regional/international MET projects. *Desirable Option:* *- A system to assist with the harmonization of SIGMETs/Advisories across FIR or RHWAC boundaries is desirable*
2.2.5	Automatic hazardous weather alerting systems	(a) Automatically alerting for the forecasters on the occurrence of hazardous weather phenomena.	(a) Automatic alerting system for hazardous weather implemented.
2.3	**Verification**		
2.3.1	Regular and comprehensive verification and validation for advisories for en-route hazardous weather information	(a) Regular and comprehensive verification techniques and systems; (b) Regular and comprehensive verification and validation for advisories (including post-event analysis); and (c) Publish the results of verification and validation.	(a) Advisories are verified and validated regularly using observation data (e.g. special air-reports, METAR and satellite data); and (b) Results of verification and validation are published.
2.3.2	Assessment and verification by MWOs and aviation users (e.g. IATA, IFALPA, CANSO)	(a) Regular framework to obtain user feedback	(a) Regular framework to obtain user feedback (e.g. regular coordination meeting, user forum); and (b) Feedback results.
2.3.3	On-going research and development	(a) Reflect the results of verification and validation to improvement of RHWA accuracy continuously; and (b) Verify the products used to make RHWAs, such as NWP products.	(a) Report on progress and future plan.
2.4	**Communications**		
2.4.1	Reliable meteorological data	(a) System to collect observational data,	(a) Status of dissemination and receipt of OPMET

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acquisition and dissemination systems	special air-report, OPMET, WAFS etc. for the RHWAC AOR on a real-time basis.	information, SIGMET, VAA and TCA etc.; and (b) Operational experience of data centre and monitoring.
2.4.2 The means of disseminating the products via the aeronautical fixed service (AFS), including the AMHS, ATFN and the internet	(a) Disseminate the advisory to RODBs, MWOs, WAFC Provider States and users, such as airlines, on real-time basis.	(a) System to disseminate advisories and related products via AFS.
2.4.3 Establish an operational web-based site that allows access to all authorized users	(a) Host a webpage to display advisories and related products, 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 show the advisories and related products.

3. Institutional Requirements

Operational Requirements	Functional Requirements	Selection Considerations (Evidence)
3.1 Resource management		
3.1.1 Well established ability to manage RHWAC operations on a 24/7 basis	(a) Ensure sustainable operation of RHWAC on 24/7 basis.	(a) Experience in the successful operation of an international centre (e.g. VAAC, TCAC, TCWC, RSMC, WAFC).
3.1.2 A sustainable cost-recovery mechanism	(a) Ensure sustainable cost-recovery.	(a) Equitable cost recovery system in place (or can be implemented); and (b) RHWAC demonstrates a cost effective solution for the provision of advisory information.
3.1.3 The capability and resources for sustainable operations of the RHWAC	(a) Sufficient number of qualified and competent staff to continue RHWAC services;	(a) Sufficient resources (e.g. sufficient number of qualified staff, budget and systems) for sustainable development and operation of

Operational Requirements		Functional Requirements	Selection Considerations (Evidence)
		(b) Support systems (communications, administration, IT, management etc) in place; and (c) Back-up procedures in case of disasters or outages.	regional centre services; and (b) Back-up procedures for the RHWAC is established and regularly tested.
3.2	**QMS, qualifications, competencies and training**		
3.2.1	Implementation of a quality management system	(a) Implementation of a quality management system.	(a) QMS in compliant with ICAO Annex 3 implemented for performance monitoring and continuous improvement; and (b) Provide quality information in management reports.
3.2.2	Qualifications of meteorological personnel to WMO standards and practices	(a) Clear specification of required qualifications for meteorologists (BIP-M) and meteorological technicians (BIP-MT) as outlined in WMO-No.49 Technical Regulations and WMO-No.1083 - Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology.	(a) Aeronautical meteorological personnel qualified to WMO standards.
3.2.3	A competency-based system, including training and assessment for meteorological personnel	(a) Competency program in place for meteorological personnel, as per WMO Aeronautical Meteorological Personnel Competency Standards and Implementation Guidance of Aeronautical Meteorological Observer Competency Standards (b) Formal training exercises including distance learning and on-the-job-training; and	(a) Aeronautical meteorological training and assessment programme established; (b) Assessment documents; (c) Operational experience for regional service (e.g. VAAC, TCAC, RSMC); and (d) Command of language of its forecasters for verbal and written communication. (e) Aeronautical meteorological personnel considered competency as per WMO standards.

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	(c) Regular assessment of the currency and competence of personnel through an established and documented assessment system based on external and internal assessors, assessing methods and supervisor checks	
3.2.4 Experience in technical support and training for States in the AOR	(a) Provide technical support and training for States in the region including development of training materials; and (b) Follow up the outcome of training.	(a) Well-established training centre or training programme; (b) Guidance materials for forecast support products; (c) Experience and plans for technical/scientific support for other States; and (d) Education, training, test and competency evaluation for analysis and forecasting are conducted.
3.2.5 User liaison and training	(a) Ensure user liaison; and (b) Provide technical support and training to users (operators/pilots).	(a) User liaison mechanisms and response to user requests (b) Experience in preparation of training materials for users, such as on-line training materials, pamphlets, brochures.

4. User-oriented Requirements

Requirements	Explanation	Selection Considerations (Evidence)
4.1 User-oriented		
4.1.1 Boundary consistency with neighbouring RHWACs	*Desirable Option:* *- The AOR of a RHWAC should be one consecutive region without isolated areas* *- Complex boundaries should be avoided*	(a) Geographical proximity to States with deficiency *Desirable Option:* *- Isolated areas and complex boundaries of AORs*

Requirements	Explanation	Selection Considerations (Evidence)
		should be avoided as much as possible
4.1.2 Consideration of the maximum benefits and requirements of aviation users (e.g. geographical distribution and volume of international air traffic flow)	*Desirable Option:* *- The AOR of the RHWACs should be established to provide seamless information for safe flights.*	*Desirable Option:* *- Should be assessed by aviation users such as airlines*
4.1.3 Desirable Option: *- Not sever major traffic flows as much as possible, especially with very high density ones*	*Desirable Option:* *- "Very high density" traffic flows should not cross more than one RHWAC boundary.*	(a) e.g. "Major Traffic Flows" in APAC Region are designated in APAC eANP
4.1.3 Support for MWOs	*Desirable Option:* *- Hazardous weather advisories, in the first instance, should support MWOs in issuance of SIGMETs.*	*Desirable Option:* *- Should be assessed by in conjunction with input from MWOs*

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