FW21 File Weather Format

FW21 is a comma separated values (csv) file format for hourly fire weather observations. FW21 relies on recognition of key fields in the csv header to enable use of the data for the fourth generation of the National Fire Danger Rating System (NFDRS4), as well as for use in fire behavior/spread models. The intent of the FW21 csv format is to satisfy the requirements of both NFDRS4 and fire behavior models while both minimizing and simplifying the data format for both humans and software.

This document describes FW21 files as defined in April 2023 in preparation for the launch of the new Fire Environment Mapping System (FEMS), which will allow users to generate weather observation download files in the FW21 format. Development of a formal data standard, under the stewardship of the National Wildland Fire Coordinating Group (NWCG), is being considered.

File Content and Structure

Every FW21 file minimally includes the following eight required data elements:

Date/Time of Weather Observation	Wind Speed
Air Temperature	Wind Azimuth
Relative Humidity	Solar Radiation
Precipitation	Snow Flag

The order of fields in an FW21 file is not important. While not required, quality control flags (see below) also may be included in an FW21 file. Even more optional data elements can be added to fulfill the specific needs of users or custom applications. Aside from increasing file size, the presence of optional data does not prevent an FW21 file from being used to import data into existing NFDRS4 and fire behavior/spread applications, as they ignore any unrecognized or unnecessary data fields present in the file.

Quality Control Flags

In addition to the required elements, FW21 files can include data fields that indicate whether a record's original value for any required field passed a quality control (QC) check or was otherwise replaced with an estimated value. Separate QC flag fields are applied to: temperature; relative humidity; precipitation; wind speed and azimuth; and solar radiation (plus wind gust speed and azimuth, if present). There are three possible QC flag values:

- 0 = Original value retained (was present and fulfilled QC validation)
- 1 = Original value was missing and has been replaced with an estimated value
- 2 = Original value was deemed "suspicious" (failed QC validation) and has been replaced with an estimated value

Field Names and Data Formats

Because data fields can be in any order in an FW21 file, applications rely on standardized field names to correctly parse and ingest key data elements. The list below identifies standardized field names used for FW21 files, followed by a description of the format and/or data type used for the associated values. Values in an FW21 file can be in either English or Metric units, with the measurement type identified in the field name.

Note: When importing FW21 datasets, applications will internally convert any Metric data to English units that are used by NFDRS4 and fire behavior/spread models. If an FW21 file includes both English and Metric unit data fields for any element, only the English unit values are imported.

DateTime – An ISO 8061 formatted date/time, which is comprised of concatenated fields for year, month, day of month, hour, minute, second, and offset from UTC (plus or minus sign, followed by the offset time in hours and minutes). Observation date/time values in FW21 files reflect local time at the observation site.

- For example, an observation taken at noon local time at a site in the Mountain time zone (which is seven hours earlier than UTC time) on January 6, 2004, would have this value: 2004-01-06T12:00:00-07:00
- See also: https://www.iso.org/iso-8601-date-and-time-format.html

Temperature(F) – Temperature in degrees Fahrenheit, as real numbers.

Temperature(C) –Temperature in degrees Celsius, as real numbers.

RelativeHumidity(%) – Percent relative humidity, as real numbers.

Precipitation(in) – Precipitation in inches, as real numbers.

Precipitation(mm) – Precipitation in millimeters, as real numbers.

WindSpeed(mph) – Wind speed (20 foot mast) in miles per hour, as real numbers.

WindSpeed(kph) – Wind speed (10 meter mast) in kilometers per hour, as real numbers.

WindAzimuth(degrees) – WindSpeed direction in degrees from north, as integers.

SolarRadiation(W/m2) – Solar radiation in watts per square meter, as real numbers.

SnowFlag – Boolean value indicating ground is snow covered (1) or not (0). Blank records are assumed to be 0 (not snow covered).

GustSpeed(mph) – Wind gust speed (20 foot mast) in miles per hour, as real numbers.

GustSpeed(kph) – Wind gust speed (10 meter mast) in kilometers per hour, as real numbers.

GustAzimuth(degrees) – GustSpeed direction in degrees from north, as integers.

Tflag – Temperature QC flag, with value 0, 1, or 2.

RHflag – Relative humidity QC flag, with value 0, 1, or 2.

PCPflag – Precipitation QC flag, with value 0, 1, or 2.

WSflag – Wind speed QC flag, with value 0, 1, or 2.

WAflag – Wind azimuth QC flag, with value 0, 1, or 2.

SRflag – Solar radiation QC flag, with value 0, 1, or 2.

GSflag – Wind gust speed QC flag, with value 0, 1, or 2.

GAflag – Wind gust azimuth QC flag, with value 0, 1, or 2.

Example FW21 File and File Naming Guidance

Below is an example FW21 datafile for the Remote Automated Weather Station (RAWS) at White Reef, Utah. It shows the 24 hourly records for a single day (March 16, 2021); however, actual FW21 datafiles typically have thousands of hourly records, covering multiple months or years.

Because the associated weather station is not identified in the datafile contents, it is important to identify the weather station in the file name. In this example, both the RAWS name (White Reef) and station identifier (422805) are included in the filename. Users may opt to include other helpful information in the file name, such as the data source and the range of dates or years covered by the file's records. Although the file structure uses the csv format, the file name suffix is ".fw21" (not .csv) so that NFDRS4 and fire behavior/spread applications will properly recognize it as a potential weather data import file.

File name: UT_White-Reef_422805.fw21

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DateTime, Temperature(F), RelativeHumidity(%), Precipitation(in), WindSpeed(mph),
WindAzimuth(degrees), SolarRadiation(W/m2), SnowFlag, GustSpeed(mph),
GustAzimuth(degrees),Tflag,RHflag,PCPflag,WSflag,WAflag,SRflag,GSflag,GAflag
 2021-03-16T00:00:00-07:00,40,84,00.00,14,203,0,0,25,223,0,0,0,0,0,0,0,0
 2021-03-16T01:00:00-07:00,38,94,00.01,11,217,0,0,20,197,0,0,0,0,0,0,0,0
 2021-03-16T02:00:00-07:00,36,95,00.16,13,183,0,0,24,186,0,0,0,0,0,0,2,0
 2021-03-16T03:00:00-07:00,35,93,00.17,8,184,0,0,20,185,0,0,0,0,0,0,0,0
 2021-03-16T04:00:00-07:00,33,95,00.05,2,166,0,0,9,192,0,0,0,0,0,0,0,0
 2021-03-16T05:00:00-07:00,32,97,00.00,0,34,0,0,5,151,0,0,0,0,0,0,0,0
 2021-03-16T06:00:00-07:00,36,100,00.00,8,240,0,0,16,240,1,1,1,1,1,1,1,1
 2021-03-16T07:00:00-07:00,37,100,00.00,4,255,1,0,9,255,1,1,1,1,1,1,1,1
 2021-03-16T08:00:00-07:00,34,97,00.00,0,245,13,0,0,0,0,0,0,0,0,0,0,0
 2021-03-16T09:00:00-07:00,34,94,00.00,2,186,56,0,5,188,0,0,0,0,0,0,0,0
 2021-03-16T10:00:00-07:00,39,82,00.00,0,164,334,0,3,253,0,0,0,0,0,2,0,0
 2021-03-16T11:00:00-07:00,37,82,00.26,2,53,456,0,4,45,0,0,0,0,0,2,0,0
 2021-03-16T12:00:00-07:00,36,87,00.07,4,47,726,0,5,21,0,0,0,0,0,2,0,0
 2021-03-16T13:00:00-07:00,38,85,00.02,5,31,667,0,9,17,0,0,0,0,0,2,0,0
 2021-03-16T14:00:00-07:00,39,86,00.00,4,27,648,0,9,35,0,0,0,0,0,2,0,0
 2021-03-16T15:00:00-07:00,39,83,00.00,5,52,549,0,8,42,0,0,0,0,0,2,0,0
 2021-03-16T16:00:00-07:00,40,81,00.00,7,13,215,0,10,42,0,0,0,0,0,0,0,0
 2021-03-16T17:00:00-07:00,41,81,00.00,6,41,115,0,10,30,0,0,0,0,0,0,0,0
 2021-03-16T18:00:00-07:00,40,82,00.00,5,56,40,0,9,41,0,0,0,0,0,0,0,0
 2021-03-16T19:00:00-07:00,40,81,00.00,5,36,10,0,9,39,0,0,0,0,0,0,0,0
 2021-03-16T20:00:00-07:00,40,82,00.00,5,35,0,0,8,41,0,0,0,0,0,0,0,0
 2021-03-16T21:00:00-07:00,41,81,00.00,4,48,0,0,7,49,0,0,0,0,0,0,0,0
 2021-03-16T22:00:00-07:00,41,79,00.00,4,60,0,0,7,51,0,0,0,0,0,0,0,0
 2021-03-16T23:00:00-07:00,41,82,00.00,5,119,0,0,8,140,0,0,0,0,0,0,0,0
```

Example FW21 file