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Interagency Wildland Fire Weather Station Standards & Guidelines

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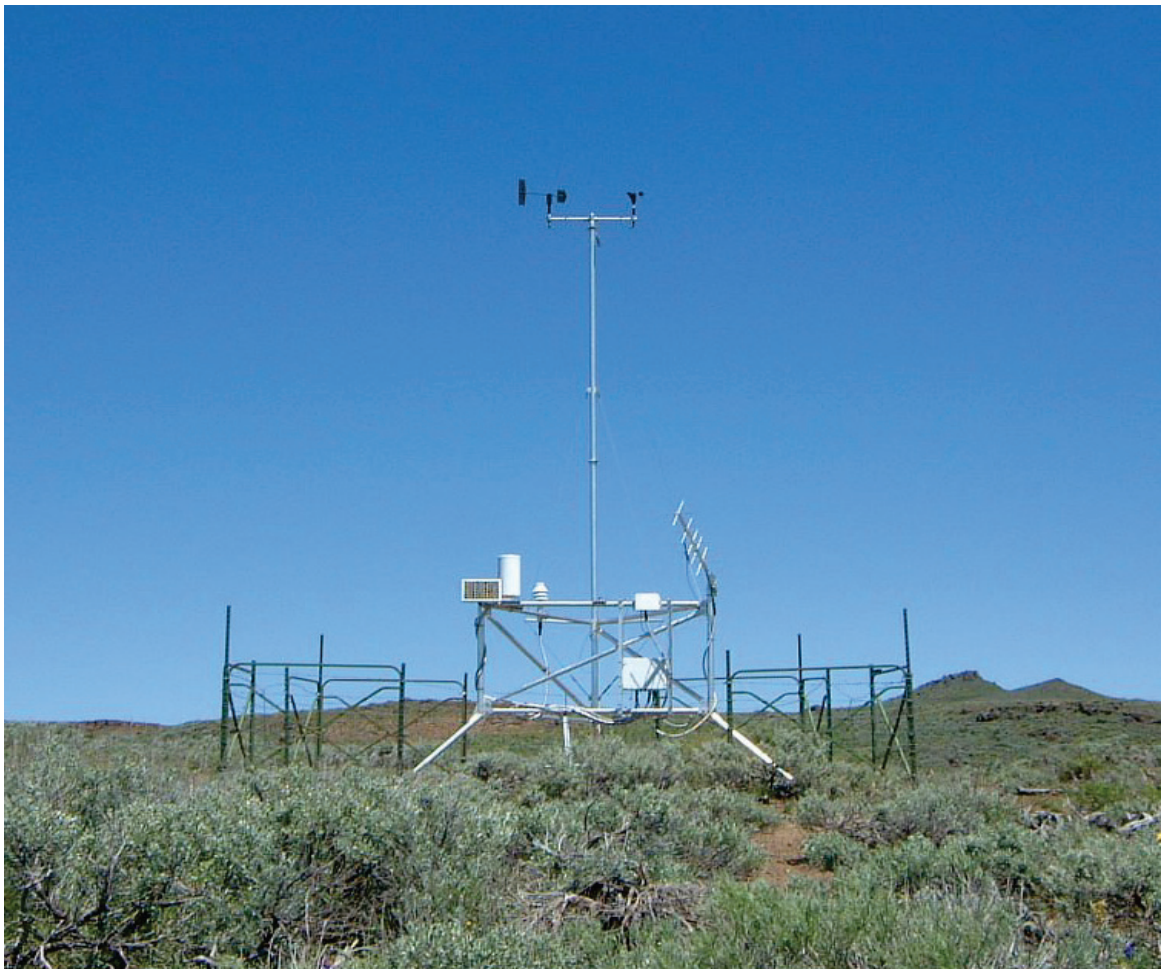

Interagency Wildland Fire Weather Station Standards & Guidelines

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This product is posted on National Wildfire Coordinating at http://www.nwcg.gov/.

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INTRODUCTION

This document has been composed to provide common standards for weather stations used by the wildland fire agencies to provide weather data observations. These weather data are used for a wide variety of applications including calculation of the National Fire Danger Rating System (NFDRS) indices, fire behavior, burned area fire rehabilitation, planned ignitions, and other land management operations. This document supplements and supersedes the *Weather Station Handbook - An Interagency Guide for Wildland Managers*, PMS 426-2, with regard to NFDRS standards.

This document is partitioned into three sections: (1) NFDRS Weather Station Standards & Guidelines (2) Fire Remote Automatic Weather Stations (RAWS) Standards & Guidelines and (3) NFDRS Manual Weather Station Standards and Guidelines.

This 2014 edition of the *Interagency Wildland Fire Weather Station Standards and Guidelines* supersedes the 2012 edition.

QUALITY ASSURANCE

The station owner, at the field level, is responsible for ensuring weather data quality by:

- Ensuring that maintenance is performed per standards, and that this maintenance and all other significant station activity is documented in the weather section of Wildland Fire Information Management (WFMI).
- Visually confirm outputs from the station to check that the information is reflective of actual conditions, and notify appropriate organizations if data quality is suspect.
- Ensuring that the station is physically secure and that the site is maintained as needed.

Two methods of data quality control can be implemented. The first method is an automated oversight system, such as *Station Event Report* (SER), to continually monitor data for errors relating to out of range observations and performance problems from non-functional sensors. SER quality control is available to the field user through coordination with the WFMI Weather system administrator if the station transmits data via Geostationary Operational Environmental Satellite (GOES). The second method is periodic review and verification by an agency/regional/local fire weather user. Should errors or problems be detected, the station owner/user is responsible for initiating action to correct.

Ultimately, the station owner is responsible for ensuring the station is delivering acceptable weather data.

EQUIPMENT SELECTION

When selecting which type of automated weather station equipment to purchase, consider more than just the lowest bid. Consider more detailed life-cycle costs of equipment, data transmission, maintenance, data storage and retrieval, and the value of corporate (shared) data. Talk to several vendors, other users, and consult your agency weather station coordinator. The weather station owner is responsible for ensuring that equipment will meet minimum interagency fire weather station standards.

Additional fire management needs, as well as those of other multiple use interests, should be factored when selecting equipment. Expandability, serviceability (including service contract and training availability), transportability, and compatibility with current and future national systems must be considered.

NFDRS WEATHER STATION STANDARDS & GUIDELINES

INTRODUCTION

The National Fire Danger Rating System (NFDRS) is a decision support system used by wildland fire management agencies to assess current fire danger at local and national levels. It consists of a variety of indices that portray current potential fire danger conditions. Remote Automatic Weather Stations (RAWS) used for NFDRS calculations must have annual maintenance to ensure trusted outputs starting with the green-up date.

The weather station network supporting NFDRS has grown considerably in the last 30 years. The original RAWS network was conceived to support the coarse-scale application of fire danger rating. Today, RAWS data are routinely used to support decisions impacting firefighter safety, whether or not to initiate a fuels treatment prescription, air quality, crew readiness, and strategic seasonal and multi-year resource allocations to name a few. Demand for these data happens every day. The future use of RAWS data to support gridded, digital data products is already here and growing quickly. The current and future purpose of the RAWS network is to support point and gridded applications of fire weather for fire program analysis, fire danger rating, fire behavior prediction fire weather forecasting, and smoke management. The data from these stations support interagency fire danger predictions and provide quantification of risk elements that are critical for daily decisions regarding firefighter resource placement, staffing levels, appropriate suppression response, and strategic decisions at local, regional, and national levels. The most important value among those provided by these data is consideration for firefighter and public safety.

Stations compliant with the NFDRS standards will provide remotely sensed weather data--temperature, humidity, precipitation, wind and solar radiation on an hourly basis via the GOES satellite. Note: All of these elements do not apply to manual stations.

STATION CLASSIFICATIONS

This section includes station standards for NFDRS weather stations.

Note: **The minimum NFDRS standard is the Seasonal Data Collection Station**.

NFDRS - Year Round Data Collection Stations - Includes all permanent 24-hour observing stations that meet the following criteria:

- Operates to minimum standards year round to support designated wildland fire season.
- Equipped with the minimum NFDRS sensor complement (see page 9).
- Meets minimum quality assurance requirements (see page 6).
- 24-hourly readings are delivered to Weather Information Management System (WIMS) hourly via GOES through WFMI Weather.
- NFDRS calculations are processed regularly in WIMS delivering historical data to the Fire and Aviation Management Web Applications (FAMWEB) data warehouse.
- (Optional) winterized rain gauge (weighing gauge, heated gauge, etc.).

NFDRS - Seasonal Data Collection Stations - Includes all permanent 24 hour observing stations that meet the following criteria:

- Operates to minimum standards to support designated wildland fire season (can operate 12 months or less).
- Equipped with the minimum NFDRS sensor complement (see page 9).
- Meets minimum quality assurance requirements (see page 6).
- 24 hourly readings are delivered to WIMS hourly via GOES through WFMI Weather during seasonal operational period.
- NFDRS calculations are processed regularly (during seasonal operational period) in WIMS delivering historical data to the FAMWEB data warehouse.

Other - Includes all resource, special purpose, portable (non-fire) and miscellaneous stations that provide accurate weather data but does not meet the fire weather station standards.

WIMS IDENTIFICATION NUMBERS

Any permanent RAWS station that is intended to be used for NFDRS purposes needs to obtain a WIMS identification number through the servicing Geographic Area Predictive Services unit. The physical station owner will coordinate with the local dispatch organization to identify a WIMS station owner. The WIMS station owner will contact Predictive Services to obtain a WIMS identification number and set up the station profile in WIMS. Once the station is established in WIMS, the WIMS station owner will assign personnel to conduct the daily observation verification and NFDRS processes.

TELEMETRY POLICY

The following telemetry and input standardization **ONLY affects stations in support of NFDRS**.

All stations designated for NFDRS use will deliver data to WFMI Weather via GOES Satellite telemetry and send to WIMS on an hourly basis. The GOES transmitter and format used must be compatible with the WFMI Weather system.

GOES telemetry is the minimum standard; however, station owners may apply additional telemetry options as desired at the local level.

National Environmental Satellite, Data, and Information Service Identifiers (NESDIS ID):

This is an eight digit (letter and number) identification number assigned by the National Oceanic and Atmospheric Administration (NOAA)/NESDIS that becomes the RAWS identification number, such as 234567EO. NESDIS identifiers are assigned to every NFDRS RAWS, as well as some portable RAWS, which allows them to transmit data to the GOES satellites. The NESDIS ID is critical metadata for every station because that identifier ties the RAWS to a specific location on earth which is latitude/longitude. The proper assignment and tracking of NESDIS ID's is critical. Inappropriate assignment or reassignment of NESDIS ID's can result in misdirected weather data and conflicting metadata.

Interagency policy and guidelines for assignment of NESDIS ID's shall be:

- NESDIS identifiers should not be changed unless there is a compelling reason to change them.
- Any change in NESDIS for existing NFDRS RAWS requires a change in WIMS and the appropriate station owner in WIMS must be consulted prior to this happening.
- NESDIS ID's are not unique for any agency per the Satellite Telemetry Interagency Working Group (STIWG). Hence there is no need to assign any special set of identifiers for any given agency.

Note: For additional information on how to obtain or change a NESDIS ID, please contact the RAWS Depot at rawshelp@blm.gov.

OPERATIONAL PERIOD

The optimal operating period for all weather stations used for the NFDRS is year-round. However, the minimum operational period is dictated by the following:

- A minimum 30-day start-up period prior to the need for NFDRS indices (for example, the wildland fire season as designated by the local manager, region, or geographic area coordination center) is required for each seasonal weather station to properly calibrate the model.
- Annual fluctuations in season length. Use of the visual greenness (available on the WFAS home page) or Growing Season Index images (both available on the U.S. Forest Service Wildland Fire Assessment System page at http://www.wfas.net) is recommended to assist the local or regional fire manager.

The following guidelines are recommended for any use of a weather station for NFDRS that is not owned by the requesting user.

- Notify the physical and/or WIMS station owner that you are using this station for NFDRS or other applications.
- When a longer operating season is required by an adjoining unit, the non-owning user should assist in the management of that station, including any additional costs for operation or maintenance.

SENSOR AND DATA REQUIREMENTS

NFDRS Station Minimum Sensor Complement

NFDRS requires hourly measurements of precipitation duration and amount. In addition, an instantaneous air temperature reading will be taken each hour. Ten minute averages will be computed for the following variables: relative humidity, wind direction, and wind speed. Solar radiation will be recorded over a 60-minute average. Detailed data sampling requirements are listed under each specific sensor/instrument in the subsections below.

A note about automated fuel temperature/moisture measurements: The Fire Danger Subcommittee recommended that a fuel moisture value be obtained from an automated model. Solar radiation sensors will provide input to the model that will produce derived fuel moisture/fuel temperature values that have been determined to be more reflective of actual conditions. Fuel Moisture Sticks are not required for NFDRS calculations; however, fuel moisture stick data is utilized by a variety of user groups for fire applications.

GOES telemetered station sensor update readings will coincide with the assigned transmission time. The instantaneous readings must be taken within the 5 minutes up to and including the transmission time. Further, if 10-minute averages are taken, the sensor average readings must be taken within the 15 minutes prior to the assigned GOES transmission time. Example: if a station transmits to GOES at 45 minutes past the hour, the sensor's instantaneous readings must be taken between 40 and 45 minutes past the hour and the averaged readings must be initiated between 30 and 35 minutes past the hour. **Sensor data must transmit in English units.**

Rain Gauge

Precipitation is the amount of water falling upon the earth as rain or in frozen form such as snow, sleet, and hail. It is expressed as the depth of water that would cover a flat surface. Rainfall output will be the cumulative total of rainfall for the rain year determined by the agency or maintenance cycle. Year-round precipitation information is not necessary for NFDRS (please see classification sections of this documentation to get either NFDRS or manual stations for more information). However, if the station reports year-round and the user determines the need for collecting year-round precipitation information, a winterized gauge (heated gauges, weighing-gauge, etc.) may be necessary. (Please note that stations, which do not have winterized precipitation gauges, will often show a large rain event in early spring due to normal thawing cycles.)

Sensor Standard

Sampling Height	1-6 feet, varies with mounting tower.
Measurement Units	Inches.
Range	00.00 through 99.99 inches.
Resolution	.01 inches.
Accuracy	+/-3% of total.

Data Standards

Type Measurement	Continuous cumulative measurement.
Data Logged	Hourly.
Data Format	XX.XX.

Wind Speed

Wind speed is the rate at which air passes a given point.

Sensor Standards

Sampling Height	20 feet.
Measurement Units	Statute miles per hour.
Range	0-100 miles per hour.
Resolution	1 statute mile per hour.
Accuracy	+/- 5% of reading.

Data Standards - 10-Minute Average

Type of measurement	10-minute average from no less than 120 samples.
Data Logged	Hourly.
Data Format	XXX.

Optional Measurement - Peak WS - Data Format Standards

Type Of Measurement	Maximum speed for previous 60 minutes from no less than 720 samples.
Data Logged	Hourly.
Data Format	XXX.

Wind Direction

Wind direction refers to the direction from which the air is moving.

Sensor Standards

Sampling Height	20 feet.
Measurement Units	Degrees from true north.
Range	0-360 degrees.
Resolution	1 degree.
Accuracy	+/- 5 degrees.

Data Standards - 10 Min Average

Type of Measurement	10-minute average from no less than 120 samples.
Data Logged	Hourly.
Data Format	XXX.

Optional Measurement - Peak WD - Data Format Standards

Type of Measurement	Direction at peak wind speed.
Data Logged	Hourly.
Data Format	XXX.

Air Temperature

Air temperature refers to the air surrounding the weather station instrumentation.

Sensor Standards

Sampling Height	4-8 feet.
Measurement Units	Degrees Celsius or Fahrenheit.
Range	-50 to +50 degrees Celsius. -58 degrees to +140 degrees Fahrenheit.
Resolution	1^{o} Fahrenheit. 1° Celsius.
Accuracy	+/- 1^{o} Fahrenheit. +/- 6^{o} Celsius.

Data Standards

Type of Measurement	Instantaneous reading.
Data Logged	Hourly.
Data Format	XXX.

Relative Humidity

Relative humidity is the percentage ratio of the actual amount of water vapor in the air to the **amount of water vapor required for saturation at existing temperature.**

Sensor Standards

Sampling Height	4-8 feet.
Measurement Units	Percent.
Range	0-100%.
Resolution	1%.
Accuracy	0-80% - +/- 2.00% at 25 degrees Celsius. 80-100% - +/- 5% at 25 degrees Celsius.

Data Standards

Type of Measurement	10-Minute average from no less than 120 samples.
Data Logged	Hourly.
Data Format	XXX.

Battery Voltage

Battery voltage is the DCP/DataLogger battery current voltage. This item is recorded for remote troubleshooting and data validation purposes.

Data Standards

Range	0-15 Volts (11.8 considered minimum).
Accuracy	.1 Volts.
Type of Measurement	Instantaneous.
Sample Interval	Hourly.
Data Format	XX.X

Solar Radiation

Solar radiation measures the amount of sunlight exposed to the fuels.

Sensor Standards

Sampling Height	5-8 feet (so not to be shaded during the day).
Measurement Units	Millivolts.
Resolution	1 Millivolt.
Output	Watts per meter squared.
Accuracy	+/- 5% (Under most normal daylight conditions).

Data Standards

Type of Measurement	60 minute average taken from 60 samples prior to transmit.
Data Logged	Hourly.
Data Format	(-)XXXX.

Universal Time Coordinated (UTC)

The station must stay synchronized with coordinated universal time. GPS units are required for hourly (or more frequent) GOES transmissions. Readings from these receivers are not required as part of the data stream.

Readings to be output in the following order:

Order	Sensor Name	SHEF Code
01	Rainfall	PC.
02	10-Min. Avg. Wind Speed	US.
03	10-Min. Avg. Wind Direction	UD.
04	Air Temperature	TA.
05	Fuel Temperature	MT.
06	10-Min Avg. Relative Humidity	XR.
07	Battery Voltage	VB.

Channels beyond the first 7 are recommended to be output in the following order.

Variations after the standard required sensor compliment will be facilitated on a case-by-case basis. Check with Remote Sensing / Fire Weather Support Unit (RSFWSU) to be sure your application is compliant with WFMI Weather/WIMS. (http://raws.fam.nwcg.gov/contracts.html)

08	Barometric Pressure	PA.
09	Peak Wind Direction	UX.
10	Peak Wind Speed	UG.
11	Fuel Moisture	MM.
12	Solar Radiation	RD.

Variations after the standard required sensor compliment will be facilitated on a case-by-case basis. Check with RSFWSU link above to be sure your application is compliant with WFMI Weather/WIMS.

08	Barometric Pressure	PA.
09	Peak Wind Direction	UX.
10	Peak Wind Speed	UG.
11	Fuel Temperature	MT.
12	Fuel Moisture	MM.

Note: This could be modified slightly depending upon WIMS/WFMI Weather interface and modifications necessary to support the Nelson Model. If modified an updated page to this document will be issued at that time.

SITE SELECTION/RELOCATION

The RAWS Network Analysis

In 2010, NWCG commissioned the Desert Research Institute (DRI) to complete a study that addressed the following question. What is the appropriate RAWS Network? The report is fire-centric and provides an analysis of the existing NFDRS RAWS in WIMS and Automated Surface Observing System (ASOS) weather stations that can be used as an aid when making decisions pertaining to the placement or movement RAWS weather stations. This document can be found on the NWCG products pare at http://www.nwcg.gov/pms/pubs/426/pms1003.pdf.

The report stresses that it is best to think of the RAWS network not in terms of size, but rather agency mission. The network has grown through a need to acquire weather information and add value by determining fire danger, fire behavior, etc. RAWS serves in both capacities of point data and weather grids, and provides unique value by representing geographic areas not generally covered by other networks. Uses of the network and the combination of the metrics provided in the study along with local knowledge should serve as network guides given budgetary constraints. Consider the following information found in the report.

If consideration is being given to moving or removing a station, the various station attributes that comprise the RAWS Uniqueness Index (RUI) should be considered in addition to local knowledge including established documents such as Fire Danger Operating Plans. It is probably best to compare index values within GACCs, rather than across the country as a whole. Low index values arise due to one or more quantitative attributes of the station, but low values do not necessarily mean a bad station. It is important to examine all of the input index values comprising the RUI. For example, a high terrain complexity score suggests that the station is measuring across a rapidly changing climate environment due to elevation differences. A high data denial score should be used as an indication that removing a station will have adverse effects on gridded weather and related fields such as fire danger. This may be due to removing the station in the data denial experiment and/or there is a relatively larger horizontal and/or vertical separation to the next station.

1. *If interest exists in adding a station, the gap maps shown in Appendices 1-10 of the analysis, PMS 1003, are based on an IDI analysis. These should be used to help assist locating the new site. Zero IDI values on the map show areas of data void (no RAWS representation on the RAWS maps; no RAWS or ASOS representation on the RAWS+ASOS maps); the grid would be improved if areas with low index values had more stations. Utilizing GIS layers, the IDI values can be overlaid on top of other variables such as values at risk, vegetation, agency boundaries, etc. to assist in determining new station locations.*

Process for Installing a New or Moving an Existing Station

1. When installing a new or moving an existing station, it is particularly important to involve NWS fire weather and Predictive Services meteorologists along with other interagency wildland fire personnel (as appropriate) in determining a new site or relocating an existing station.
2. Contact your agency and/or regional RAWS coordinator. To get help from your national coordinator, go to the National Interagency Fire Center Interagency Remote Automatic Weather Stations web page at http://raws.fam.nwcg.gov/contacts.html. It is particularly important to contact your agency weather station coordinator when moving an existing station in order to maintain integrity of historical data. If an existing station has been moved, relocation information must be updated in WIMS application to clearly include the fact that the station is reporting from a new location.
3. Obtain the following station site information: station name, county, elevation, latitude/longitude, and data measurement elements. Complete station information is to be entered in the WFMI Weather database. For latitude and longitude, NAD 83 is the datum standard and the data are to be entered in degrees/minutes/seconds and decimal seconds out to the nearest hundredth (two decimal places). Ensure that station data entered into WFMI Weather and WIMS are identical.
4. Stations that will be used for NFDRS calculations will need to obtain a 6-digit weather station identification number (also referred to as NWS/WIMS station ID number) for your station through your Geographic Area Coordination Center (GACC) Predictive Services unit.
5. Transmission via GOES satellite requires a National Environmental Satellite Data Information Systems (NESDIS) Identification Number. Contact the RAWS Depot at rawshelp@blm.gov.

Site Selection Guidelines

The standard fire weather station should be located in a large, open area away from obstructions and sources of dust and surface moisture. The station should be on level ground where there is a low vegetative cover. Furthermore, it should be situated to receive full sun for the greatest possible number of hours per day during the fire season (generally 7a.m. to 7p.m.). If located on a slope, a south or west exposure is required to meet fire danger rating standards. (John E. Deeming, 1972).

Consider security (from animals and human vandalism) when selecting a site. To prevent any damage from wildlife, livestock etc., installation of a fence is highly recommended.

The following rules govern the location of an NFDRS fire weather station:

- Locate the station in a place that is representative of the conditions existing in the general area of concern. Consider vegetative cover type, topographic features, elevation, climate, local weather patterns, etc.
- Select a site that will provide for long-term operation and a relatively unchanged exposure. Consider site development plans, e.g., roads, buildings, parking areas; ultimate sheltering by growth of vegetation; and site accessibility during the intended operational period.
- Arrange the station so as to give data that is representative of the area in which the station is situated. Consider exposure requirements for each instrument in relation to such things as prevailing winds, movement of the sun, topography, vegetative cover, nearby reflective surfaces, and wind obstructions.

In accordance with the above rules, the following situations should be avoided when selecting a station site:

- **Sources of dust** such as roads and parking areas. If unavoidable, locate station at least 100 feet on the windward side of the source.
- **Sources of surface moisture** such as irrigated lawns, pastures, gardens, lakes, swamps, and rivers. If unavoidable, locate station several hundred feet to the windward side of the source.
- **Large reflective surfaces** such as white painted buildings. The same holds for natural reflective surfaces such as lakes, ponds, canals, and large rock surfaces. If unavoidable, locate station on north side, but far enough away so as not to be artificially shaded or influenced (at least a distance equal to the height of the reflective surface or 50 feet, whichever is greater).
- **Extensively paved or black-topped areas.** If unavoidable, locate station at least 50 feet to the windward side.
- **Large buildings, trees, and dense vegetation.** Locate station at least a distance equal to the height of the obstruction. Ideally, when dealing with tall, dense vegetation the station should be located a distance that is equal to seven times the height of the obstructing vegetation.
- **Distinct changes in topography** such as gullies, peaks, ridges, steep slopes, and narrow valleys.

Site Relocation Guidelines

- Stations that do not meet the siting guidelines should be considered for relocation according to the process outlined above.
- When moving an existing station, regardless of distance moved, Predictive Services must be contacted to assist in the entire administrative process and to make contact with interagency partners and other users. It is particularly important to contact your agency weather station coordinator when moving an existing station in order to maintain integrity of historical data. Station relocation information must be updated in WFMI Weather by the person with (MaintEdit Role for the station), WIMS by the station owner, and Western Regional Climate Center (WRCC) by emailing wrcc@dri.edu to clearly include the fact that the station is reporting from a new location. It is important to note that the function of the GPS unit on the RAWS station is not to store and/or transmit location data but to keep track of transmission times.

A WIMS station ID number must be changed if:

- The station is moved to a significantly different elevation or distance from the original station location.
- The station is moved across a county boundary.

Other considerations when moving a station with regard to changing WIMS station ID numbers include the following:

- The station is moved into an area of different exposure (for example shading, wind obstructions, etc.).
- The station is moved into an area of different topography.

A new NESDIS ID is not required for a move, but station location metadata must be kept as accurate as possible. The appropriate person should enter/change that information in WFMI Weather as soon as appropriate.

Note: Agencies that are considering buying a new weather station for use in NFDRS should consult the local National Weather Service, Predictive Services and other interagency partners. A consensus among these groups will ensure the interagency NFDRS station network is adequate and limit the cost of needless station overlap.

TOWER SPECIFICATIONS

As identified within this standard, NFDRS Weather Stations may be located in very remote and rugged locations. These stations are or will be either permanent or semi-permanent sites. Some sites will be operated 12 months a year in severe environmental conditions.

There are several types of towers that incorporate NFDRS sensor compliments. Installation of these towers should be in accordance with manufacturer's specifications. Agency safety regulations apply to tower climbing. If a tower is "climbable", it must meet all applicable agency and Occupational Safety and Health Administration (OSHA) regulations (See OSHA manuals 1926.32, 1910.66 and 1910.268) for climbing criteria, located at the OSHA Laws and Regulations site at https://www.osha.gov/law-regs.html

The positioning of the tower is very important, and if positioned properly, greatly increases the speed of installation and future maintenance actions. Alignments, leveling and structural strength are the primary concerns with all types of tower and instrument installations.

Therefore, any tower that is purchased or used must be very sturdy, rugged and robust. Towers come in free standing, guyed, or portable configurations. Only guyed or freestanding towers should be used for NFDRS purposes. It should be noted that guyed towers may have additional construction costs at the site to facilitate excavation for concrete mounting pier and concrete anchor blocks.

If a guyed tower does not meet OSHA climbing specifications, it must have a tilting base. This will permit the tower to be laid over close to the ground to service all sensors. All non-climbable towers will have provisions (tilting or pivoting mast) for ground level service of instrumentation by maintenance personnel **or** be accessible by freestanding ladder, lift truck or bucket lift without contacting the tower. They also must provide adequate support and footing for technical staff to service and inspect all sensors while they are in place.

Ensure that towers have adequate mounting locations, facilities, and hardware availability to mount all sensors securely to the tower and their respective locations and heights. Severe conditions, e.g., ice loading, deep snow, high winds, may be normal for this equipment.

General Tower Specifications

- Survive 125 miles per hour winds.
- No horizontal or vertical movement (sliding once installed).
- Withstand snow loads of typical high mountain locations (if station is located in an area susceptible to these conditions).
- Support technical personnel on the tower while servicing all sensors.
- Provide adequate mounting surface and locations to meet NFDRS sensor requirements.

INSTALLATION

Once a site is selected that meets all of the site guidelines, it can then be prepared for installation of a weather station. Personnel installing weather stations should have attended a Remote Automated Weather Station (RAWS) maintenance class, or be assisted by trained personnel. Trained personnel can be located through your agency weather station coordinator.

The following is a list of minimum information from the site that is necessary for station documentation. Other information about your station is valuable and needs to be stored in WFMI Weather:

- Station Name.
- Data Collection Platform (DCP)/Datalogger Model.
- State.
- County.
- Agency.
- Region.
- Unit.
- Sub-Unit (if needed).
- Transmitter Manufacturer and Model.
- Installation Date.
- Maintained by (and/or Point of Contact).
- Phone number/e-mail for Point of Contact.
- Contract Type.
- Elevation.
- Latitude (degrees, minutes, seconds).
- Longitude (degrees, minutes, seconds).

Documentation. Installation and maintenance must be documented. It is required to record this information in WFMI Weather, and station catalogs in WIMS. Station owners will take digital photos of each NFDRS weather station looking toward the station from each of the four cardinal directions in accordance with the requirements posted on the Desert Research Institute site at http://www.raws.dri.edu/documents/2006_09_30_Photography_SOP.doc, and submit them for posting to Western Region Climate Center at wrcc@dri.edu. Photos should be updated every three years at a minimum. A hard copy folder will be kept for each station by the station owner. In this folder should be photos of the area and station, a map, and the information printout from WFMI Weather and WIMS.

System Alignment and Leveling

The tower, GOES antenna and wind direction are aligned from true north. It is important to include your local magnetic declination (east or west) readings when aligning the tower, GOES antenna, wind direction sensor, etc.

Once the tower has been aligned, it must be leveled. Once leveled, the tower should be staked to

the ground. Staking the legs prevents the tower from being moved inadvertently in the installation process and during future maintenance visits.

The **wind speed/wind direction (WS/WD).** Install according to manufacturer instructions. For NFDRS, these will be mounted at 20 feet. Pay special attention so that the WD sensor is oriented properly, is level and gives correct readings. Route data cable in accordance with manufacturer's instructions.

Using the mounting bracket supplied by the manufacturer, the **tipping bucket** should be leveled using the leveling indicator attached to the sensor.

The **antenna (GOES, cell-phone, radio-voice)** should be assembled in accordance with manufacturer's instructions. The GOES antenna should be properly aligned for azimuth and elevation. Antenna alignment is accomplished using the compass and inclinometer. Remember to compensate for declination if required.

The **solar panel** will be mounted with a southerly exposure to maximize solar input.

The **solar radiation sensor** should be installed and leveled according to the manufacturer's instructions. Mount the instrument on the tower ensuring that it is not shaded by the tower, cables or instruments at any time of the day. For example, in the case of the Vaisala/Handar 403A tower, the instrument should be mounted in the middle of the top west rail of the tower.

Structural Integrity

All **cables** should be routed from their respective sensors to the DCP/DataLogger. Care should be taken in routing the cables to provide strain relief wherever required to prevent cable damage. When routing the cables, provide enough slack at both ends to permit a drip loop for moisture dissipation. When cable routing is complete, secure all cables to the tower using cable ties. Inspect all cables and ensure that rubber o-rings are used at both ends to make watertight seals. Consider "shielded" cables (metal conduit, pvc tubing) for protection from the elements and animals.

Ensure that all guy wiring is secured and tight. Ensure that the anchor rods are secured in order to prevent the tower from moving. Make sure all tower hardware is properly tightened. The RAWS system is now ready for systems checkout for operational accuracy.

Lifecycle Management

As with any capital investment equipment, a lifecycle management plan for the weather station network should be in place and budgeted for. Ten years is the recommended life-cycle rotation for weather station equipment.

STATION MAINTENANCE POLICY

Annual Maintenance

Annual service of NFDRS RAWS stations will provide an opportunity to ensure general station integrity, perform necessary preventative maintenance, and replace sensor and components prior to expiration of their calibrated lifetimes.

In order to ensure accurate weather readings, a program of annual RAWS maintenance/calibration is required (+/- 45 days from installation or previous year's maintenance date). Every NFDRS RAWS must receive, at a minimum, one annual onsite maintenance visit by either the local user or contracted personnel to ensure sensors are within calibration standards, and verify site and station conditions. Service contracts for this purpose can be requested through the Remote Sensing / Fire Weather Support Unit (RSFWSU) site at http://raws.fam.nwcg.gov/contracts.html, or any vendor that will meet the national standards for field or depot-level service as outlined in this document.

The site inspection also allows for maintaining vegetation growth or mitigating other site parameters (for example, new irrigation systems, buildings) that may be compromising site integrity**. It is important to keep vegetation trimmed at the surface to ensure it doesn't block wind and air flow to sensors.** Reasonable attempts must be made to keep the site in accordance with siting guidelines. If there are regulations prohibiting appropriate site maintenance required to provide representative data, develop a plan to bring the station into compliance. This could be done by obtaining any necessary special authorizations to manage vegetation, or in the most unfavorable case, moving the station. If sites are considerably compromised, it is critical to document this in the station metadata, including photographs, so that users of the data have the opportunity to assess its value to them.

Unscheduled Maintenance / Emergency Repair

Local land managers are responsible for monitoring the quality of the data produced by the weather stations in their fire response area. In the event of system failures, bad data, or questionable data, it is the responsibility of the station owner to initiate corrective action.

1. Year-round response time to GOES systems time drift will be immediate unless it is determined that there is no interference with another station. Validation of interference can be made through the RSFWSU.
2. All other NFDRS station failures will be responded to as appropriate in light of the following:
    a. Bad data affects the outputs of the model immediately. Responses to bad data, during fire season where the station is located, should be initiated immediately. Failures that occur outside fire season will be repaired before the station is initiated for the following fire season.
    b. **During fire season, action must be taken to respond to missing data system failures where the station is located will be as soon as possible, but no more than 3 days.**

ANNUAL MAINTENANCE AND SENSOR REPLACEMENT STANDARDS

Sensors and key components of an NFDRS RAWS station must be recalibrated or replaced on a regular basis to ensure the collection of consistent and reliable weather data throughout the NFDRS RAWS network. Annual service of NFDRS RAWS stations will provide an opportunity to ensure general station integrity, perform necessary preventative maintenance, and replace sensors and components prior to expiration of their calibrated lifetimes. The entries for specific equipment below outline yearly preventative maintenance, as well as minimum replacement times for each component. Minimum replacement time represents the optimum time to change any individual component. The servicing personnel may perform this function within +/- 45 days of the yearly expiration date to meet NFDRS maintenance requirements.

Field Service

Tipping Bucket – Remove cover. Clean cover and orifice to ensure free flow of water. Do not disassemble further. Check all connections and verify that the instrument is level. Unless the rain year is reset automatically by the DCP/DataLogger on a certain date each year, reset the tipping bucket to 00.00. Then simulate .02 inches of rain and validate that it was recorded by the DCP/DataLogger.

MINIMUM FIELD VALIDATION - 1 Year.

MINIMUM DEPOT CALIBRATION/REPLACEMENT - 3 Years.

Wind Speed - Check for damage and alignment of cups, ice skirt, free movement of bearings.

MINIMUM CALIBRATION/REPLACEMENT - 2 Years.

Wind Direction - Check for damage of pointer and feather, free movement of bearings. Manually rotate the sensor through each of the four quadrants and scan the data for accuracy.

MINIMUM CALIBRATION/REPLACEMENT - 2 Years.

Ultrasonic Wind Speed/Wind Direction – No calibration required, clear any obstruction between arms of transducers.

Relative Humidity/Air Temperature - Not field serviceable; do not open.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Battery - Perform a voltage test. Replace batteries according to manufacturer recommendations or if you suspect problems. Some manufacturers recommend yearly, others recommend every three years.

MINIMUM REPLACEMENT – As necessary.
"D" cell (Supplemental Power) – yearly.

GOES Antenna - Check for broken, loose, or bent elements, proper alignment, and connectors for corrosion.

MINIMUM CALIBRATION/REPLACEMENT - As Needed.

Cables - Check for cracking, deterioration, corrosion, proper routing, and security. Ensure O-rings are installed on all connectors. Replace as required for corrosion, aging, etc. Treat all connectors with moisture inhibitor (if required by manufacturer).

MINIMUM CALIBRATION/REPLACEMENT - As Needed.

Tower - Check for structural damage, proper alignment, and leveling. Be aware of potential risk to safety when dealing with a potentially damaged tower, e.g., tower rust, corrosion, cable fray, etc.

MINIMUM CALIBRATION/REPLACEMENT - As Needed, if structure is compromised or as per manufacturer's specifications.

DCP/DataLoggers - Check for security, damage, and ensure that all cables are properly connected. Verify the unit has the most recent version of the software or firmware installed. Change out as needed, e.g., defective, evidence of moisture, corrosion, rust, etc.

MINIMUM CALIBRATION/REPLACEMENT – As needed or in accordance with manufacturer's specifications.

Solar Radiation - Sensor must be cleaned periodically using only *water* and/or a mild detergent such as dishwashing soap.

MINIMUM CALIBRATION/REPLACEMENT - 3 Years.

Depot Sensor Calibration Standards

The depot or vendor's maintenance facility under contract will rehabilitate and calibrate sensors to the specifications contained in this document.

Sensor Documentation - A maintenance history record shall be kept for each component that is repaired/calibrated by any depot facility under contract. These records are kept on file by serial number and used by depot and agency staff for spotting systematic problem areas that may have impact on the program. The documentation is useful in working to develop better quality products.

Test Equipment – The test equipment and associated tools used during depot sensor calibration routines shall follow a general practice of "Traceability protocol" based on standards maintained by the National Bureau of Standards (NBS). This results in claims of calibrations that are "traceable to NBS".

Documentation

Complete station information (location, elevation, data measurement elements, etc.,) will be captured in the WFMI Weather database. For latitude and longitude, North American Datum 22 (NAD83) is the datum standard to be used and be recorded in degrees, minutes and seconds. WFMI Weather users should initiate coordination with WIMS users (if not the same person) to ensure that location information matches precisely in both systems. It is especially important that this happen before WIMS managers generate the enhanced location information in WIMS.

Annual maintenance and emergency repair will be documented in WFMI Weather. It is the

responsibility of every person that visits the site to ensure that WFMI Weather is updated and reflective of the condition of the station. This will include, at a minimum:

- Maintenance date (for example, date that relative humidity / air temperature was changed / calibrated).
- Specific sensors and serial numbers of those sensors (documented in WFMI Weather or other appropriate database).
- A narrative of the site visit, including the date of the visit, the personnel at the site and what maintenance was accomplished.

The station owner will also maintain a hard copy of the documentation file for each station. This will include photos, site access instructions, purchase history and other relevant information.

Note: Basic NFDRS station metadata consists of latitude, longitude, station name, national weather service identifier, NESDIS identifier, elevation and aspect. It is critical that this basic information be shared with all systems and that it is accurate. Basic metadata resides on WFMI Weather and the WIMS system and the goal is to have automated sharing metadata between systems. This will reduce the occurrence of conflicting and inaccurate metadata.

FIRE RAWS STANDARDS & GUIDELINES

INTRODUCTION

By definition, a Fire RAWS is a portable RAWS that conforms to standards of data collection and maintenance specified in this publication. Portable Fire RAWS are used in planned ignitions, wildfires and on other incidents and projects to relay current weather information representative of an area of interest. Fire RAWS are extremely beneficial to fire managers as they represent micro-scale climate and weather patterns within a small geographic area. Incident Meteorologists (IMETS) and local users rely on the information from Fire RAWS to help them determine and predict small scale weather features. These forecasts are critical to firefighter safety, fire behavior forecasts, daily decisions regarding resource placement, appropriate suppression response and strategic decisions.

The portable Fire RAWS network consists of approximately 50 National Fire Equipment System (NFES) Fire RAWS Kit (NFES order #5869) based at NIFC in Boise, Idaho, and more than 300 agency owned portable RAWS units scattered in various locations. Although most of the portable Fire RAWS currently being used in the field have similar equipment, the lack of established national standards for Fire RAWS has created ambiguity in the integrity of the network of stations. Established national standards for Fire RAWS will reduce the risk of bad data, malfunctioning sensors or stations, and potential for poor decisions based on misrepresentative data. National standards will provide the greatest opportunity for success in using Fire RAWS. Therefore in order to foster a more effective and efficient use of Fire RAWS and to mitigate the risk of potential bad data, the Fire Weather Subcommittee in conjunction with the RAWS Partners Group established national standards for Fire RAWS in May 2008.

SENSOR AND DATA REQUIREMENTS

These Fire RAWS standards are established to ensure a reliable level of data quality is available to wildland fire management operations, and do not apply to portable RAWS used for non-fire management uses. This category includes, but is not limited to Incident RAWS Kit (NFES #5869) currently available from the NFES. Due to the mobile and transient nature of their deployments, Fire RAWS data are not suitable for NFDRS applications. These standards are the minimum required, and may be exceeded by individual organizations.

Stations that are portable or mobile or are sometimes referred to as “quick deploy” should have such an indicator in their name in WFMI Weather (for example, Los Padres Portable #1). This helps other “downstream” users understand that these stations should not be considered for any long-term study or use.

Both required and optional sensor specifications follow.

STANDARDS FOR REQUIRED SENSORS AND DATA

Sensor data must transmit in English units.

Wind Speed

Wind speed is the rate at which air passes a given point.

Sensor Standards

Sampling Height	6 feet or higher.
Measurement Units	Statute miles per hour.
Range	0-100 miles per hour.
Resolution	1 Statute mile per hour.
Accuracy	+/- 5% of reading.

Data Standards - 10-Minute Average

Type of measurement	10-minute average from no less than 120 samples.
Data Logged	Hourly.
*Data Format	XXX.

Optional Measurement - Peak WS - Data Format Standards

Type of Measurement	Maximum speed for previous 60 minutes from no less than 720 samples.
Data Logged	Hourly.
*Data Format	XXX.

Wind Direction

Wind direction refers to the direction from which the air is moving.

Sensor Standards

Sampling Height	6 feet or higher.
Measurement Units	Degrees from true north.
Range	0-360 degrees.
Resolution	1 degree.
Accuracy	+/- 5 degrees.

Data Standards - 10 Min Average

Type of Measurement	10-minute average from no less than 120 samples.
Data Logged	Hourly.
*Data Format	XXX.

Optional Measurement - Peak WD - Data Format Standards

Type of Measurement	Direction at peak wind speed.
Data Logged	Hourly.
*Data Format	XXX.

Air Temperature

Air temperature refers to the air surrounding the weather station instrumentation.

Sensor Standards

Sampling Height	4-8 feet.
Measurement Units	Degrees Fahrenheit or Celsius.
Range	-58 degrees to +140 degrees.
Fahrenheit.	
	-50 to +50 degrees Celsius.
Resolution	1 degree Fahrenheit or .1 Celsius.
Accuracy	+/- 1 degree Fahrenheit.
	+/- .6 degree Celsius.

Data Standards

Type of Measurement	Instantaneous reading.
Data Logged	Hourly.
*Data Format	XXX.

Relative Humidity

Relative humidity is the percentage ratio of the actual amount of water vapor in the air to the amount of water vapor required for saturation at existing temperature.

Sensor Standards

Sampling Height	4-8 feet.
Measurement Units	Percent.
Range	0-100 %.
Resolution	1 %.
Accuracy	0-80% - +/- 2.00% at 25 degrees Celsius.
	80-100% - +/- 5% at 25 degrees Celsius.

Data Standards

Type of Measurement	10-Minute average from no less than 120 samples.
Data Logged	Hourly.
*Data Format	XXX.

STANDARDS FOR OPTIONAL SENSORS AND DATA

Rain Gauge - Optional

Precipitation is the amount of water falling upon the earth as rain or in frozen form such as snow, sleet, and hail. It is expressed as the depth of water that would cover a flat surface. Rainfall output will be the cumulative total of rainfall for the rain year determined by the agency or maintenance cycle. However, if the station reports year-round and the user determines the need for collecting year-round precipitation information, a winterized gauge (heated gauges, weighing-gauge, etc.) may be necessary. (Please note that stations, which do not have winterized precipitation gauges, will often show a large rain event in early spring due to normal thawing cycles.)

Sensor Standards

Sampling Height	1-6 feet, varies with mounting tower.
Measurement Units	Inches.
Range	00.00 through 99.99 inches.
Resolution	.01 inches.
Accuracy	+/-3% of total.

Data Standards

Type of Measurement	Continuous cumulative measurement.
Data Logged	Hourly.
*Data Format	XX.XX.

Battery Voltage – Optional

Battery voltage is the DCP/DataLogger battery current voltage. This item is recorded for remote troubleshooting and data validation purposes.

Data Standards

Range	0-15 Volts.
Resolution	1 Volt.
Accuracy	+/- .1 Volts.
Type of Measurement	Instantaneous.
Sample Interval	Hourly.
*Data Format	XX.X.

Solar Radiation - Optional

Solar radiation measures the amount of sunlight exposed to the fuels.

Sensor Standards

Sampling Height	4-8 feet (so not to be shaded during the day).
Measurement Units	Millivolts.
Resolution 1	Millivolt.
Output	Watts per meter squared.
Accuracy	+/- 5%.

Data Standards

Type of Measurement	60 minute average taken from 60 samples prior to transmit.
Data Logged	Hourly.
*Data Format	(-)XXXX.

Fuel Temperature - Optional

Fuel temperature is a temperature reading imbedded within a standard pine dowel, fully exposed to sunlight, above a representative fuel bed.

Sensor Standards

Sampling Height	10-12 inches.
Measurement Units	Degrees Fahrenheit or Celsius.
Range	14 to 140 degrees Fahrenheit.
	10 to 60 degrees Celsius.
Resolution	1 degree Fahrenheit or Celsius.
Accuracy	+/- 1 degree Fahrenheit or Celsius.

Data Standards

Type of Measurement	Instantaneous.
Data Logged	Hourly.
Data Format	XXX.

Fuel Moisture - Optional

Fuel moisture is the % weight of water particles present in a 100-gram '10-hour' Ponderosa pine dowel stick.

Sensor Standards

Sampling Height	10-12 inches or as recommended by manufacturer.
Range	0-25 grams.
Resolution	1.0%.
Accuracy	0-12% FM +/-1.9%.
	12-30% FM +/- 3.6%.
	> 30% FM +/- 16%.

Data Standards

Type of Measurement	Instantaneous.
Data Logged	Hourly.
Data Format	XXX.

Barometric Pressure - Optional

Barometric pressures measures the force exerted by the weight of the atmosphere per unit area, adjusted for elevation.

Sensor Standards

Sampling Height	As recommended by manufacturer.
Measurement Units	Inches Mercury (Hg).
Range	23.60 to 32.50 Hg.
Accuracy	+/- 0.02 Hg.

Data Standards

Type of Measurement	Instantaneous.
Data Logged	Hourly.
*Data Format	XXX.

*For those Fire RAWS that report via GOES, data format and transmission requirements are the same as NFDRS stations.

Radio Alert Function (optional)

The Incident RAWS Kit (NFES #5869) has a radio voice alert function that can broadcast current weather information upon either interrogation or detection of pre-set parameters. This function should be adjusted to user requirements. Other commercially available equipment may also offer this feature, and should also be adjusted to local requirements.

SITE SELECTION

Specific fire management and/or incident requirements may dictate site selection for where to setup a Fire RAWS. This should always be done in coordination with appropriate personnel. The general rule of thumb would be to locate the Fire RAWS in the area of your specific concern.

Site Selection Guidelines (typical deployment)

Fire RAWS generally should be located in a large, open area away from obstructions and sources of dust and surface moisture. Consider security (from animals and human vandalism) when selecting a site. The following are guidelines for a typical fire management operation:

- Locate the station in a place that is representative of the conditions existing in the specific area of concern. Consider vegetative cover type, topographic features, elevation, local climate and weather patterns, etc.
- Deploy the Fire RAWS so as to give data that is representative of the specific area in which the project or wildland fire is located. Consider exposure requirements for each instrument in relation to such things as prevailing winds, movement of the sun, topography, vegetative cover, nearby reflective surfaces, and wind obstructions. Recommendations for station deployment:
    - Deploy a station where it represents the average conditions for your concerns.
    - If an additional Fire RAWS is available, it may be beneficial to deploy it in an area that represents worst case conditions.

In accordance with the above rules, the following situations would generally be avoided when selecting a station site:

- **Sources of dust** such as roads and parking areas. If unavoidable, locate station at least 100 feet on the windward side of the source.
- **Sources of surface moisture** such as irrigated lawns, pastures, gardens, lakes, swamps, and rivers. If unavoidable, locate station several hundred feet to the windward side of the source.
- **Large reflective surfaces** such as white painted buildings. The same holds for natural reflective surfaces such as lakes, ponds, canals, and large rock surfaces. If unavoidable, locate station on north side, but far enough away so as not to be artificially shaded or influenced (at least a distance equal to the height of the reflective surface or 50 feet, whichever is greater).
- **Extensively paved or black-topped areas.** If unavoidable, locate station at least 50 feet to the windward side.
- **Large buildings.** Locate station at least a distance equal to the height of the obstruction.

General Fire RAWS equipment specifications

Any Fire RAWS unit that is purchased or used must be very sturdy, rugged and robust. Requirements include:

- Survive 100 miles per hour winds when properly anchored.
- Withstand extremes of environmental conditions.
- Self-supporting structure with a sturdy tripod frame or other suitable system.
- Portable, easily transportable and easy to deploy.
- Powered by solar panel and/or battery system to allow for "stand alone" remote operations. Battery voltage should be checked periodically. Batteries must be changed every 3-4 years, or as needed.

Note: Prior to demobilization or movement of a Fire RAWS, it is important to consult with neighboring agencies and fire teams. It is possible that these neighbors may be using the Fire RAWS data.

FIRE RAWS MAINTENANCE POLICY

Annual Maintenance

At a minimum, annual service (+/- 45 days) for Fire RAWS must be performed to ensure general system integrity, allow necessary preventative maintenance, and to replace sensors and components prior to expiration of their calibrated lifetimes. Service contracts for this purpose can be requested through the BLM's Remote Sensing / Fire Weather Support Unit (RSFWSU) in Boise, Idaho, or any vendor that will meet the national standards for field or depot-level service as outlined in this document.

A Fire RAWS may be used several times in a one year period, requiring multiple unpacking and repacking actions. Care must be taken to perform this task, as environmental sensors are sensitive equipment that can easily be damaged and thrown out of calibration. Also, the humidity sensor is particularly susceptible to degradation when exposed to smoky or dusty conditions. When sensors are damaged or degraded by use before the annual service date, it is the responsibility of the Fire RAWS owner to ensure proper maintenance and recalibration is performed before the equipment is redeployed. Verification of sensor performance with alternate methods (for example, a belt weather kit) is highly recommended. Significant discrepancies should encourage maintenance action.

ANNUAL MAINTENANCE AND SENSOR REPLACEMENT STANDARDS

Sensors and key components of a Fire RAWS must be recalibrated or replaced on a regular basis to ensure the collection of consistent and reliable weather data. The entries for specific equipment below outline yearly preventative maintenance, as well as minimum replacement times for each component.

Wind Speed - Check for damage and alignment of cups, ice skirt, and free movement of bearings.

MINIMUM CALIBRATION/REPLACEMENT - 2 Years.

Wind Direction - Check for damage of pointer and feather, free movement of bearings. Manually rotate the sensor through each of the four quadrants and scan the data for accuracy.

MINIMUM CALIBRATION/REPLACEMENT - 2 Years.

Ultrasonic Wind Speed/Wind Direction – No calibration required, clear any obstruction between arms of transducers.

Relative Humidity/Air Temperature - Not field serviceable; do not open.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Battery - Perform a voltage test. Replace batteries according to manufacturer recommendations or if you suspect problems. Some manufacturers recommend yearly, others recommend every three to seven years.

MINIMUM REPLACEMENT – Per manufacturer's specification.

for internal "D" cell (Supplemental Power) – Yearly.

GOES Antenna - Check for broken, loose, or bent elements, proper alignment, and connectors for corrosion.

MINIMUM CALIBRATION/REPLACEMENT - As needed.

Cables/Wiring - Check for cracking, deterioration, corrosion, proper routing, and security. Ensure O-rings are installed on all connectors. Replace as required for corrosion, aging, etc. Treat all connectors with moisture inhibitor (if required by the manufacturer).

MINIMUM CALIBRATION/REPLACEMENT - As needed.

Masts/structural members - Check for structural damage, proper alignment, and leveling. Be aware of safety risks when dealing with a potentially damaged structure (for example, rust, corrosion, cable fray, etc.).

MINIMUM CALIBRATION/REPLACEMENT - As needed (or per manufacturer's specifications).

DCP/DataLogger - Check for security, damage, and ensure that all cables are properly connected. Verify the unit has the most recent version of the software or firmware installed. Change out as needed (defective, evidence of moisture, corrosion, rust, etc.).

MINIMUM CALIBRATION/REPLACEMENT – As needed (or per manufacturer's specifications).

Tipping Bucket (optional) – Remove cover. Clean cover and orifice to ensure free flow of water. Do not disassemble further. Check all connections and verify that the instrument is level. Unless the rain year is reset automatically by the DCP/DataLogger on a certain date each year, reset the tipping bucket to 00.00. Then simulate .02 inches of rain and validate that it was recorded by the DCP/DataLogger. Other rain gauge equipment should be maintained to manufacturer's specification.

MINIMUM FIELD VALIDATION - 1 Year.

MINIMUM DEPOT CALIBRATION/REPLACEMENT - 3 Years.

Solar Radiation (optional) - Sensor must be cleaned periodically using only *water* and/or a mild detergent such as dishwashing soap.

MINIMUM CALIBRATION/REPLACEMENT - 3 Years.

Fuel Temp (optional) – Fuel stick sensor should be checked for obvious cracking, deterioration and security. Not field serviceable; do not open.

MINIMUM CALIBRATION/REPLACEMENT – As needed (or per manufacturer's specifications).

Fuel Moisture (optional) – Fuel stick sensor should be checked for obvious cracking, deterioration and security. Not field serviceable; do not touch or remove wood veneer. Fuel stick should be oriented North/South with screws facing the ground. Optimum height should be 12 inches above the fuel bed and level.

MINIMUM CALIBRATION/REPLACEMENT – 1 Year.

Barometric Pressure (optional) – Not field serviceable; do not open.

MINIMUM CALIBRATION/REPLACEMENT – As needed.
(or per manufacturer's specifications).

Depot Sensor Calibration Standards

The maintenance service under contract will rehabilitate and calibrate sensors to the specifications contained in this document.

Sensor Documentation - A maintenance history record shall be kept for each component that is repaired/calibrated by any maintenance service under contract. These records are kept on file by serial number and used by depot and agency staff for spotting systematic problem areas that may have impact on the program.

Test Equipment – The test equipment and associated tools used during depot sensor calibration routines shall follow a general practice of "Traceability protocol" based on standards maintained by the National Bureau of Standards (NBS). This results in claims of calibrations that are "traceable to NBS".

Documentation

The Fire RAWS owner or maintenance service provider must ensure annual maintenance and emergency repair is documented in WFMI Weather. This will include, at a minimum:

- Maintenance date (date that Relative Humidity / Air Temperature was changed / calibrated).
- Specific sensors and serial numbers of those sensors (documented in WFMI Weather or other appropriate database).
- A narrative of the annual service, including what maintenance was accomplished and any miscellaneous information.

NFDRS MANUAL WEATHER STATION STANDARDS AND GUIDELINES

INTRODUCTION

The traditional, manual-type fire weather stations have been a valuable source of data since their inception in the 1920's (Finklin, 1990). The observations were dependent on the presence of an observer who read the instruments, enter the data on appropriate forms, and communicate the data to a central office. Since the observations were observer dependent, the stations were typically located at an administrative or field office in a valley bottom or at a lookout or guard station at higher elevations.

STATION CLASSIFICATIONS

This section includes station standards for manual weather stations.

Note: **The minimum manual standard is the Seasonal Data Collection Station**.

Manual Weather Stations - Includes manual stations providing basic NFDRS inputs to WIMS during operational period. One observation is delivered to WIMS at 1300 hours for every 24-hour period during operating season. There are two types of manual NFDRS weather stations:

Manual - Year Round Data Collection Stations - Includes all permanent stations that meet the following criteria:

- Operates to minimum standards year round to support designated wildland fire season.
- Equipped with the minimum equipment (see page 38).
- Meets minimum quality assurance requirements.
- NFDRS calculations are processed regularly in WIMS delivering historical data to the FAMWEB data warehouse.
- (Optional) winterized rain gauge (weighing gauge, heated gauge, etc.) if necessary.

Manual - Seasonal Data Collection Stations - Includes all permanent 24 hour observing stations that meet the following criteria:

- Operates to minimum standards to support designated wildland fire season (can operate 12 months or less).
- Equipped with the minimum equipment (see page 38).
- Meets minimum quality assurance requirements.
- NFDRS calculations are processed regularly (during seasonal operational period) in WIMS delivering historical data to the FAMWEB data warehouse.

OPERATIONAL PERIOD

The optimal operating period for all manual weather stations used for the NFDRS is year-round. However, the minimum operational period is dictated by the following:

- A minimum 30-day startup period prior to the need for NFDRS indices, i.e., the wildland fire season as designated by the local manager, Region, or Geographic Area Coordination Center, is required for each seasonal weather station to properly calibrate the model.
- Annual fluctuations in season length. Use of the visual greenness or Growing Season Index images (both available on the U.S. Forest Service Wildland Fire Assessment System page at http://wfas.net) is recommended to assist the local or regional fire manager.

Non-owner use. The following guidelines are recommended for any use of a weather station for NFDRS that is not owned by the user.

- Notify the station owner that you are using this station for NFDRS or other applications.
- When a longer operating season is required by an adjoining unit, the non-owning user should assist in the management of that station, including any additional costs for operation or maintenance.

SENSOR AND DATA REQUIREMENTS

NFDRS Manual Fire Weather Station Minimum Instrument Complement

To provide the data necessary for computing fire danger rating (NFDRS) components and indexes, a fire-weather station should contain the following basic equipment:

- Dry bulb and wet bulb thermometers (psychrometer).
- Maximum and minimum thermometers.
- Instrument shelter for housing the thermometers.
- Anemometer and wind speed readout device.
- Wind vane.
- Fuel moisture sticks and scale.
- Nonrecording rain gauge.
- Hydrothermograph.

More specific information related to instrumentation for a manual fire weather station can be found in the *Weather Station Handbook – An Interagency Guide for Wildland Managers*, PMS 426-2 (Finklin, 1990).

Rain Gauge

Precipitation is the amount of water falling upon the earth as rain or in frozen form such as snow, sleet, and hail. It is expressed as the depth of water that would cover a flat surface.

Sensor Standards	**Rim level 36 inches above the ground**
Sampling Height	Varies.
Measurement Units	Inches.
Range	Varies.
Resolution	0.01 inches.
Accuracy	0.01 inches.
Data Standards	
Type Measurement	1 measurement per day.
Data Logged	1 measurement per day.
Data Format	XX.XX.

Wind Speed

Wind speed is the rate at which air passes a given point.

Sensor Standards	
Sampling Height	20 feet above open level ground or surrounding vegetation.
Measurement Units	Statute Miles per Hour.
Range	0-100 miles per hour.
Accuracy	1 mile per hour.
Data Standards	
Type of measurement	10-minute average at the time of observation.
Data Logged	1 observation per day.
Data Format	XXX.

Wind Direction

Wind direction refers to the direction from which the air is moving.

Sensor Standards

Sampling Height	20 feet above open level ground or surrounding vegetation.
Measurement Units	Degrees from true north.
Range	0-360 degrees.
Accuracy	+/- 10 degrees.

Data Standards - 10 Minute Average

Type of Measurement	10-minute average at the time of observation.
Data Logged	1 daily measurement.
Data Format	XXX.

Air Temperature

Air temperature refers to the air surrounding the weather station instrumentation. Instruments are located inside an instrument shelter. Floor of the shelter is 48 inches above level ground.

Sensor Standards

Sampling Height	4.5 to 5 feet, inside shelter.
Measurement Units	Degrees Fahrenheit.
Range	-58 degrees to +140 degrees Fahrenheit.
Accuracy	+/- 0.3 degrees Fahrenheit.

Data Standards

Type of Measurement	Instantaneous reading for 1300 observation, max/min temperature.
Data Logged	1 daily measurement.
Data Format	XXX.

Relative Humidity

Relative humidity is the percentage ratio of the actual amount of water vapor in the air to the amount of water vapor required for saturation at existing temperature. Instruments are located inside an instrument shelter. Floor of the shelter is 48 inches above level ground.

Sensor Standards

Sampling Height	4 to 4.5 feet, inside shelter.
Measurement Units	Percent.
Range	0-100%.
Accuracy – from wet bulb/dry bulb	3 %.

Data Standards

Type of Measurement	Instantaneous from 1300 observation and max/min from hydrothermograph.
Data Logged	1 daily measurement.
Data Format	XXX.

Fuel Moisture (optional) – Fuel stick sensor should be checked for obvious cracking, deterioration and security. Not field serviceable; do not touch or remove wood veneer. Fuel stick should be oriented North/South with screws facing the ground. Optimum height should be 10 inches above the fuel bed and level.

Fuel moisture indicator sticks are used to estimate the moisture content of the small diameter (1/4 to 1 inch or 10-hour time lag) dead woody fuels. Unlike conventional weather instruments, the fuel moisture sticks do not measure any single weather element; rather, they measure the effects of sky condition, temperature, humidity, precipitation, and season on the flammability of forest fuels as characterized by the percent fuel moisture of the stick.

Sensor Standards

Sampling Height	10 inches above a fresh litter bed, exposed 7 am – 7 pm local time.
Measurement Units	Grams – conversion to percent fuel weight moisture.
Range	0% - 25%.
Accuracy	+/- 0.5%.

Data Standards

Type of Measurement	Instantaneous from 1300 observation.
Data Logged	1 daily measurement.
Data Format	XX.X.

SITE SELECTION

Process for Installing a New and/or Moving an Existing Station:

- When installing a new or moving an existing station, it is particularly important to involve NWS fire weather and Predictive Services meteorologists along with other interagency wildland fire personnel (as appropriate) in determining a new site or relocating an existing station.
- Contact your agency and/or regional RAWS coordinator. To get help from your national coordinator, go to the interagency web page at National Interagency Fire Center Interagency Remote Automatic Weather Stations at http://raws.fam.nwcg.gov/contacts.html. It is particularly important to contact your agency weather station coordinator when moving an existing station in order to maintain integrity of historical data. If an existing station has been moved, relocation information must be updated in WIMS application to clearly include the fact that the station is reporting from a new location.
- Obtain the following station site information: station name, legal (Township, Range, quarter-section), county, elevation, latitude/longitude, and data measurement elements. Complete station information is to be entered in the WFMI Weather database. For latitude and longitude, NAD 83 is the datum standard and the data are to be entered in degrees/minutes/seconds and decimal seconds out to the nearest hundredth (two decimal places). Ensure that station data entered into WFMI Weather and WIMS are identical.
- Obtain a six-digit weather station identification number (also referred to as NWS/WIMS station ID number) for your station through your GACC Predictive Services unit.

Site Selection Guidelines:

The standard fire weather station should be located in a large, open area away from obstructions and sources of dust and surface moisture. The station should be on level ground where there is a low vegetative cover. Furthermore, it should be situated to receive full sun for the greatest possible number of hours per day during the fire season. The site should be "shadow free" from 0700 to 1700 LST. If located on a slope, a south or west exposure is required to meet fire danger rating standards. (John E. Deeming, 1972)

Consider security (from animals and human vandalism) when selecting a site. To prevent any damage from wildlife, livestock etc., installation of a fence is highly recommended.

The following rules govern the location of an NFDRS fire weather station:

- Locate the station in a place that is representative of the conditions existing in the general area of concern. Consider vegetative cover type, topographic features, elevation, climate, local weather patterns, etc. Usually a station's data are applied to many tens of square miles, if not hundreds of square miles.
- Select a site that will provide for long-term operation and a relatively unchanged exposure. Consider site development plans, e.g., roads, buildings, parking areas; ultimate sheltering by growth of vegetation; and site accessibility during the intended operational period.
- Arrange the station so as to give data that is representative of the area in which the station is situated. Consider exposure requirements for each instrument in relation to such things as prevailing winds, movement of the sun, topography, vegetative cover, nearby reflective surfaces, and wind obstructions.

In accordance with the above rules, the following situations should be avoided when selecting a station site:

- **Sources of dust** such as roads and parking areas. If unavoidable, locate station at least 100 feet on the windward side of the source.
- **Sources of surface moisture** such as irrigated lawns, pastures, gardens, lakes, swamps, and rivers. If unavoidable, locate station several hundred feet to the windward side of the source.
- **Large reflective surfaces** such as white painted buildings. The same holds for natural reflective surfaces such as lakes, ponds, canals, and large rock surfaces. If unavoidable, locate station on north side, but far enough away so as not to be artificially shaded or influenced (at least a distance equal to the height of the reflective surface or 50 feet, whichever is greater).
- **Extensively paved or black-topped areas.** If unavoidable, locate station at least 50 feet to the windward side.
- **Large buildings, trees, and dense vegetation.** Locate station at least a distance equal to the height of the scattered obstructions. Ideally, when dealing with tall, dense vegetation the station should be located a distance that is equal to seven times the height of the obstructing vegetation.
- **Distinct changes in topography** such as gullies, peaks, ridges, steep slopes, and narrow valleys.

For additional information: *Weather Station Handbook - An Interagency Guide for Wildland Managers*, PMS 426-2. (Finklin, 1990)

Note: Agencies that are considering buying a new weather station for use in NFDRS, should consult the local National Weather Service, Predictive Services and other interagency partners. A consensus among these groups will ensure the interagency NFDRS station network is adequate and limit the cost of needless station overlap.

INSTALLATION

Once a site is selected that meets all of the site standards, it can then be prepared for installation of a weather station. The suggested layout for a standard fire weather station is available in the *Weather Station Handbook - An Interagency Guide for Wildland Managers*, PMS 426-2. (Finklin, 1990).

STATION MAINTENANCE POLICY

Annual Maintenance

Annual service of NFDRS manual stations will provide an opportunity to ensure general station integrity, perform necessary preventative maintenance.

Every NFDRS manual station must receive, at a minimum, one annual on-site maintenance visit by either the local user or contracted personnel to ensure sensors are within calibration standards, and verify site and station conditions.

The site inspection also allows for maintaining vegetation growth or mitigating other site parameters, e.g., new irrigation systems, buildings, that may be compromising site integrity**. It is important to keep vegetation trimmed at the surface to ensure it doesn't block wind and air flow to sensors.** Reasonable attempts must be made to keep the site in accordance with siting guidelines. If there are regulations prohibiting appropriate site maintenance required to provide

representative data, develop a plan to bring the station into compliance. This could be done by obtaining any necessary special authorizations to manage vegetation, or in the most unfavorable case, moving the station. If sites are considerably compromised, it is critical to document this in the station metadata, including photographs, so that users of the data have the opportunity to assess its value to them.

Unscheduled Maintenance / Emergency Repair

Local land managers are responsible for monitoring the quality of the data produced by the weather stations in their fire response area. In the event of instrument failures, bad data, or questionable data, it is the responsibility of the station owner to initiate corrective action.

All NFDRS station failures will be responded to as appropriate in light of the following:

- Bad data affects the outputs of the model immediately. Responses to bad data, during fire season where the station is located, should be initiated immediately. Failures that occur outside fire season will be repaired before the station is initiated for the following fire season.
- During fire season, action must be taken to respond to missing data as soon as possible, but no more than 3 days. Outside fire season responses will be made before the station is initiated for the following fire season.

ANNUAL MAINTENANCE AND SENSOR REPLACEMENT STANDARDS

Sensors of an NFDRS manual fire weather station must be recalibrated or replaced on a regular basis to ensure the collection of consistent and reliable weather data throughout the NFDRS fire weather network. Annual service of NFDRS manual fire weather stations will provide an opportunity to ensure general station integrity, perform necessary preventative maintenance, and replace sensors and components prior to expiration of their calibrated lifetimes.

Maintenance Checklist

This checklist servers as a guide for the inspector and is helpful in training new observers. Its use is strongly recommended.

A. Enclosure

- Fence and gate in good repair.
- Area well maintained.
- Vegetation neatly clipped.
- In keeping with the surroundings.

B. Instrument Shelter

- Well ventilated.
- Door faces north.
- Level and solidly mounted.
- Clean inside and out.
- Kept well painted.

C. Rain Gauge

- Firmly mounted, with top level and round.
- Free of dents, leaks, and debris.
- Measuring stick legible and in good repair.
- 45 degree angle from top of gage clears all obstructions.
- Top approximately 3 feet above ground.
- Mount kept painted.

D. Psychrometers

- Wick changed every two weeks.
- Wick extends an up stem.
- Wicking clean, and not crusted.
- Thermometer bulbs clean.
- Thermometer marking clearly legible.
- Thermometers agree within ½ degree when read as dry-bulb thermometers.
- Clean mineral-free water used.
- Wet bulb brought to its lowest point.
- Extra wicks on hand.

E. Anemometers

- Cups at proper elevation.
- Cups firmly attached to spindle.
- Cups undamaged.
- Spindle turns freely.
- Firmly mounted and plumb.
- Maintenance schedule followed.
- Protected from lightning.
- Electrical contacts in good order.
- Power supply adequate.
- Recording device satisfactory.

F. F. Fuel Moisture Sticks and Scale

- Stick fully exposed to the sun throughout the day.
- Stick in good condition. (Replace when cracked or after 60 days).
- Litter bed in good condition.
- Scale checked with 100 gram weight and adjusted to zero if necessary.

G. Operation and Records

- Precipitation measured and correctly recorded.
- Wind measured and recorded correctly.
- Wet bulb and dry bulb temperatures measured and recorded correctly.
- Maximum and minimum temperature values measured and recorded correctly.
- Station catalog information correct.
- Reading taken at scheduled time.
- Records neat and legible.
- Tables used correctly.

When a fire weather station is inspected, a written record should be made for administrative review and subsequent action where needed. An inspection form is a convenient way of summarizing the good or poor characteristics of a site and of indicating where remedial measures are needed.

Maintenance procedures for the instrumentation installed at manual weather stations are found in the *Weather Station Handbook - An Interagency Guide for Wildland Managers*, PMS 426-2. (Finklin, 1990)

Field Service

Nonrecording rain gauge – Check for leaks or dents. Clean.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Hydrothermograph – Perform a calibration test.

MINIMUM VALIDATION – Periodically.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Wind Speed - Check for damage and alignment of cups. Clean.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Wind Direction - Check for damage of pointer and feather, free movement of bearings. Manually rotate the sensor through each of the four quadrants and scan the data for accuracy. Clean.

MINIMUM CALIBRATION/REPLACEMENT – Yearly.

Relative Humidity/Air Temperature – Check for defects. Clean.

MINIMUM CALIBRATION/REPLACEMENT – Periodically.

Sensor Documentation - A maintenance history record shall be kept for each component that is repaired/calibrated. These records should be kept on file at the local unit. The documentation is useful in working to develop better quality products.

OBSERVER REQUIREMENTS

The observers at manual fire weather stations are typically agency personnel with specialties outside the field of fire weather. Training should be provided to foster proper skill and awareness in observing practices; familiarity with instruments and simple maintenance measures.

Observer responsibilities include the following tasks:

- Making the required observations at the required times with required accuracy.
- Encoding the logging or dispatching the data at necessary; actual transmission of data may be the task of another person.
- Changing the charts of recording instruments on the scheduled days.
- Performing calibration checks of recording instruments and making simple adjustments as necessary.
- Maintaining the instrument is in good order. This includes daily or periodic external dusting and cleaning of instruments to maintain easy readability of marked graduations, maintain free movement of linkages on recording instruments, and deter corrosion.
- Noting instrumental defects, such as column separation in thermometers; applying simple corrective measures or reporting to supervisor for further action.

Further details on observer responsibilities are outlined in the *Weather Station Handbook - An Interagency Guide for Wildland Managers*, PMS 426-2. (Finklin, 1990)

ACRONYMS

DCP - Data Collection Platform, also known as a DataLogger. The central processing unit for an automated weather stations through which all sensor data is gathered and forwarded to the GOES radio transmitter.

FAMWEB Data Warehouse - The FAMWEB Data Warehouse pulls data from existing applications/databases that manage data on FIRESTAT fire occurrence daily-and other federal/state agencies annually, incidents, and weather. Data in the warehouse is organized into categories of data called topic areas.

FENC - Fire Environment Committee chartered under the NWCG.

FEOU - Fire Environment Observation Unit – previously the RAWS Partners - chartered by the Fire Weather Subcommittee under the Fire Environment Committee.

Fire RAWS - A portable RAWS that conforms to standards of data collection and maintenance specified in the Fire Weather Stations Standards and Guidelines document.

FWSC - Fire Weather Subcommittee – a subcommittee under the Fire Environment Committee.

GOES - Geostationary Operational Environmental Satellite - The satellite used for data relay from weather stations to WFMI Weather. Note: The GPS sensor is only used to ensure transmission synchronization with GOES.

GREEN-UP - Green-up for the 1978 version of the NFDRS model is defined as the beginning of a new cycle of plant growth. Green-up usually occurs once a year, except in desert areas where rainy periods can produce a flush of new growth more than once a year.

IMET - Incident Meteorologist.

NESDIS - National Environmental Satellite Data Information Service.

NFDRS - National Fire Danger Rating System.

NFDRS Update - Update to the NFDRS system that includes the implementation of the Nelson Model in conjunction with solar radiation sensors to automate fuel moisture calculations.

NWCG - National Wildfire Coordinating Group.

NWS - National Weather Service.

RAWS - Remote Automatic Weather Stations

RSFWSU - Remote Sensing/Fire Weather Support Unit – Operated by the BLM as an interagency weather station repair and maintenance facility located in Boise, Idaho.

WFAS - Wildland Fire Assessment System.

WIMS - Weather Information Management System – The national operational NFDRS calculator.

WFMI Weather - The Wildland Fire Management Information (WFMI) Weather module provides access to the weather data that is transmitted from the more than 2500 Remote Automatic Weather Stations (RAWS) located throughout the U.S.

WRCC - Western Regional Climate Center - One of 6 regional climate centers of the National Climatic Data Center (NCDC). The official archive location for hourly RAWS data.

WWV - Call sign for worldwide universal time radio transmission.

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