Rural Training Center-Thailand Mobile Emergency Weather Station: Technical Paper

Sparky, the Batt-mobile
MEWS Capabilities

www.neighborhoodlink.com/org/rtcth E-mail: rtc2k5@gmail.com

Ready to Serve and Sustain Our Community.

You may post questions / comments to the Discussion area of our website

Sparky is the RTC-TH alternative energy demonstration vehicle and EmComm (emergency communications) vehicle. Part of Sparky's EmComm capability is MEWS (the Mobile Emergency Weather Station). This paper describes those capabilities.

Sparky, the Batt-mobile

Sparky would be deployed within a round-trip operating radius of 20 km from the main RTC-TH base of operations. This allows for about 50% reserve battery capacity to operate Emcomm equipment and still have enough battery power to return to base for recharging. The plan would be to deploy Sparky to pre-determined portable operating sites that are considered "safe sites", emergency shelter sites, or emergency helicopter landing zones. Provisioning plans call for 2 days for 2 people before returning to base for re-supply.

Most of Sparky's primary MEWS equipment is mounted on the above dash bracket. (L to R) Seiko weather station, Strike Alert lightning detector, barometric altimeter, magnetic compass, bi-axial tilt meter, GPS.

Redundancy is part of the planning for MEWS. Often advanced instruments require power from batteries or other electrical supply source. Backup systems begin with replacement power supply or manual systems using no electrical power. The aim is to select systems and backups enabling Sparky to continue providing Advanced level MEWS reports if a primary equipment item fails or is damaged. The bottom line, worst case scenario is to fall back to Basic level MEWS observations and reports which are capable of providing minimal emergency flight weather data.

Sparky's Advanced level MEWS primary and back-up systems				
Observation / Measurement			Primary	Back-up
1	Location		GPS	Topographic Map
	Date / Time		Seiko WF 100	Calendar, mechanical wrist watch
2	2.1 Air Temp (dry)		Kestrel 4500NV	Hygrometer
	2.2 Wet Bulb Temp			
	2.3 Temp difference			
	2.4 Relative Humidity			
	2.5 Dew Point Temp.			Hygrometer, Dew Pt. chart
	2.6 Heat Stress Index			Hygrometer, reference charts
	2.7Wind Chill Index			Dwyer wind gauge, Wind-chill chart
3	3.1	Ave wind speed		Dwyer wind gauge, Beaufort wind chart
		Gusts		
	3.2	Wind direction	Kestrel 4500 with wind vane accessory	Sparky roof mounted wind vane, magnetic compass
		Gust direction		
4	4.1 Cloud cover		Direct observation and Cloud cover reference chart	
	4.2 Cloud base height		Dew point calculation method	Cloud reference chart
	4.3 Cloud type		Direct observation and Cloud cover reference chart	
	4.4 Rainfall		Sparky roof mounted gauge	Ground/post mounted gauge
	4.5 Visual range		Pre-determined from map study	
	4.6 Severe weather		Strike Alert Lightning Detector	Flash / Boom estimation method
			Direct observation and Cloud type reference chart	

Summary of MEWS Advanced Equipment and Power Supply			
Equipment	Primary Power	Secondary Power	Manual Back-up
Garmin II GPS	(4) AA batteries	Spare batteries 12 VDC vehicle power	Map and Compass
Kestrel 4500NV	(2) AA batteries	Spare batteries	Dwyer Wind gauge, hygrometer, sling psychrometer
Seiko WF110 Forecaster	(4) AA batteries		Thermometer, hygrometer, altimeter, sundial, calendar, mechanical watch
Strike Alert Lightning Detector	(2) AAA batteries		Flash / Boom method

MEWS observations are not truly mobile (i.e. on the move). RTC-TH MEWS is actually a stop 'n park operation. The ability to relocate Sparky / MEWS gives flexibility to provide on-site weather data from a variety of sites in a disaster area. If Sparky cannot access the area, Basic MEWS observers could go in by foot, bicycle, and motorbike or even by raft or boat if needed.

Garmin II GPS Unit
Latitude, Longitude, Altitude, Date, Time, Azimuth

Back up: topographic maps ,mechanical wristwatch, magnetic compass

Seiko WX station
Time, Date, Dry Air Temp, Barometric trend, forecast graphic icons

Strike Alert lightning detector

Back up: hygrometer, altimeter: Dry and Wet bulb temperatures, relative barometric pressure changes, and reference charts

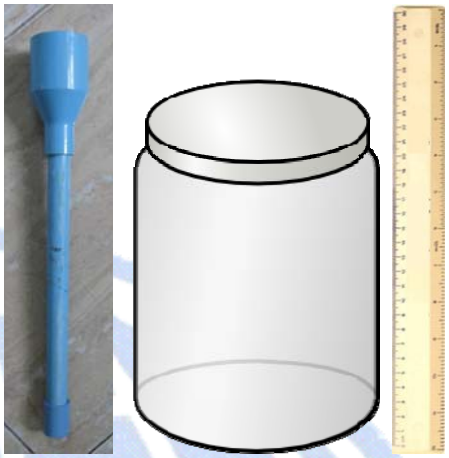
Kestrel 4500, a handheld portable fully integrated weather station

Back up: hygrometer, Dwyer wind gauge and various reference charts

Kestrel 4500 with wind vane accessory mounted

Back up: Roof mounted wind vane and compass

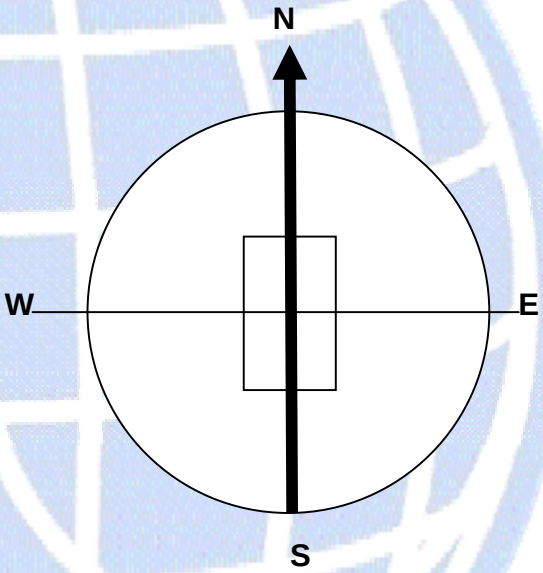
Roof mounted rain gauge



Back up: post mounted rain gauge or empty jar and ruler

Basic Vehicle Orientation for MEWS

Whenever possible, park Sparky pointed to the north when preparing to make MEWS observations. This makes it easier to determine wind directions when using the roof mounted wind vane. [**Note**: For frequent stop 'n park recon work, this will be faster than setting up the Kestrel 4500NV wind vane.]



Where to Stop 'n Park:

In order for MEWS observations to conform as closely as possible to meteorological standards, use the guidelines in the table below. MEWS is not a replacement for official government weather stations. The data provided are a supplement to official weather reports. The key advantage of MEWS is being on-site in the disaster area.

Stop 'n Park Guidelines	
Weather variable	Observation Site Guideline
Temperature Relative Humidity Heat Stress Rain Wind speed Wind direction	• Level area • standoff 4X height of tall trees/buildings • 30 m away from paved surfaces • Be surrounded by 9m of short grass or bare soil • Thermometer must be shaded

It is especially important to follow the guidelines as much as possible if operating in support of an emergency helicopter landing zone LZ. [***Note***: Rotor downwash can produce winds in excess of hurricane intensity. Be sure all equipment is secured for these high wind conditions. Position the MEWS operation outside the LZ and if possible, with a clear view of the approaching/landing pilot, the LZ and the LZ approaches and departure corridors.

MEWS Observations:

MEWS observations are done 3 times a day (e.g. local sunrise, Mid-afternoon, usually between 3-4pm, and local sunset). When directly supporting helicopter LZ operations, additional observations would be made and reported before landings and take-offs, or when severe weather conditions arise. Helicopter flight operations are difficult in mountainous terrain or when pilots fly in unfamiliar areas. Part of the reason for MEWS is to try to improve flight safety during emergency operations

MEWS can support emergency helicopter flight ops with relevant flight weather reports.

MEWS can also provide other useful weather data. Heat stress indices and windchill data can be important in coordinating relief supplies to meet the needs of survivors.

Other Equipment:

In addition to an amateur VHF radio and MEWS equipment, Sparky has other emergency signaling equipment:

Magnetic roof mounted halogen rotating yellow beacon.

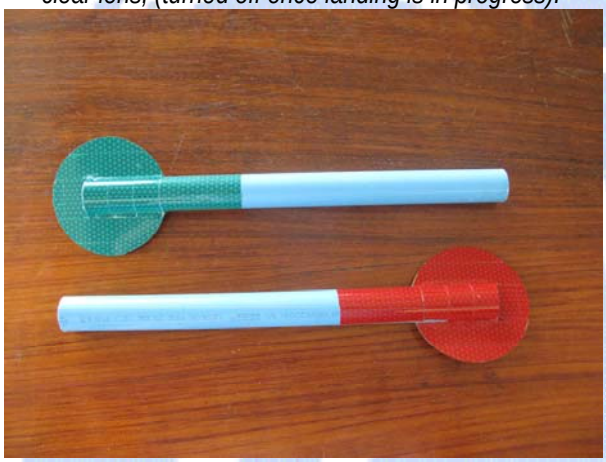
Public Address system.

Signal mirror and CD backup reflector

2-color high visibility ground signal panels

High intensity xenon strobe LZ marker with alternate clear lens; (turned off once landing is in progress).

Orange wind streamer (for use at an LZ) to be located upwind of LZ touchdown spot.



PVC reflector wands for night traffic control or LZ aircraft marshalling (each wand has a red and a green face)

Safety vests for MEWS operators (orange for day, reflector vest for night)

In its commitment to community-based education and community service, the RTC-TH is willing to provide MEWS training to any interested Ham radio operators free of charge via e-tutoring (e.g. email or Skype). Small group instruction is available at cost either at RTC-TH facilities or at a host group site. If training off-site, we ask that room and board be provided in addition to any materials costs associated with the training. Contact us at rtc2k5@gmail.com to arrange for MEWS training.

The reference tables used for MEWS observing and reporting are found at the end of this paper.

MEWS is part of the RTC-TH EmComm program. The slogan of the EmComm program is "Ready to Serve and Sustain Our Community." Keeping Sparky, MEWS capable and ready to go is another tangible measure of our commitment to supporting our local community.

[***Note:*** The reference charts used in MEWS observations are included in this paper.

Ready to serve and sustain our community.

RTC-TH M.E.W.S. Weather Observation Log

1. Header

Location

Lat ° ' " N | Long ° ' " E

Lat N | Long E | Elev m AMSL

Date

Local time 24-hr format — Hour →

Observer (initial; see back)

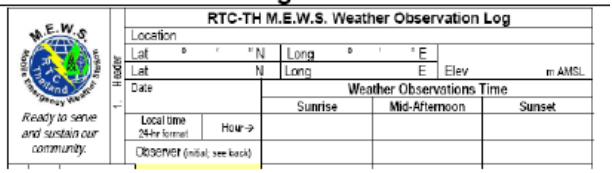
				Weather Observations Time		
				Sunrise	Mid-Afternoon	Sunset
2. Temperature / Relative Humidity	2.1	Air (Dry bulb)	Thermometer in shade; 1.5 m above ground	°C	°C	°C
	2.2	Wet Bulb		°C	°C	°C
	2.3	Difference	Subtract 2.2 from 2.1;	°C	°C	°C
	2.4	Rel. Humidity	Use 2.1, 2.3; R H Table	%RH	%RH	%RH
	2.5	Dew Point	Use 2.1, 2.3; Dew Pt Table	°C	°C	°C
	2.6	Heat Stress	Use 2.1, 2.4 ; HSI Table	Heat Stress °C	Heat Stress °C	Heat Stress °C
			Danger Level (if any from Heat Stress Index table)	□Cautn □Danger □ Ex Cautn □Ex Dangr	□Cautn □Danger □ Ex Cautn □Ex Dangr	□Cautn □Danger □ Ex Cautn □Ex Dangr
	2.7	Wind Chill	Use 2.1, 3.1; Wind Chl Tbl	Wind Chill. °C	Wind Chill. °C	Wind Chill. °C
			Danger Level (if any from Wind Chill chart)	□Trvl Dngr □Frstbte10 □TShltr Dgr □Frstite30 □Frostbite □Frstbte5	□Trvl Dngr □Frstbte10 □TShltr Dgr □Frstite30 □Frostbite □Frstbte5	□Trvl Dngr □Frstbte10 □TShltr Dgr □Frstite30 □Frostbite □Frstbte5
3. Wind Speed / Direction	3.1	Report wind speed in ***knots to air crews;*** km/h to all others.				
		Average	Get 3 readings & average	km/h knts	km/h knts	km/h knts
		Gusts	Record highest gust	km/h knts	km/h knts	km/h knts
		Wind Speed Guidelines for Helicopter Flight Operations				
		10 knots / 18.5 km/h ideal; OK to fly			Above 45 knots / 83 km/h; No flights.	
		Gusts above 20 knots/ 37 km/h; No flights			Max tailwind 5 knots/ 6 km/hr; No take off	
	3.2	Steady Wind Direction	Circle direction steady **wind comes FROM**	N NE S SW E SE W NW	N NE S SW E SE W NW	N NE S SW E SE W NW
		Variable Wind Direction	Circle 1 or more directions **wind comes FROM**	N NE S SW E SE W NW	N NE S SW E SE W NW	N NE S SW E SE W NW
4. Sky Conditions	4.1	Cloud Cover	Use Definitions in Cloud Cover Table	□ Clear □ Cloudy □ Scattered □ Overcast □ Broken	□ Clear □ Cloudy □ Scattered □ Overcast □ Broken	□ Clear □ Cloudy □ Scattered □ Overcast □ Broken
	4.2	Use local mountain of known elevation (above mean sea level) and report clouds above, at, or below mountain top.				
		Cloud Base Ht (Loc Rel) m	Relative to local Mtn	□ Clouds above mtn □ Clouds at mtn top □ Clouds below mtn	□ Clouds above mtn □ Clouds at mtn top □ Clouds below mtn	□ Clouds above mtn □ Clouds at mtn top □ Clouds below mtn
			m AMSL			
			DewCal (2.1-2.5)/9.8x1000m	m AGL	m AGL	m AGL
		*Min. flight altitudes: **Day** = 160m AGL; **Night** – 500 m AGL; **Low cloud ceiling** = No flights.*				
	4.3	Cloud Type	High	□ Cirrus □ Altostrat □ Altocum	□CuNim	□ Cirrus □ Altostrat □ Altocum	□CuNim	□ Cirrus □ Altostrat □ Altocum	□CuNim
			Middle						
			Low	□ Stratus □ Nimstrat	□ Cumul	□ Stratus □ Nimstrat	□ Cumul	□ Stratus □ Nimstrat	□ Cumul
			Vertically Developed						
	4.4	Rainfall	Measure at 0900 hrs each morning. Report amount for last 24 hrs.			mm
	4.5	Visual Range (Visibility)	Name of 3.2 km mark	□ more □ less than □ Rain □ Fog □ Haze □ Smoke	□ more □ less than □ Rain □ Fog □ Haze □ Smoke	□ more □ less than □ Rain □ Fog □ Haze □ Smoke
			Name of 5 km mark	□ more □ less than □ Rain □ Fog □ Haze □ Smoke	□ more □ less than □ Rain □ Fog □ Haze □ Smoke	□ more □ less than □ Rain □ Fog □ Haze □ Smoke
		*Helicopter minimum visibility: **Day** = 3.2 km / 2 miles; **Night** = 5 km / 3 miles; **Low visibility** = No flights*				
	4.6	Severe Weather	Thunderstorms	□ Yes □ No	□ Yes □ No	□ Yes □ No
			Lightning — Flash, count secs to boom / 3	N NE E SE S SW W NW □ Yes km	N NE E SE S SW W NW □ Yes km	N NE E SE S SW W NW □ Yes km
		Warn air crews of any severe weather in your area.				

All weather observers write their initials and clearly print their name using block letters			

M.E.W.S. Summary Weather Observation Log Instructions

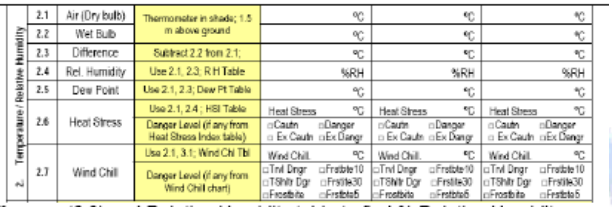
Header

Location: Local Place Name
Latitude, Longitude from GPS, survey records or map measurement.
Elevation: Survey records or map measurement (GPS elevations are not reliable).



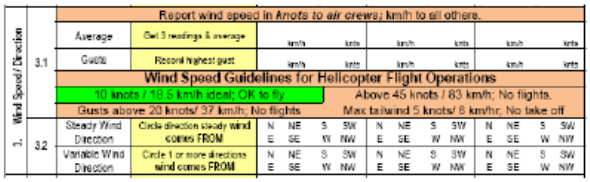
Date/Hour: Use local Thai standard time in 24-hour format. **Observer:** initials in box. Full name (print clearly) on top/back of form

Temperature / Relative Humidity



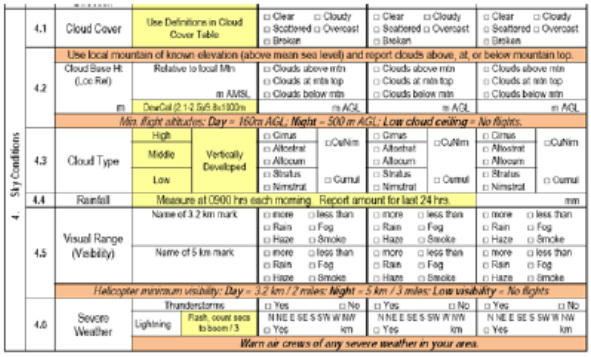
2.1 Air (Dry Bulb) Temp: Read thermometer kept in the shade, 1.5 m above the ground.
2.2 Wet Bulb Temp from hyrgrometer kept in the shade, 1.5 m above the ground.
2.3 Difference between Dry and Wet Bulb temperatures.
2.4 Relative Humidity: Use Dry Bulb Temp (2.1), Difference (2.3) and Relative Humidity table to find % Relative Humidity.
2.5 Dew Point Temperature: Use Dry Bulb Temp (2.1), Difference (2.3) and Dew Point Temp table to find Dew Point Temp.
2.6 Heat Stress Temperature: Use Dry Bulb Temp (2.1), % Relative Humidity (2.4) and Heat Stress Index Table to find Heat Stress Temperature and relevant advisory warning.
2.7 Wind Chill: Use the Dry Bulb Temp (2.1) and Wind Speed (3.1) and Wind Chill Table to find the Wind Chill Temperature and relevant advisory warning.

Wind Speed / Direction



3.1 Average and Gust Wind speeds: Use Beaufort Table or direct measurements 3 times and average results. Gusts are short, strong blasts of wind. *Report wind speeds in knots to air crews. Advise air crews when wind speeds are close to affecting helicopter flight operations.*
3.2 Steady or Variably blowing winds. If steady, circle letter for direction. If variable, circle all appropriate letters for directions.

Sky Conditions



Sky Conditions

4.1 Cloud cover: Look at the sky and follow the definitions for each cloud cover classification.
4.2 Cloud Base Height: If relative to a local mountain, give its name and elevation above mean sea level. Note Local Relief in meters. If using the Dew Point method, subtract Dew point temp (2.5) from Dry temp (2.1) and divide result by 9.8; multiply quotient by 1000m. *Advise air crews when cloud base height (ceiling) are close to affecting helicopter flight operations.*
4.3 Cloud Type: Check the appropriate box based on cloud description in the guide book
4.4 Rainfall: Measure water in rain gauge each day at 0900 hrs. Rain gauge should be in open area, away from tall objects, with top of gauge 50 cm above ground to avoid splash water from entering gauge.
4.5 Visual Range: Pick landmarks 3.2 km and 5 km from your observation site. Report when visual range is more or less than the known distances to these landmarks. *Advise air crews when visual range is close to affecting helicopter flight operations.* Check appropriate boxes for reasons of reduced visibility.
4.6 Severe Weather: Primary concerns and thunderstorms and lightning. Check the appropriate boxes. If lighting, watch for flash, count seconds until you hear the thunder, divide by 3 = approximate distance in km. Circle direction to storm.

Relative Humidity Chart for °C Temperatures

Dry Bulb Temperature (Air Temperature °C	Dry Bulb Temperature minus Wet Bulb Temperature in °C																	
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
-20	70	41	11															
-17.5	75	51	26	2														
-15	79	58	38	18														
-12.5	82	65	47	30	13													
-10	85	69	54	39	24	10												
-7.5	87	73	60	48	35	22	10											
-5	88	77	66	54	43	32	21	11	1									
-2.5	90	80	70	60	50	42	37	22	12	3								
0	91	82	73	65	56	47	39	31	23	15								
2.5	92	84	76	68	61	53	46	38	31	24								
5	93	86	78	71	65	58	51	45	38	32	1							
7.5	93	87	80	74	68	62	56	50	44	38	11							
10	94	88	82	76	71	65	60	54	49	44	19							
12.5	94	89	84	78	73	68	63	58	53	48	25	4						
15	95	90	85	80	75	70	66	61	57	52	31	12						
17.5	95	90	86	81	77	72	68	64	60	55	36	18	2					
20	95	91	87	82	78	74	70	66	62	58	40	24	8					
22.5	96	92	87	83	80	76	72	68	64	61	44	28	14	1				
25	96	92	88	84	81	77	73	70	66	63	47	32	19	7				
27.5	96	92	89	85	82	78	75	71	68	65	50	36	23	12	1			
30	96	93	89	86	82	79	76	73	70	67	52	39	27	16	6			
32.5	97	93	90	86	83	80	77	74	71	68	54	42	30	20	11	1		
35	97	93	90	87	84	81	78	75	72	69	56	44	33	23	14	6		
37.5	97	94	91	87	85	82	79	76	73	70	58	46	36	26	18	10	3	
40	97	94	91	88	85	82	79	77	74	72	59	48	38	29	21	13	6	
42.5	97	94	91	88	86	83	80	78	75	72	61	50	40	31	23	16	9	2
45	97	94	91	89	86	83	81	78	76	73	62	51	42	33	26	18	12	6
47.5	97	94	92	89	86	84	81	79	76	74	63	53	44	35	28	21	15	9
50	97	95	92	89	87	84	82	79	77	75	64	54	45	37	30	23	17	11

- Use the hygrometer to get the Dry Bulb and the Wet Bulb Temperature. Example, Dry Bulb = 30°C, Wet Bulb = 28°C.
- Subtract the Wet Bulb temperature from the Dry Bulb temperature. Example, 30°C – 28°C = 2°C. Find the column for 2°C across the top of the chart.
- Locate 30°C in the Air Temperature column at the left side of the chart.
- Find the intersection of the column and row to get the % relative humidity. For the example of 2°C and 30°C, the relative humidity is 86%.

DEW POINT TEMPERATURE CHART (°C)

Dry Bulb Temperature (Air Temperature °C	Dry Bulb temperature minus Wet Bulb temperature in °C															
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0
-20	-25	-33														
-17.5	-21	-27	-38													
-15	-19	-23	-28													
-12.5	-15	-18	-22	-29												
-10	-12	-14	-18	-21	-27	-36										
-7.5	-9	-11	-14	-17	-20	-26	-34									
-5	-7	-8	-10	-13	-16	-19	-24	-31								
-2.5	-4	-6	-7	-9	-11	-14	-17	-22	-28	-41						
0	-1	-3	-4	-6	-8	-10	-12	-15	-19	-24						
2.5	1	0	-1	-3	-4	-6	-8	-10	-13	-16						
5	4	3	2	0	-1	-3	-4	-6	-8	-10	-48					
7.5	6	6	4	3	2	1	-1	-2	-4	-6	-22					
10	9	8	7	6	5	4	2	1	0	-2	-13					
12.5	12	11	10	9	8	7	6	4	3	2	-7	-28				
15	14	13	12	12	11	10	9	8	7	5	-2	-14				
17.5	17	16	15	14	13	12	12	11	10	8	2	-7	-35			
20	19	18	18	17	16	15	14	14	13	12	6	-1	-15			
22.5	22	21	20	20	19	18	17	16	16	5	10	3	-6	-38		
25	24	24	23	22	21	21	20	19	18	18	3	7	0	-14		
27.5	27	26	26	25	24	23	23	22	21	20	16	11	5	-5	-32	
30	29	29	28	27	27	26	25	25	24	23	19	14	9	2	-11	
32.5	32	31	31	30	29	29	28	27	26	26	22	18	13	7	-2	
35	34	34	33	32	32	31	31	30	29	28	25	21	16	11	4	
37.5	37	36	36	35	34	34	33	32	32	31	28	24	20	15	9	0
40	39	39	38	38	37	36	36	35	34	34	30	27	23	18	13	6
42.5	42	41	41	40	40	39	38	38	37	36	33	30	26	22	17	11
45	44	44	43	43	42	42	41	40	40	39	36	33	29	25	21	15
47.5	47	46	46	45	45	44	44	43	42	42	39	35	32	28	24	19
50	49	49	48	48	47	47	46	45	45	44	41	38	35	31	28	23

- Use the hygrometer to get the Dry Bulb and the Wet Bulb Temperature. Example, Dry Bulb = 30°C, Wet Bulb = 28°C.
- Subtract the Wet Bulb temperature from the Dry Bulb temperature. Example, 30°C – 28°C = 2°C.
- Find the column for 2°C across the top of the chart. Locate 30°C in the Air Temperature column at the left side of the chart. Find the intersection of the column and row to get the Dew Point Temperature. For the example of 2°C and 30°C, the Dew Point Temperature is 27°C.
- Divide 27°C by 10°C = 2.7 X 1000 m = 2700 m (the altitude of the bottom of the clouds)

Heat Stress Index (Sensible Temperature)

Air Temp	Relative Humidity								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
46°C	44°C	49°C	57°C	66°C					
43°C	41°C	44°C	51°C	58°C	56°C				
41°C	38°C	41°C	45°C	51°C	57°C	65°C			
38°C	35°C	37°C	40°C	43°C	49°C	56°C	62°C		
35°C	32°C	34°C	36°C	38°C	42°C	46°C	51°C	58°C	
32°C	29°C	31°C	32°C	34°C	36°C	38°C	41°C	45°C	50°C
29°C	27°C	28°C	29°C	30°C	31°C	32°C	34°C	36°C	36°C
27°C	24°C	25°C	26°C	26°C	27°C	28°C	29°C	30°C	31°C

Danger Level	I Caution	II Extreme Caution	III Danger	IV Extreme Danger	---
Heat Index	27-32°C	32-40°C	40-54°C	Above 54°C	Relative humidity rarely observed
Heat Syndrome	Fatigue possible with prolonged exposure and/or physical activity	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and/or physical activity	Heat / sunstroke highly likely with continued exposure	Generally not applicable but conditions would be extremely dangerous

- Use a hygrometer placed in a shaded position about 1.2 m / 5 ft above the ground.
- Air Temperature is read from the Dry Bulb Thermometer.
- Relative Humidity is calculated using the Relative Humidity Table. This requires the following data: Air Temperature and the Temperature Difference between the Dry and Wet Bulb readings.

Wind Chill

Wind Velocity (km/h)	Measured Air Temperature (°C)										
0	5	0	-5	-10	-15	-20	-25	-30	-35	-40
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54
20	1	-5	-12	-18	-24	-31	-37	-43	-49	-56
25	1	-6	-12	-19	-25	-32	-38	-45	-51	-57
30	0	-7	-13	-20	-26	-33	-39	-46	-52	-59
35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61
45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62
50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63
55	-2	-9	-15	-22	-29	-36	-43	-50	-57	-63
60	-2	-9	-16	-23	-30	-37	-43	-50	-57	-64
65	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65
70	-2	-9	-16	-23	-30	-37	-44	-51	-59	-66
75	-3	-10	-17	-24	-31	-38	-45	-52	-59	-66
80	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67

Travel can be dangerous

Use heated vehicles; temporary shelters unsuitable and dangerous.

Frostbite in 30 minutes

Starts danger of frostbite and possible death.

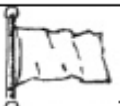
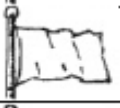
Frost-bite in 10 minutes

Frostbite within 5 minutes

Adapted by G.K. Lee for RTC-TH M.E.W.S.

Beaufort Wind Table for Land Effects

MEWS weather observers should set up a flag near their operating position. Use the Description and flag references to estimate the wind speed. Report the range of wind speeds from the chart rather than a specific number.

Description	Flag	WMO term	Mph	Km/ hr	Knots	Force	Psu lbs/sq ft (Kg/sq m)
			Report wind speed in knots to flight crews				
Calm; smoke rises vertically	---	Calm	<1.0	<1.5	<0.9	0	0.006266 (0.003059)
Smoke indicates wind; flag hangs limp, wind vanes do not move		Light Air	1-3	1.5-6	1-3	1	0.02924 (.01428)
Wind felt on face, leaves rustle, flag stirs, wind vanes move		Light breeze	4-7	6-12	4-6	2	0.142 (0.6934)
		5 Knots maximum tailwind for helicopter take-off					
Leaves and twigs in constant motion; flag occasionally extends		Gentle Breeze	8-12	12-20	7-10	3	0.3759 (1.835)
		10 Knots ideal for helicopter flight operations					
Dust and paper fly; small branches move; Flag flaps		Mild Breeze	13-18	21-29	11-16	4	0.8145 (3.977)
small leafy trees begin to sway; white crested wavelets appear on lakes/ponds; Flag ripples		Fresh Breeze	19-24	30-39	17-21	5	1.504 (7.342)
		20 Knots maximum gusts for helicopter flight operations					
Large branches move; wires whistle; umbrellas hard to use; Flag snaps		Strong Breeze	25-31	40-50	22-27	6	2.485 (12.13)
Whole trees sway; hard to walk; Flag extended		Near Gale	32-38	51-61	28-33	7	3.822 (18.66)
Twigs and small branches broken; cars veer on roads; Flag tatters		Gale	39-46	62-74	34-40	8	5.597 (27.33)
Slight structural damage occurs (roof shingles blow off)		Strong Gale	47-54	75-87	41-47	9	7.769 (37.93)
		45 Knots maximum winds for helicopter flight operations					
Trees broken or uprooted, considerable damage to buildings		Storm	55-63	88-101	48-55	10	10.53 (51.39)
Wide spread damage caused	---	Violent Storm	64-72	02-114	56-63	11	13.78 (67.3)
	---	Hurricane	>73	>115	>63	12	>13.78 (>67.3)

Disclaimer: Use of the pressure data to calculate tower/antenna wind loads is at your own risk. The RTC-TH and HSØZHM assume no liability for the use of this data. Pressure values are the upper limits for a wind category.

Table of Cloud Cover Terms

Term	Amount of blue	Amount of cloud
Clear	Nearly all blue	Little or no clouds
Scattered clouds	Mostly blue	Some clouds
Broken clouds	Big blue patches	Mostly clouds
Cloudy	Some blue	Mostly clouds
Overcast	Little or no blue	Nearly all clouds

Flash / Boom Storm Distance Estimation

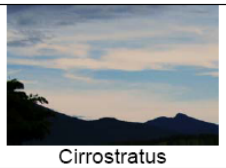
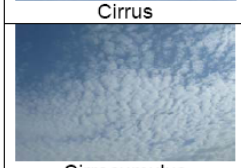
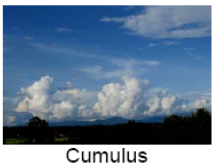
Use this method to estimate the distance to a thunderstorm.

- Immediately upon seeing a flash of lightning, count the number of seconds until you hear the boom of the thunder.
- Divide the number of seconds by 3 = km estimated distance to the storm

When the flash and boom are almost instantaneous, you may be in big trouble.

People have been struck by lightning 56+ km away from a thunderstorm.

MEWS Simplified Cloud Identification Chart

High 12,000m to 6,000m	 Cirrus	 Cirrostratus	**Vertically Developed** 12,000m to 500m
	 Cirrocumulus	 Contrails	
Middle 6,000m to 2,000 m	 Altostratus	 Altocumulus	
Low 2,000m to Surface	 Stratus	 Stratocumulus	 Cumulonimbus
	 Nimbostratus	 Fog (ground level)	 Cumulus

Estimating Cloud Base Height: Identify cloud type; report Low clouds as 2000m, use lower limit for other cloud types.

Flight Advisories: Report flight advisory to air crews for the following conditions.
Low Clouds near or at l60m AGL (day); 500m AGL (Night). No flights if below these minimum limits.
Reduced Visibility: Smoke, dust, haze, fog reducing visual range to 3.2 km (Day) or 5 km (Night); No flights if below these minimum limits.
Severe Weather: Thunderstorms, lightning, heavy rain, excessive winds, or other weather extremes.