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National Fire Danger Rating System
Weather Station Standards

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NATIONAL FIRE DANGER RATING SYSTEM

Weather Station Standards

A publication of the NWCG Fire Weather Working Team

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This publication is available at www.nwcg.gov or www.fs.fed.us/raws.

PREFACE

The National Fire Danger Rating System (NFDRS) is a 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.

The weather station network supporting NFDRS has grown in a piecemeal fashion over the past 30 years. Inconsistent station standards, maintenance, fire weather network analysis, data communication and archiving has left the system with some deficiencies - - both real and perceived. This fragmented approach has compromised system reliability and data integrity. 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 safety. Firefighter safety is our number one priority.

As stated by Mary Jo Lavin, former Director, USFS Fire & Aviation Management, "We cannot afford breakdowns in this important element of the fire management program for many reasons, including the accomplishment of safe and efficient fire management program operations. We need to strengthen management of this program element to ensure accurate, timely, and consistent data collection is provided from every NFDRS reporting station---no matter what, we must insure that this is done!" The NWCG Fire Weather and Fire Danger Working Teams are committed to better planning, technology transfer, and life-cycle management as we move to the NFDRS update.

This NFDRS Update will be a more passive (less human interaction required) and explicit (in space and time) fire management decision support tool. Several complexities in the current NFDRS have recently been removed; specifically the human and lightning risk factors. A new dead fuel moisture model that depends solely on sensed data is being field-tested. Human entry state-of-the-weather will no longer be required. This means that every automated observation entering the system can be processed and archived. Our historical databases tell us, time and time again, that critical fire weather observations are often missing during periods of high fire activity.

The vision of the NFDRS Update is to move towards fire behavior based information (versus climatologic) that smoothly transitions between information needs for both fire behavior and fire danger. We hope to do this by more completely describing the state of the fuels (arrangement and moisture) with much less human intervention.

Stations compliant with the NFDRS Update will provide remotely sensed weather data--temperature, humidity, precipitation, wind and solar radiation on an hourly basis via the GOES satellite.

Over the past ten years, several attempts have been made at implementing standards for interagency weather stations supporting NFDRS. As we plan for the NFDRS Update, it is critical that we establish and implement weather station standards to support this technology.

Much of the current fire weather network, in concert with higher resolution mesoscale weather models and satellite-sensed live fuel moisture, is posed to provide the needed data for the NFDRS Update. With a coordinated technology investment over the next 5 years of weather station life-cycle planning and maintenance, the entire fire weather network can provide regular and reliable weather inputs to the NFDRS and other wildland fire management activities.

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INTRODUCTION

This document has been composed to provide common standards for weather stations used by the wildland fire agencies for calculation of NFDRS indices. This document is intended to supplement and update portions of The Weather Station Handbook: an Interagency Guide for Wildland Managers, Finklin/Fischer, (NFES 2140, PMS 426-2). The standards contained herein are a reflection of a cost/benefit analysis, interagency discussion and direction provided by the Fire Weather Working Team to the Weather Station Standards Task Group.

STATION CLASSIFICATIONS

This section includes station standards for current NFDRS weather stations as well as standards for the NFDRS Update. WIMS will be modified to include an entry for these station classifications in the station catalog. ***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 12 months of the year to support designated wildland fire season
- operates properly with 3-day response time to system failure year-round
- equipped with the minimum NFDRS sensor compliment
- meets minimum quality assurance requirements
- 24-hourly readings are delivered to WIMS** hourly via GOES
- NFDRS calculations are processed regularly in WIMS delivering historical data to the NIFMID database.
- (Optional) winterized rain gauge (weighing gauge, heated gauge, etc.) if necessary.

***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)
- operates properly with 3-day response time to system failure during fire season. Outside fire season, response is at owner discretion.
- equipped with the minimum NFDRS sensor compliment
- meets minimum quality assurance requirements
- 24 hourly readings are delivered to WIMS*** hourly via GOES during seasonal operational period.
- NFDRS calculations are processed regularly (during seasonal operational period) in WIMS delivering historical data to the NIFMID database.

Other - Includes all resource, special purpose, portable and miscellaneous stations that provide accurate weather data but does not meet the NFDRS standard.

Manual Weather Stations - Includes manual stations providing basic NFDRS inputs to WIMS during operational period. One observation is delivered to WIMS every 24-hour period during operating season. Stations are maintained according to the publication NFES 2140 AWeather Station Handbook - An Interagency Guide for Wildland Managers. **This classification goes away when full transition to the NFDRS Update has taken place.**

****During the transition period, GOES telemetered stations may transmit a minimum of 8 times daily during the seasonal operating period.**

*****During the transition period, telephone telemetered stations will deliver data to WIMS a minimum of 4 times daily during the seasonal operating period.**

TELEMETRY POLICY AND TRANSITION PLAN

The following telemetry and input standardization will begin upon adoption of these standards. It must be stressed that **this ONLY affects stations in support of NFDRS**. A transition period to prepare for the NFDRS Update over the next five years will give managers the ability to minimize future financial impacts as they upgrade their networks through normal life-cycle management.

1. All existing non-GOES telemetered automated NFDRS weather stations (AWS) will submit hourly readings to WIMS a minimum of once per day during the operational period. It is recommended that owners of non-GOES stations participate in the HUB* (as it currently exists, without further modification) rather than purchase additional copies of COTS software to perform this function. Data delivery to WIMS, where local HUBS already exist, is acceptable.

2. Upon full transition to the NFDRS Update, all stations designated for NFDRS use will deliver data to WIMS via GOES Satellite telemetry on an hourly basis. The GOES transmitter and format used must be compatible with the ASCADS system. Implementation and/or transition to GOES telemetry is to be accomplished over the normal life-cycle management process of each participating agency and within 5 years of acceptance of this document by NWCG.

GOES telemetry is the minimum standard for the NFDRS Update. However, station owners may apply additional telemetry options as desired at the local level.

* For more information about the HUB see WIMS Tech Note 98-09.

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:

1. A minimum 30-day start up period prior to the need for NFDRS indices is required for each seasonal weather station to properly calibrate the model. Seasonal start-up guidelines are described in the NFDRS User's Guide, NFES No. 1522, PMS No. 430-3, October 1985, Page 6.

2. Wildland fire season as designated by the local manager, Region, or Geographic Area Coordination Center

3. Annual fluctuations in season length. Use of the visual greenness images available on the WFAS home page 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.

1. Notify the station owner that you are using this station for NFDRS or other applications.

2. 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

Automated NFDRS Station Minimum Sensor Compliment

Hourly measurements of precipitation duration and amount, 10-minute average wind speed, 10-minute average wind direction, air temperature, and relative humidity. The NFDRS Update will require solar radiation sensor.

A note about automated fuel temperature/moisture measurements: The National Fire Danger Working Team recommended that a fuel moisture value obtained from an automated source (fuel moisture/fuel temperature sensors) are not to be used in NFDRS calculations. Only OBSERVED measurements of fuel conditions are to be used (manual fuel sticks). In the NFDRS Update, solar radiation sensors will provide input to the model that will produce fuel moisture/fuel temperature values determined to be more reflective of actual conditions.

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 taken between 30 and 45 minutes past the hour.

Note: GOES telemetered NFDRS stations will be assigned transmission slots as near the top of the hour as possible. The intent is to have these assignments within 15 minutes either side of 00 (0045-0015). Non-NFDRS GOES telemetered stations will be assigned transmissions slots in the bottom half of the hour (0015-0045).

Sensors shown as optional may be used to accommodate local needs. Not every sensor possibility is listed.

Rain Gauge (NFDRS)

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 section of this documentation 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 Requirements

Sampling Height	1-6 feet, varies with mounting tower
Measurement Units	Inches
Range	00.00 through 99.99 inches
Resolution	.01 inches

Data Requirements

Type Measurement	Continuous cumulative measurement
Sample Interval	Hourly
Data Format	XX.XX

Wind Speed (NFDRS)

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

Sensor Requirements

Sampling Height	20 feet
Measurement Units	Statute Miles per Hour
Range	0-150 mph
Resolution	.25 miles per hour

Data Requirements - 10-Minute Average

Type of measurement	10-minute average from 600 samples
Sample Interval	Hourly
Data Format	XXX

Optional Measurement - Peak WS - Data Format Requirements

Type Of Measurement	Maximum speed from previous 60 minutes
Sample Interval	Hourly
Data Format	XXX

Wind Direction (NFDRS)

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

Sensor Requirements

Sampling Height	20 feet
Measurement Units	Degrees from True North
Range	0-359 degrees
Accuracy	+/- 2 degrees

Data Requirements - 10 Min Average

Type of Measurement	10-minute average from 600 samples
Sample Interval	Hourly
Data Format	XXX

Optional Measurement - Peak WD - Data Format Requirements

Type of Measurement	Direction at Peak Wind Speed
Sample Interval	Hourly
Data Format	XXX

Air Temperature (NFDRS)

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

Sensor Requirements

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

Data Requirements

Type of Measurement	Instantaneous reading
Sample Interval	Hourly
Data Format	XXX

Fuel Temperature - Optional

Fuel temperature is a temperature reading imbedded within a ¾-inch pine dowel, fully exposed to sunlight, above a representative fuel bed.

Sensor Requirements	
Sampling Height	10-12 inches
Measurement Units	Degrees Fahrenheit
Range	-58 degrees to +122 degrees Fahrenheit
Resolution	.1 degree
Data Requirements	
Type of Measurement	Instantaneous
Sample Interval	Hourly
Data Format	XXX

Relative Humidity (NFDRS)

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 Requirements	
Sampling Height	4-8 feet
Measurement Units	Percent
Range	0-100 %
Accuracy	0-80% - +/- 2% at 20 degrees Centigrade 80-100% - +/- 5% at 20 degrees Centigrade
Data Requirements	
Type of Measurement	10-Minute average from 600 samples
Sample Interval	Hourly
Data Format	XXX

Battery Voltage (NFDRS)

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

Data Requirements	
Range	0-15 Volts
Accuracy	.1 Volts
Type of Measurement	Instantaneous
Sample Interval	Hourly
Data Format	XX.X

Barometric Pressure - Optional

Atmospheric pressure corrected for elevation.

Sensor Requirements	
Sampling Height	Varies with enclosure mounting
Measurement Units	Inches of Mercury
Output	Varies with site elevation.
Resolution	.15% of range span
Data Requirements	
Type of Measurement	Instantaneous
Sample Interval	Hourly
Data Format	XX.XX

Fuel Moisture - Optional
Fuel moisture is the weight of water particles present in a 100-gram pine dowel stick. This measurement may be a calculated value derived from moisture readings of a pine dowel.

Sensor Requirements	
Sampling Height	10-12 inches
Range	0-25 grams
Accuracy	10 % of indicated value
Data Requirements	
Type of Measurement	Instantaneous
Sample Interval	Hourly
Data Format	XXX

Solar Radiation - (NFDRS Optional/NFDRS Update **Required**)
Solar radiation measures the amount of sunlight exposed to the fuels.

Sensor Requirements	
Sampling Height	5-8 feet
Measurement Units	Millivolts
Output	Watts per meter squared
Accuracy	+/- 5%
Data Requirements	
Type of Measurement	Instantaneous
Sample Interval	Hourly
Data Format	(-)XXXX

Coordinated Universal Time - The station must stay synchronized with coordinated universal time. GPS units or WWV synchronization clocks are required for hourly (or faster) GOES transmissions. Readings from these sensors are not required as part of the data stream. If the latitude/longitude/elevation information is available, make note of the accurate location and assure it is recorded in ASCADS/WIMS.

GPS Sensor (Latitude) - Optional

Sensor Requirements	
Sampling Height	Various
Measurement Units	Degrees from equator
Range	20 to 85 degrees
Accuracy	+/- 300 feet
Data Requirements	
Type of Measurement	Instantaneous
Sample Interval	Daily
Data Format	XX.XXX

GPS (Longitude) - Optional

Sensor Requirements	
Sampling Height	Various
Measurement Units	Negative degrees from Greenwich
Range	80 to 180 degrees
Accuracy	+/- 300 feet

Data Requirements

Type of Measurement	Instantaneous
Sample Interval	Daily
Data Format	-XXX.XXX

GPS (Elevation) - Optional

Sensor Requirements

Sampling Height	Various
Measurement Units	Feet above/below mean sea level
Range	-200 to +20,000
Accuracy	+/- 900 feet

Data Requirements

Type of Measurement	Instantaneous
Sample Interval	Daily
Data Format	XXXXX

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 to be sure your application is compliant with ASCADS/WIMS.

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

***NFDRS Update**

The standard order for the NFDRS Update will be:

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	10-Min Avg. Relative Humidity	XR
06	Battery Voltage	VB
07	Solar Radiation	RD

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 to be sure your application is compliant with ASCADS/WIMS.

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

*This could be modified slightly depending upon WIMS/ASCADS interface and modifications necessary to support the NFDRS Update. An updated page to this document will be issued at that time.

SITE SELECTION

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

1. When installing any station, it is particularly important to involve a fire weather forecaster and other interagency wildland fire personnel (as appropriate) in determining a new site or relocating an existing station.
2. When moving an existing station, the NWS 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 ASCADS and WIMS to clearly include the fact that the station is reporting from a new location.

3. Contact the agency or regional RAWS/AWS coordinator. To find out who your contact would be, call the Information Systems Help Desk located in Boise, Idaho at 800-253-5559 or the interagency web page at **http://www.fs.fed.us/raws**.

4. Obtain the following station site information: station name, legal (Township, Range, quarter-section), county, elevation and lat/long in degrees, minutes, seconds format.

5. Obtain a 6-digit National Weather Service (NWS) identification number (also referred to as the WIMS number) for your station.

6. Transmission via GOES satellite requires a National Environmental Satellite Data Information Systems (NESDIS) Identification Number in addition to the NWS ID number. Contact your agency NESDIS ID coordinator. If you don't know your agency coordinator, contact the Information Systems Help Desk or use the interagency web page **http://www.fs.fed.us/raws**.

Site Selection Considerations

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. If located on a slope, a south or west exposure is required to meet fire danger rating standards (Deeming, Lancaster, Fosberg, and others 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 should govern the location of a standard fire weather station:

1. 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.

2. 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.

3. Arrange the station so as to give data that is representative of the specific 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:

1. **Sources of dust** such as roads and parking areas. If unavoidable, locate station at least 100 feet on the windward side of the source.

2. **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.

3. **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).

4. **Extensively paved or black-topped areas.** If unavoidable, locate station at least 50 feet to the windward side.

5. **Large buildings, trees, and dense vegetation.** Locate station at least a distance equal to the height of the obstruction.

6. **Distinct changes in topography** such as gullies, peaks, ridges, steep slopes, and narrow valleys.

For additional information: (National Fire-Danger Rating System Users Guide, PMS No. 430-3, NFES No. 1522 (October 1985), Weather Station Handbook-An Interagency Guide for Wildland Managers, PMS No. 426-2, NFES No. 2140 (March 1990). Another reference currently out of publication but possibly still available include the Fire Weather Observers Handbook (Fischer/Hardy – 1976).

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. Your agency weather station coordinator will assure that the equipment you purchase will meet minimum interagency NFDRS standards.

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

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. (See section under Tower Specifications for more information.)

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. If a tower is "climbable", it must meet all applicable agency and OSHA regulations (See OSHA manuals 1926.32, 1910.66 and 1910.268) for climbing criteria.

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. It should be noted that guyed towers have additional construction costs at the site to facilitate excavation for concrete mounting pier and concrete anchor blocks. (These costs could be in excess of $2500-$5000 each depending upon location.)

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. These towers can be installed with effectively no impact on the environment.

Assure 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, i.e., ice loading, deep snow, high winds may be normal for this equipment.

General Tower Specifications

- Survive 125 MPH winds
- No horizontal or vertical movement (sliding once installed)
- Withstand snow loads of typical high mountain locations of Western US (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 standards, it can then be prepared for installation of a weather station. Personnel installing weather stations should have attended a Remote Automated Weather Station/Automatic Weather Station (RAWS/AWS) 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 the Automated Sorting, Conversion and Distribution System (ASCADS). A listing of that information is available by accessing ASCADS.

ITEM	EXAMPLES
Slope	*20 %*
Aspect	*180 degrees (Compass Reading)*
Site	*Mid slope*
Antenna angle	*43 degrees* (*GOES Transmit*)
Antenna azimuth	*116 degrees (GOES Transmit)*
Elevation	*6500*
Latitude	*42 02 30* (degrees, minutes, seconds)
Longitude	*113 09 30* (degrees, minutes, seconds)
All serial #'s for sensors and DCP/Data loggers	

Documentation. Installation and maintenance must be documented. Currently, it is necessary to record this information in ASCADS, and station catalogs in WIMS*. A hard copy folder should 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 ASCADS.

*Ultimately, maintenance, station and site information will all be housed online with station metadata. Collaboration will take place between the ASCADS and WIMS managers to address and resolve metadata issues with the intent of not duplicating the storage of data and seamless access to the information for the user.

System Alignment and Leveling
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 **Fuel Temperature (FT)/Fuel Moisture (FM) is an optional sensor.** Readings from fuel temperature sensors are informational and not used in NFDRS calculations, nor the NFDRS Update. A calculated fuel temperature will be displayed from the NFDRS processor. If present, the sensor should be placed so the sensor is on the south side of the tower where it can take advantage of the unobstructed effects of solar heating. The sensor should be installed 10-12 inches above the fuel bed. The fuel bed will consist of actual dead fuels that represent the area.

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. (Solar radiation is not required in NFDRS, but will be a required measurement for the NFDRS Update).

Structural Integrity

All **cables** should be routed from their respective sensors to the Data Collection Platform (DCP)/Data Logger. 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/AWS system is now ready for systems checkout for operational accuracy.

Lifecycle Management

As with any capitol 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.

MAINTENANCE AND CALIBRATION

In order to ensure accurate weather readings, a program of regularly scheduled maintenance/calibration (annual rehabilitation), and timely response to system failures (emergency repair) is required. This maintenance plan requires every NFDRS station to receive at a minimum, an annual rehabilitation/maintenance site visit. All weather stations need maintenance and the instrumentation requires calibration (automated/manual, regardless of manufacturer).

There are two maintenance contract options in the wildland fire community Depot and Full-ride. Every automated NFDRS station in the network will have a contract. Contracts are available through the BLM's Remote Sensing/Fire Weather Support Unit (RSFWSU) in Boise, Idaho or vendors that will meet these national standards.

Depot Maintenance Contract
Depot level maintenance is a contract through a bench-level rehabilitation and calibration facility (such as the BLM's Remote Sensing/Fire Weather Support Unit (RSFWSU) in Boise, Idaho), or a vendor. Station owners are responsible for annual station rehabilitation, emergency repair, and quality assurance. Equipment is removed and shipped to a depot or vendor facility for rehabilitation and calibration as per Depot Sensor Calibration Standards below.

Full-Ride Maintenance Contract
A full ride contract requires RSFWSU or vendor personnel to respond to the station to perform annual station rehabilitation, emergency repair, and quality assurance.

Rehabilitation Maintenance Standards - Using Depot or Full-Ride Contract
The performance of preventative maintenance, calibration and certification will be ***at minimum on an annual basis*** to all NFDRS stations. Preventive maintenance must follow the manufacturer's recommendations and these standards. See Depot Sensor Calibration Standards below.

Emergency Repair
Failures of systems or components require emergency repair. Various methods, both automated (such as ASCADS/Watchdog) and manual, are used in keeping abreast of the operations of the complete weather station network. The watchdog evaluates various system operations to give accurate indications of how a system is performing. If problems are identified, corrective measures and processes begin.

Repair Priority
1. Year-round response time to GOES systems time drift will be responded to immediately and in no less than 3 days regardless of station classification.
2. All other NFDRS station failures will be responded to as follows:
    A. Three days response time to failures during fire season.
    B. Non-fire season failures will be responded to as necessary.

ANNUAL REHABILITATION MAINTENANCE

Field Maintenance Standards

Instructions for returning sensors to Depot for calibration: clearly mark the station they are from prior to sending to the depot facility.

Minimum replacement means swap out of individual component under the terms of the depot contract under which the station is being maintained. This does not mean purchasing a new component or sensor, nor is this the same as life-cycle management.

Tipping Bucket - Disassemble, clean, check all connections. Using the precipitation gauge calibrator, run 399 ml (or the appropriate amount for the model of bucket being used) of water through the collector and ensure that the recording device (either the DCP or the tipping bucket counter) reads 50 counts, plus/minus 2 counts.

MINIMUM FIELD CALIBRATION - 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

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

MINIMUM CALIBRATION/REPLACEMENT - Yearly

Fuel Temperature - Check for deterioration and cracking of the wood.

MINIMUM CALIBRATION/REPLACEMENT - 3 Years

Fuel Moisture - 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 CALIBRATION/REPLACEMENT - 3 Years for internal
"D" cell (Supplemental Power) - yearly

WWV Receiver - Perform pass/fail functional check and replace if necessary.

MINIMUM CALIBRATION/REPLACEMENT - As Needed

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.

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 (i.e., tower rust, corrosion, cable frey, etc.).

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

DCPs and Data Loggers - 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 - 4 Years

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

MINIMUM CALIBRATION/REPLACEMENT - 2 Years

Documentation - Documentation of the site visit will be captured in the ASCADS database*. It is the responsibility of every person that visits the site to assure that ASCADS is updated. Owner will maintain a hard copy documentation file for each station. This will include photos, site access instructions, purchase history and other related site information.

*Ultimately, maintenance, station and site information will all be housed online with station metadata. Collaboration is necessary between the ASCADS and WIMS managers to address and resolve metatdata issues with the intent of not duplicating the storage of data and seamless access to the information for the user.

Depot Sensor Calibration Standards

The depot or manufacturer's maintenance facility under contract will rehabilitate and calibrate sensors to the standards listed below and manufacturer's specifications.

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".

Wind Sensors - Check and record torque readings for all sensors before and after depot calibration.

Wind Speed - Perform torque test, disassemble, change bearings, inspect for corrosion, test for proper operation of reed switch or proper voltage and frequency output for units with hall-effect devices. Ensure that the unit meets or exceeds a maximum starting threshold of .25 MPH. Clean and paint as needed. Torque specifications for wind speed sensors will meet or exceed <.05 inch/lbs.

Wind Direction - Perform torque test, check potentiometer for linearity of all four quadrants and replace as required. Change bearings, check pointer assembly for static balance and check for corrosion. Align and adjust according to manufacturers specifications. Torque readings will meet or exceed <.75 inch/lbs.

Tipping Bucket - Disassemble, clean and inspect for corrosion, mechanical wear and damage. Check and align the contact closure mechanism for proper operation. Assemble and run operational test and check (T&C). Paint as needed.

Relative Humidity/Air Temperature - Calibrate sensors for voltage and current according to manufacturers specifications. Calibrate the RH sensor at the 12% and 76% levels. After calibration the RH sensor will read within plus or minus 3% of the ambient room relative humidity. Test the air temperature by using temperature standards and check the resistance at said levels to plus or minus .5 degree.

Fuel Moisture - Calibrate sensors for voltage and current according to manufacturers specifications.

Fuel Temperature - Check stick for weathering/wear and replace as necessary. Using an ohmmeter, check the thermistor at various temperature settings. The resistance must correspond to the published calibration curve within plus or minus one degree.

WWV Receiver - Each receiver is checked for proper software revision, then tested for operation at 5 MHz, 10 MHz, and 15 MHz using the WWV TEST program.

Cables - Inspect all cables for serviceability, clean and check all connectors for corrosion and O-ring installation and check all connections with a megger. Check armor for correct orientation with respect to sensor end.

Antenna - Clean connections, check and replace elements as necessary. Connect antenna to a DCP/Data Logger and with watt meter in line check for proper power out and at minimum a 10 to 1 ratio on the forward to reflected power readings.

Solar Radiation - LI-200SA specifications: Calibrate against an Epply Precision Spectral Pyranometer (PSP) under natural daylight conditions. Absolute error under these conditions is +/-5% maximum, typically +/-3%. Sensitivity: Typically 80μA per 1000 W m^2.

Global Positioning System (GPS) - Replace faulty GPS receivers and/or antennas when breakdowns occur.

Data Collection Platform/Datalogger - Check unit to make sure it has correct software installed. Adjust all voltages out of the power supply and regulator and align all cards. Adjust the RF power output to manufacturer specifications. Adjust modulation and frequency as necessary. Run and monitor the complete unit for a minimum of 5 days in the environmental test chamber at various temperatures with a full complement of sensors.

Documentation - A maintenance history record shall be kept for each sensor and DCP that is repaired/calibrated by a Depot facility. These records are kept on file by serial number and used by Depot staff for spotting systematic problem areas that may have impact on the program. The documentation also is helpful in working with manufacturers in order to develop better quality products.

QUALITY ASSURANCE

To assure data quality for NFDRS calculations the system will be monitored at all levels of data acquisition and storage. Field data acquisition, transmission and data archive to the data warehouse (WIMS and NIFMID) will be the responsibility of the station owner. The station owner is responsible for the first level of quality assurance including:

- ensuring that maintenance is performed and documentation of activities on each station is completed in ASCADS to these standards.
- visually checking outputs from the station on a regular basis (daily) to assure that the information is reflective of actual conditions.

Two methods of intervention and detection will be implemented. The first level will be an automated oversight system, such as watchdog, that will continually monitor data for errors relating to out of range observations and performance problems from non-functional sensors. The second level will be a periodic review and checking by an Agency/Regional Fire Weather Coordinator. Should errors or problems be detected the station owner will be notified and be responsible for taking emergency repair actions per priority. Should no action occur to resolve the error or the problem the issue will be referred to the Agency/Regional Fire Weather Coordinator for resolution.

Ultimately, the local station manager is responsible for quality assurance.

POSITIONS, RESPONSIBILITIES AND TRAINING STANDARDS

The following positions are used in fire weather station operations and are required to implement the fire weather program. They require a level of specific skill and knowledge to perform the fire weather responsibilities. Personnel should be assigned only to positions in which they have demonstrated the ability to perform successfully. In each position, interagency coordination and communication between different levels (local/regional/national) is necessary.

Station Owner/Program Manager - Responsible for appropriate site selection and placement of the fire weather station, maintenance, assurance that accurate observations are taken and transmitted to WIMS, and that appropriate NFDRS calculations are made. This includes reading and assuring appropriate response to "watchdog" reports, assuring a field support technician/first responder is available to support their station(s), *and visual checks of data on a frequent basis (daily) to assure that station readings are reflective of actual conditions.*

Field Support Technician/First Responder - Responsible for performing annual site maintenance and responding to system failures in a timely manner, and documenting in ASCADS. Provides status report to Station Owner/Program Manager. Required to attend basic field rehabilitation training. Training will include performing field rehabilitation standards for the specific stations within their area of responsibility.

Depot Technician - Responsible for bench rehabilitation and calibration of all station components under their contract. Provide technical support to field technicians and first responders as needed.

Agency/Regional Fire Weather Coordinator - Responsible for agency/regional level oversight and quality control. This includes spot checks for data accuracy and WIMS station catalog status. Assures that ASCADS metadata and maintenance documentation is current. Assures that training is available at the regional/local level as needed. Assists with station operation and lifecycle management planning.

Depot Manager - Responsible for administration of depot contract(s). Provides a maintenance summary to Agency coordinator annually.

GLOSSARY

Automated Sorting Conversion and Distribution System (ASCADS) - BLM Administered Interagency system used as interagency method of retrieving data from the GOES satellite and forwarding to WIMS. It is used for metadata storage, maintenance documentation, and produces watchdog.

Automatic Weather Station (AWS) - Non-GOES telemetered

COTS – Commercial off-the-shelf, referring to a package of software or program available for purchase and use from a commercial vendor

File Transfer Protocol (FTP) - Process used to transfer files across different types of systems (i.e., internet, pc to pc, servers, etc.)

FWWT - Fire Weather Working Team

Geostationary Operational Environmental Satellite (GOES) - The satellite used for data relay from NFDRS weather stations to ASCADS.

HUB - Multi-modem PC housed at NITC calling telephone telemetered weather stations, delivering the data to WIMS.

National Information Technology Center (NITC) - Located in Kansas City - WIMS Host

National Weather Service (NWS)

National Interagency Fire Management Integrated Database (NIFMID) - Data warehouse for archiving fire management information to include weather observations.

National Fire Danger Rating System (NFDRS)

National Advisory Group Fire Danger Rating (NAGFDR) - Recently renamed Fire Danger Working Team.

National Wildfire Coordinating Group (NWCG)

National Environmental Satellite Data Information Service (NESDIS)

Remote Automatic Weather Station (RAWS) - GOES telemetered

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

Watchdog - Automated process in ASCADS for assessing weather station performance.

Weather Information Management System (WIMS) -

Western Regional Climate Center (WRCC)

Wildland Fire Assessment System (WFAS) - A portion of the NFDRS Update.

WWV - Call sign for worldwide universal time radio transmission.

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