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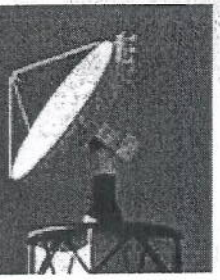
Radar Network &
Doppler Services Upgrade



Severe Thunderstorm Training Needs Analysis and Forecaster Competency Certification Plan for Queensland (2007/2008)

Background

As part of the Radar Network and Doppler Services Upgrade Project (RNDSUP), a process has been designed to ensure forecasters continue to add maximum value to severe thunderstorm forecasting, and to document the skills involved.

From analysis of forecaster operations, a set of skills and knowledge required for competent thunderstorm forecast and warning operations has been identified. The determination of both training needs and competency have been established on the basis of the Severe Thunderstorm Competencies (see Appendix I or http://bmtc.bom.gov.au/cdoe/rndsup/comp_docs/Unit%20of%20Competency%20Proforma%20BoM%20Units.pdf).

A certification plan for Severe Thunderstorm forecasters has been subsequently developed. The plan includes a training needs analysis, completion of identified training, and competency certification. Harald Richter, a RNDSUP BMTC trainer, will visit Brisbane between 19 November 2007 and 21 December 2007 to perform an initial round of certification. Those forecasters who staff the convective roster will be offered the opportunity to undertake the certification process in this first round. Should forecasters in the initial target group be unavailable during this period, they will be given priority in the next round. Other forecasters are also welcome to avail themselves of the BMTC trainer's personal guidance during his visit, as opportunities arise.

The certification of forecasters as competent has become increasingly important in recent years. Positive outcomes expected from the certification process are:

- The certification process provides trainers with an opportunity for feedback from the forecasters which allows the establishment of individual training needs. It therefore paves the way for a customised individual training plan. Such customised training is far more effective than "bulk training" given to a heterogeneously skilled group of trainees.
- Forecasters are under increasing pressure to demonstrate that they add value to the automated functions of forecast systems. Certification constitutes evidence that adequate efforts have been made to facilitate this outcome.

- The Bureau is under increasing pressure to demonstrate that its personnel are suitably competent. The certification process will provide the required documentation.
- As a result of the certification process it is expected that the consistency and overall quality of thunderstorm forecasts and warnings will increase thus providing greater benefit to the community.
- Competency certification provides a safeguard for forecasters and the Bureau in general in the event of future forecast failures. It would demonstrate that the Bureau has taken reasonable steps to minimise the likelihood of occurrence of such failures.
- Certification provides a meaningful contribution to individual performance reviews.
- More formally, the Bureau agreed to a need for competency-based assessments as part of the Pollock and Kimpel reports on the 14 April 1999 Sydney hailstorm (see Office Notice 70/718 of 30 March 2000). The Assistant Director Services (ADS) underlined this stance in a services circular found at http://web.bom.gov.au/spb/scirculars/sc70_49_03_06.shtml .
- This process also forms part of the Bureau's methods to reduce risk exposure.

Process

The most authentic way to assess a convective forecaster's ability to do the job is to observe the forecaster on the job. It is intended that the BMTC trainer will spend some time shadowing forecasters on the convective roster, and may undertake some solo shifts on the roster during his time in Qld. Should suitable severe thunderstorm events occur during the period, the option to undertake the process during a live event can be taken, though this will only occur if it does not interfere with operational requirements.

While some time may be spent with forecasters during the convective analysis process, opportunities to fully assess severe thunderstorm forecasting and warning processes are unlikely to arise in real-time for all target forecasters during the initial round of certification.

The best alternative for a reliable assessment is through a realistic simulation of actual job functions, or "simulation." The Displaced Real Time Simulator (DRTS) is a software system that is designed to fulfil that function. Supporting observations and model output, all accessible via a single web page, allows the forecaster to interrogate the pre-storm environment and produce a convective forecast. The simulator, which feeds radar and TIFS data as a function of its internal clocktime, then constitutes the primary tool for the regional and metro warning decisions for severe thunderstorms. Additional non-radar observations during the simulation period are accessible via a second web page. The Displaced Real Time Simulation should take approximately 3-4 hours, and opportunities to undertake the simulation will be provided during project shifts or by other agreed arrangements.

At the end of the assessment, the forecaster is found either competent or not yet competent. In the latter case, the assessor will point the candidate to a customised training program at the end of which the forecaster repeats the assessment, until found fully competent.

Forecasters assessed as competent will be awarded a certificate of competency.

What will be assessed?

The short answer is "whatever it takes to do the job on the Queensland convective roster." More specifically, the scope of this assessment involves the ability to

- Forecast the areal distribution of thunderstorms and severe thunderstorms out to two days lead time.
- Issue thunderstorm forecasts using the Thunderstorm Interactive Forecast Preparation System (TIFS).
- Confidently predict the evolution past severe threshold criteria of existing deep convection outside the Brisbane Metro Warning area and issue required regional severe thunderstorm warning using TIFS, in line with published policy guidelines (see http:// link to WOSPB internal webpage).
- Recognise severe (or nearly severe) convection in the Brisbane Metro Warning area and issue required cell-based severe thunderstorm warnings using TIFS.
- Source all required data needed to define the storm environment and its time evolution.
- Use the radar data viewing software 3D-Rapic competently.

A detailed breakdown of all aspects of the thunderstorm forecast and warning process is included in the training needs analysis and competency assessment pro-forma below.

How do we ensure that this assessment adheres to a high standard?

Prior to the start of the assessment process, the initial drafts of this document are reviewed by several independent assessors. Only subject matter experts qualify as permissible reviewers.

Reviewer Name	Review Date
Roger Deslandes (BMTC)	07/11/2007
Bruce Gunn, Ann Farrel (QLDRO)	09/11/2007
Harald Richter (BMTC)	13/11/2007
Harald Richter (BMTC)	27/11/2007

After each individual assessment, constructive feedback from the candidate might be incorporated into the assessment plan/tool straight away.

Prerequisites

It is assumed that all forecasters involved in the assessment program have staffed the convective roster in the past, or have at least been fully trained to do so. No prior additional training should be required for participation in this assessment.

Privacy and Confidentiality

The assessment results will be recorded so that individual forecasters and/or the Bureau have the ability to demonstrate that a given forecaster is indeed competent. However, the

information gained from this assessment process will adhere to the Bureau's Privacy Policy, in accordance with the Privacy Act 1988. More information on this topic is available at www.privacy.gov.au .

It should be noted that, throughout the process, the BMTC trainer will make time available with forecasters to provide tailored guidance in areas of personal interest. This includes those already assessed as competent and those working through targetted skills and knowledge development, so additional time spent with the trainer should not imply any competency problems.

Appeals Procedure

Forecasters who disagree with the assessment result should lodge a formal appeal in writing to the Regional Weather Services Manager. This claim will then be reviewed by the Regional Weather Services Manager and the assessor and, if not resolved to the candidate's satisfaction, could lead to a new assessment by an independent assessor. Details regarding the Bureau's appeals procedure can be found in Clause 49 of the Bureau's Certified Agreement at http://web.bom.gov.au/mgt/mgtfunctions/personnel_industrial/industrial_rels/agreement/2006-08_Intranet/_Toc130107927.

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Severe Thunderstorm Training Needs Analysis and Forecaster Competency Certification Record

The checklist below constitutes the Bureau's thunderstorm competencies in an assessable format. All candidates who are certified through on-the-job observation or displaced realtime simulations will be checked against this list.

Full name of candidate: _____

Full name of assessor: _____

Date/s of assessment (DD/MM/YYYY): _____

Competency Element	Individual Performance Criteria	Y / N	Comments
Thunderstorm Forecasts			
Forecast potential Thunderstorm areas During forecast Period	• Analyse and forecast areal distribution of higher surface moisture • Take into account moisture depth as a measure for the potential to mix out the surface dewpoint • Determine and forecast areas of surface-based instability • Determine and forecast areas of elevated instability • Assess the sensitivity of soundings to perturbations in the surface parcel properties • Identify viable lifting mechanisms in areas of positive buoyancy (terrain; boundaries, vorticity maxima) • Determine the likelihood of surface initiation based on CIN and a realistic mixed-layer parcel • Ground-truth numerical models against current observations		
Forecast potential Severe thunderstorm Areas and Associated Severe weather During forecast period	• Analyse and forecast areas of sufficient deep layer shear for storm organisation • Recognise areas of overlap between high buoyancy and high deep layer shear • Recognise areas of likely pulse severe storms • Assess probability for damaging winds based on environmental criteria (shear, downdraft potential, midlevel wind speeds) • Assess probability for large hail based on environmental criteria (CAPE through hail growth layer, shear, wet bulb freezing level) • Assess probability for flash-flood producing rain (high RH sounding, light steering flow, anticipated storm intensity) • Assess probability for supercell tornadoes (low-level hodograph, high boundary layer humidity, supercell environment)		
Contribute to	• Ability to create three-level graphic		

Forecast policy And issue Thunderstorm forecasts	(storms likely/severe and severe storms likely) in TIFS • Ability to write a concise, grammatically correct and readable forecast discussion in TIFS		
Severe Thunderstorm Warnings			
Analyse detected Thunderstorm or Developing thunderstorm	Monitoring Criteria • Proactive in setting up a statewide monitoring capability for deep convection through o 3D-Rapic Merged Mode or equivalent o Visible or (in the dark) IR satellite displays o GPATS lightning • Proactive in setting up a radar-specific monitoring mode (a CAPPI window) with the CAPPI set to the hail nomogram-supported height (or equivalent) • Monitoring of appropriate alerts (mainly wind gust alerts) Specific Regional Warning Criteria • Ability to detect deep convection with the potential to become severe (i.e. embedded in a severe-supporting storm environment) via radar, visible satellite, lightning or otherwise • Outside radar range, recognition of satellite-based severity signatures (V-notch, overshooting tops and strong "head blocking") Radar reflectivity-based severity signatures: • tall or elevated 50 dBZ reflectivity core (past hail nomogram levels or equivalent) suggesting hail/wind • storm top displacement • persistent WER/BWER • tight low-level reflectivity gradient on inflow flank • forward-flank V-notch • very high absolute reflectivity • low-level hook echo suggesting supercellular nature • bowing segments suggesting damaging winds • TBSS identified on S-band radars suggesting large hail • Recognise slow cell motion and/or cell training as a flash flood alerter • WDSS MEHS indicating large hail – cross checked against base data Radar velocity-based storm severity signatures: • Ability to deal with poor quality velocity data (e.g., dual PRT unfolding errors) • Ability to deal with aliased velocity data • midlevel storm rotation including strength assessment through mesocyclone nomogram or otherwise • low-level storm rotation including strength assessment through mesocyclone nomogram or otherwise		

	• low-level storm rotation: establish link to potentially tornadogenic near-storm environments via the low-level hodograph and the boundary layer RH • storm top divergence • strong convergence below the updraft suggesting a sustained or intensifying updraft • strong rear-inflow jets suggesting damaging surface winds • damaging wind measurements close to the surface • mid-level convergence as a short fuse downburst precursor • low-level divergence as a downburst confirmation signature General radar-based severity assessment skills • Ability to asses spatial and temporal continuity (and time trends) of severity signatures • Ability to separate meteorologically significant radar severity signatures from transient and/or weak signatures • Ability to balance signature-based severity evidence for final warning decision • Have all data types and signatures been integrated to arrive at the final warning decisison (= balance of ALL available evidence)?		
Assess thunderstorm evolution and movement	Storm Motion Assessments • Determine cell motions using manual timing techniques or TITAN/WDSS-based motion vectors • Recognition of algorithm weakness in motion vector determination in cases of new cells or recent onset of cell propagation (anomalous storm motion) • Recognition of the onset of anomalous storm motion due to supercell processes (most often this equates to the timely recognition of left-movers)! Near-Storm Environmental Assessments • Update awareness of storm environment (surface) through ongoing surface analysis, satellite and radar • Particularly, awareness of surface boundaries with which storms under observation might interact throughout the relevant warning duration period • Update awareness of upper level storm environment through recent soundings, AMDARS, satellite, wind profiler information		
Formulate and disseminate thunderstorm warnings according to policy guidelines	• Ability to run TIFS in monitoring mode (using Auto-Refresh or frequent manual refresh operations) • Ability to switch TIFS into warning dissemination mode (disabling all refresh functions) • Remove all nonwarned cells from the TIFS display using the appropriate delete operation (the deletion "bin", via the cell property editor or VIL filtering) OR deletion of all cells with manual insertion		

	of new cells • Adjustment of cell size, location and shape • Adjustment of cell motion vectors • Drawing of suitable immediate threat areas • Adding of severe phenomena such as large hail, damaging winds, flash flooding and/or tornadoes • Appropriate severe phenomena included in the warning • In case of supercells, phenomena upgrade from damaging to destructive winds and addition of the "Very Dangerous Storm" tag (following local policy) • Editing of auto-generated text • Proofreading by a second person • Is the final warning graphic and text commensurate with the level of threat? • Product issue with appropriate address zones • Completion of required follow-up phone calls		

Assessor Report:

Candidate's Signature: _____

Assessor's Signature: _____

Date of Signatures (DD/MM/YYYY): _____

Assessment Schedule

Date	Candidate	Assessment Tool(s)	Potentially Available Candidates
19 Nov (Mon)			Tony Wedd (CR)
20 Nov (Tue)			Tony Wedd (CR)
21 Nov (Wed)			Jonty Hall (CR)
22 Nov (Thu)			Tony Auden (CR) **Jonty Hall (PS)**
23 Nov (Fri)	Tony Auden	08 Nov 2006 DRTS	Tony Auden (CR)
24 Nov (Sat)			Tony Wedd (CR)
25 Nov (Sun)			Tony Wedd (CR)
26 Nov (Mon)			Tony Auden (CR)
27 Nov (Tue)	Ivor Blockley		Tony Auden (CR)
28 Nov (Wed)	Craig Mitchell		Brett Harrison (CR)
29 Nov (Thu)			Tony Wedd (CR) **Brett Harrison (PS)**
30 Nov (Fri)	Samantha Taylor		Tony Wedd (CR)
1 Dec (Sat)			Tony Auden (CR)
2 Dec (Sun)			Tony Auden (CR)
3 Dec (Mon)	Jeff Callaghan		Tony Wedd (CR)
4 Dec (Tue)			Tony Wedd (CR)
5 Dec (Wed)	Bryan Rolstone		Brian Rolstone (CR)
6 Dec (Thu)	Peter Otto		Tony Auden (CR) **Brian Rolstone (PS)**
7 Dec (Fri)	Ben Annells		Tony Auden (CR)
8 Dec (Sat)			Tony Wedd (CR)
9 Dec (Sun)			Tony Wedd (CR)
10 Dec (Mon)	Jonty Hall		Tony Auden (CR)
11 Dec (Tue)			Tony Auden (CR)
12 Dec (Wed)	Vikash Prasad		Gavin Holcombe (CR)
13 Dec (Thu)	Gavin Holcombe		Tony Wedd (CR) **Gavin Holcombe (PS)**
14 Dec (Fri)	Tony Wedd		Tony Wedd (CR)
15 Dec (Sat)			Tony Auden (CR)
16 Dec (Sun)			Tony Auden (CR)
17 Dec (Mon)			Tony Wedd (CR)
18 Dec (Tue)			Tony Wedd (CR)
19 Dec (Wed)	Brett Harrison		Geoff Doueal (CR) **Peter Otto (PS)**
20 Dec (Thu)	Geoff Doueal		Tony Auden (CR) **Geoff Doueal (PS)**
21 Dec (Fri)			Tony Auden (CR)

CR = Convective Roster
PS = Project Shift

List of Candidates to be assessed:

SPOCs	a/SPOCs	SevWx
Ivor Blockley	Ben Annells	Tony Auden
Jeff Callaghan	Brett Harrison	Samantha Taylor
Geoff Doueal	Vikash Prasad	Tony Wedd
Manfred Greitschus	Bryan Rolstone	
Jonty Hall	Peter Otto	
Gavin Holcombe		
Craig Mitchell		

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Appendix I

VICTORIAN QUALIFICATIONS AUTHORITY

Unit 1	**Assess thunderstorm and severe thunderstorm potential**
Unit Descriptor	This unit describes the skill, knowledge and application required to assess the ability of the environment to support thunderstorms, severe thunderstorms and related severe weather within the Australian Bureau of Meteorology forecast period.
Pre-requisite Unit(s)	Candidates will have completed the Graduate Diploma in Meteorology awarded by the Bureau of Meteorology Training Centre (BMTC). They will have completed a period of supported on the job training and be employed within a Regional Forecast Centre (RFC).
Application of the Unit	Candidates must follow Regional Severe Thunderstorm Directives, Weather Services Handbook procedures and use a forecast preparation system such as the Australian Integrated Forecast System (AIFS) and the Thunderstorm Interactive Forecast-Preparation System (TIFS). The unit will be applied to all forecasters within the ABoM jurisdiction as an introductory and skills maintenance competency.

ELEMENT	PERFORMANCE CRITERIA
1 **Forecast potential thunderstorm areas during forecast period**	1.1 Areas of ***instability, moisture*** and ***upmotion*** are identified using observations and ***Numerical Weather Prediction (NWP)*** data. 1.2 ***Times*** and ***locations*** where they coexist are identified
2 **Forecast potential severe thunderstorm areas and associated**	2.1 Within areas that have the potential for thunderstorms identify areas of ***shear*** sufficient to support severe convection

	severe weather during forecast period	2.2 Based on specific pre-storm environmental characteristics, diagnose the environment's potential to support severe convective weather ***(large hail, damaging winds, tornadoes and heavy precipitation).***
3	**Contribute to forecast policy and issue thunderstorm forecasts**	3.1 ***Thunderstorm forecasts*** are ***discussed*** and confirmed with ***forecast team.***
		3.2 Agreed thunderstorm ***policy*** is released for region.
		3.3 Forecast ***disseminated*** to all ***clients.***

Key Competencies

The seven key competencies represent generic skills considered necessary for effective participation by an individual in the workplace. They have been customised to meet the requirements of this unit.

Key Competency	Example of Application	Performance Level
How are ideas and information communicated within this competency?	Communicating ideas and information relating to forecasts to forecast team and a range of clients such as media and emergency services.	3
How can information be collected, analysed and organised?	Collecting, analysing, organising and synthesizing a wide range of forecast information (observations and Numerical Weather Prediction Output) based on a range of conceptual models.	3
How are activities planned and organised?	Planning and accessing forecast information to meet weather conditions and expectations of clients.	3
How is team work used within this competency?	Follow policy and procedure and communicate relevant information to team members.	3
How are mathematical ideas and techniques used?	Use conceptual models relevant to forecast situations.	3

How are problem solving skills applied?	Identifying and solving problems and situations that arise during forecasting. For examples system / software failures and / or conflicting information.	3
How is use of technology applied?	Use complex forecast systems and software.	3

RANGE STATEMENT

Conditions that may impact on diagnoses and forecasts including the following:

- Climatology
- Knowledge of local conditions that are associated with severe thunderstorms
- Locations refer to those parts of a state that may be under threat from thunderstorms and severe thunderstorms
- Times typically refer to the zero to thirty six hour time frame
- Forecast products and clients will vary from region to region e.g., Thunderstorm Outlook, Significant Weather Outlook
- Limited coverage of high resolution NWP
- Forecast preparation systems / software
- The forecast team includes all operational forecasters in the Regional Forecast Centre
- Dissemination methods may include fax, web and telephone
- Clients may include all public safety and media agencies
- Policy refers to the general overarching guidance that ensures consistency between all individual forecast products

EVIDENCE GUIDE

Required skills and knowledge – all listed skills and knowledge are considered to be of equal importance

Candidates will be able to:
Analyse and forecast necessary conditions for:
Instability: e.g., Lifted Index (LI), Convective Available Potential Energy (CAPE), lapse rate, potential instability, Convective Inhibition (CIN)
Moisture: surface and mid-tropospheric dew points, moisture depth

Upmotion: Identify lifting mechanisms that may include orography, fronts, troughs, convergence lines, sea breeze fronts based on observations (e.g surface-based, radar, satellite

imagery) and assess NWP vertical motion fields.

Integrate the above through composite analysis/prognosis
Manual techniques, NWP or decision support tools

Forecast severe thunderstorm potential:

- Environmental buoyancy and shear profiles determine the environment's ability to support the following storm types:
- Severe multicell storms – controlling process: generation of new cells by cold pool / shear interactions
- Severe pulse updraft/downdraft storms: controlling process: buoyancy
- Severe squall-lines – controlling process: linear initiation mechanism and cold pool-shear interactions; mid-level wind structure
- Supercells: controlling process: updraft / deep-shear interactions

Forecast severe weather potential based on the environment's potential to support:

- Damaging winds: for example, assess downdraft strength and mid-level wind speed
- Tornadoes: for example, assess large values of low-level bulk shear.
- Hail: for example, assess updraft strength, storm-relative inflow and
- wet-bulb freezing level
- Heavy Convective Precipitation: for example, assess seasonally high values of precipitable water, significant warm cloud depth, high values of boundary layer moisture, expected slow cell speed, potential for repeated cell generation and slow cell movement over an area ("training")

Formulated thunderstorm forecast is presented to team members using a range of communication skills that include: listening, verbal / non-verbal and presentation skills.

Issue all thunderstorm forecasts through the Australian Integrated Forecasting System (AIFS) and/or the Thunderstorm Interactive Forecast-Preparation System (TIFS) and follow associated procedures as specified in regional directives

Context of and specific resources for assessment	Assessment to be undertaken by a qualified assessor following a period of supported on the job training. All assessment tools for this unit to be developed by the Bureau of Meteorology Training Centre (BMTC). Any modifications or changes to processes and tools to be approved by SRTD at BMTC. Assessment period for this unit is dependent on the weather situation, and the time allocation will be commensurate with the complexity thereof.

Method of assessment

Assessment will be against each of the performance criteria and skills and knowledge specified in the evidence guide and may be through the following:

- A severe thunderstorm case study (formative)
- Completion of online quizzes for confirmation of underpinning knowledge.(formative)
- On the job observation (summative) OR
- A displaced real-time scenario (summative). This option is suggested when severe thunderstorms are unlikely to occur during the assessment period.
- Can be assessed with Unit 2, Identify, assess and forecast thunderstorms and severe thunderstorms.

Unit 2	**Identify, assess and forecast thunderstorms and severe thunderstorms**
Unit Descriptor	This unit describes the skill, knowledge and application required to identify, assess and provide short-term forecasts of thunderstorms, severe thunderstorms and related severe weather. This process includes issuing thunderstorm and severe thunderstorm information and warnings.
Pre-requisite Unit(s)	Candidates will have completed the Graduate Diploma in Meteorology awarded by the Bureau of Meteorology Training Centre (BMTC). They will have completed a period of supported on the job training and be employed within a Regional Forecast Centre (RFC). Unit 1, Assess thunderstorm and severe thunderstorm potential, must be completed prior to the commencement of this unit. Candidates must follow Regional Severe Thunderstorm Directives, Weather Services Handbook procedures and use forecast preparation system such as the Australian Integrated Forecast System (AIFS) and the Thunderstorm Interactive Forecast-Preparation System (TIFS).
Application of the Unit	The unit will be applied to all weather forecasters within the ABoM jurisdiction as an introductory and skills maintenance competency.

ELEMENT	PERFORMANCE CRITERIA
1 **Analyse detected thunderstorm or developing thunderstorm**	1.1 Thunderstorm or developing thunderstorm is identified and consistency with expectations is assessed
	1.2 Thunderstorm ***features*** and ***trends*** are identified
	1.3 Likely ***severe weather phenomena*** are identified
	1.4 ***Type*** of thunderstorm and ***development stage*** are classified
2 **Forecast**	2.1 Thunderstorm intensity and ***development stage*** are forecast

thunderstorm evolution, movement and weather	2.2	***Thunderstorm track*** is forecast
	2.3	***Severe weather phenomena*** are forecast
3 **Formulate and disseminate thunderstorm forecast policy**	3.1	Severe thunderstorm ***warnings*** are prepared and issued
	3.2	Thunderstorm, severe thunderstorm and ***associated severe weather phenomena*** are incorporated into the public weather, marine and aviation forecasts as appropriate
	3.3	Clients are informed following procedures documented in ***local directives***

Key Competencies

The seven key competencies represent generic skills considered necessary for effective participation by an individual in the workplace. They have been customised to meet the requirements of this unit.

Key Competency	Example of Application	Performance Level
How are ideas and information communicated within this competency?	Communicating ideas and information relating to forecasts to forecast team and a range of clients such as media and emergency services.	3
How can information be collected, analysed and organised?	Collecting analysing, organising and synthesizing a wide range of forecast information (observations and Numerical Weather Prediction model output) based on a range of conceptual models.	3
How are activities planned and organised?	Planning and accessing forecast information to meet weather conditions and expectations of clients.	3
How is team work used within this competency?	Follow policy and procedure and communicate relevant information to team members.	3
How are mathematical ideas and techniques used?	Use conceptual models relevant to forecast situations.	3

How are problem solving skills applied?	Identifying and solving problems and situations that arise during forecasting. For example system / software failures and / or conflicting information.	3
How is use of technology applied?	Use complex forecast systems and software.	3

RANGE STATEMENT

Conditions that may impact on diagnoses and forecasts include the following:

- Radar characteristics (Doppler, wavelength, resolution, volumetric capability)
- Spatial and temporal observation coverage (e.g, - density of observations; types – e.g Profilers, aircraft observation (AMDAR) availability)
- Climatology
- Software packages (e.g. - Helindex, Hodotool, forecast preparation systems)
- Forecast products and clients will vary from region to region.
- Procedures documented in local directives may vary according to regional requirements.
- The forecast team includes all operational forecasters in the Regional Forecast Centre
- Dissemination methods may include fax, web and telephone
- Clients may include all public safety and media agencies
- Policy refers to the general overarching guidance that ensures consistency between all individual forecast products.

EVIDENCE GUIDE

Required skills and knowledge – all listed skills and knowledge are considered to be of equal importance

Candidates will be able to:
Identify and locate initiating convective clouds that have the potential to become severe:
Through observations (e.g. radar, lightning (GPATS) and/or satellite imagery).

Assess location, timing and movement against forecast policy and update if required.

Identify (severe) thunderstorm features:

- Using Automatic Weather station (AWS): heavy precipitation, wind gust etc
- Spotter observations of: (precipitation intensity, hail, wind gusts, wall cloud, tornadoes)
- Radar (for more detail see radar assessment sheet):
- Reflectivity based (e.g. echo intensity and height, elevated echoes, hook-echo, bounded weak echo region, anomalous storm motion

- Velocity based (e.g. rotation, convergence, divergence signatures)
- Satellite observations (overshooting tops, V-notch, longevity etc.)

Assign thunderstorm type (severe/non-severe) and stage of development if sufficient supporting evidence

For severe storms infer and/or diagnose severe weather:

Large hail, damaging/destructive winds, heavy precipitation capable of producing flash flooding, tornadoes from observations and in particular radar (radar base-data and derived products (e.g., the Warning Decision Support System (WDSS)).

Forecast thunderstorm trends:

Forecast severe thunderstorm intensity, stage of development and movement:

- Use manual techniques and/or employ conceptual models of thunderstorm type, life cycle and interaction of the thunderstorm with the environment.
- Use radar-based algorithms - TITAN, WDSS.

Forecast weather elements based on persistence and forecast of thunderstorm evolution.

Warning threat is communicated to team members using a range of communication skills that include: listening, verbal / non verbal and presentation skills.

Issue all necessary forecast products through AIFS and /or TIFS and follow procedures specified in regional directives

- Policy refers to the general overarching guidance that ensures consistency between all individual forecast products.

- A warning is a document consisting of text and possibly graphical elements. A warning communicates geographical areas under threat of severe convective weather over the next hour, including the time period over which this threat is expected to persist.

Context of and specific resources for assessment	Assessment to be undertaken by a qualified assessor following a period of supported on the job training. All assessment tools for this unit to be developed by the

Bureau of Meteorology Training Centre (BMTC). Any modifications or changes to processes and tools to be approved by SRTD at BMTC.

Assessment period for this unit is dependent on the weather situation and the time allocation will be commensurate with the complexity thereof.

Method of assessment

Assessment will be against each of the performance criteria and skills and knowledge specified in the evidence guide and may be through the following:

- A severe thunderstorm case study (formative)
- Completion of online quizzes for confirmation of underpinning knowledge (formative)
- On the job observation (summative) OR
- A displaced real-time scenario (summative). This option is suggested when severe thunderstorms are unlikely to occur during the assessment period.
- Can be assessed with Unit 1, Assess thunderstorm and severe thunderstorm potential.