Very Portable Remote Automatic Weather Stations[1]

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Abstract: Remote Automatic Weather Stations
(RAWS) were introduced to Forest Service and
Bureau of Land Management field units in 1978
following development, test, and evaluation
activities conducted jointly by the two
agencies. The original configuration was
designed for semi-permanent installation.
Subsequently, a need for a more portable RAWS
was expressed, and one was developed. The
latest configuration is a truly portable,
self-contained RAWS that can transmit via the
GOES satellite or via the users' own radios. It
contains a voice synthesizer and tells you what
the weather conditions are at the station on
your own radio. Possible future developments
discussed include: Smaller, light versions;
voice recognition circuits; data collection
platforms that also transmit data.

The small weather stations used by the
Forest Service and Bureau of Land Management
(BLM) have traditionally been located outside
ranger stations or similar offices. Once or
twice a day someone dutifully treks to the
station, observes and records instrument
readings, and uses a telephone or radio to relay
the data to some central or subcentral office.
The data may then be entered, through a suitable
terminal, into the Administrative Forest Fire
Information Retrieval and Management System

(AFFIRMS). AFFIRMS then calculates the
localized fire danger rating, based on those and
other data, in accordance with the National
Fire-Danger Rating System (NFDRS) methods.
Unfortunately, the weather at a ranger station
is not always correlative with or even
indicative of weather on top of a mountain, over
the hills, or in other pertinent areas.
Accessibility, cost of personnel and
transportation, and time differences in readings
have essentially precluded the use of
nonautomatic stations for securing weather data
in remote locations. Also, people are not
always available, even at ranger stations, to
read the instruments and report the weather data
during fires or other abnormal situations--when
they are most urgently needed. Those conditions
led to the development and fielding of the first
RAWS to see widespread use by the two agencies
(Warren and Vance 1981).

BACKGROUND

It is often interesting and enlightening
when looking toward the future to have a
backward glance at where we were the same number
of years in the past. In 1974, some remote
weather stations and nets had been tried out,
generally using a VHF radio link. Apparently
all had limitations since they had not achieved
wide-spread use. Basically, the VHF stations
were limited to line-of-sight conditions,
although that could be extended some by use of
repeaters. This restricted their use to
relatively small clusters of stations which
could be interrogated from a ranger station or
similar facility. That also required frequency
allocations, repeater site availability, and
people at a station to acquire and relay the
data. The Geostationary Operational
Environmental Satellite (GOES) was in orbit and
just starting to be used by the U.S. Geological

Survey and the U.S. Army Corps of Engineers to relay water level measurements from remote sites. By investigating, we found that the basic data acquisition and transmission package, called Data Collection Platform (DCP), could be adapted to other types of measurements and interfaced with weather instruments. We reviewed the DCP's with a commercial supplier, the entire GOES data collection and data processing systems operated by the National Oceanic and Atmospheric Administration-National Environmental Satellite Service (NOAA-NESS). and the frequency allocation arrangements. We concluded that RAWS using the GOES as a relay means was feasible.

In 1976, we obtained two DCP's on loan from NOAA-NESS, rounded up some instruments, built some interfacing circuits and cables, located a couple of used towers, and set up two operating RAMS working via the GOES. In 1977. Burea [sic] of Land Management procured two prototype RAWS from a commercial supplier, based on our two home-made stations. In 1978, following a meeting of Forest Service, BLM, and National Weather Service (NWS) meteorologists and engineers, the FS/BLM developed specs and procured five RAWS each which were installed and operated that year. Now, 10 years later there are some 400 RAWS operating in the field. The stations were designed as fire weather stations but are often used for other purposes on a year-round basis. In addition there are portable units available for temporary setup in various locations.

The RAWS now in use are microprocessor controlled, solar powered, use integrated circuits, have timing accuracies of seconds per year, contain solid state memory, transmit by satellite, operate unattended, and withstand a wide range of outdoor environments throughout the continental United States and Alaska. That was conceivable, but might have been considered a far-out projection 13 years ago.

PRESENT RAWS STATUS

Several configurations of RAMS are now available: the semi-permanent, transportable, and portable. Any of the types can be equipped to transmit via the GOES /or via the users' own radios in voice or data mode, or both. The GOES transmissions must be made at an assigned time on an assigned frequency. An emergency channel can be used which will activate a transmission if certain parameters are exceeded. This is often used for water level measurements via the

GOES but has not been used for weather measurements to any great extent.

The radio transmissions occur when the user "interrogates" a station. Each calling transceiver must have a touch-tone type pad so the proper station can be selected. Up to nine RAWS could be accommodated on one frequency. The RAWS DCP's are programmable so that the proper transmission time can be selected and the various measurement parameters entered. A standard set of measurements with standard characteristics is usually used and a Programmable Read Only Memory (PROM) is available which greatly alleviates the programming task. The DCP's can also be completely programmed in a shop and then shipped and activated on arrival at the field site, so that a programming test set is not even required in the field.

FUTURE RAWS

The present RAMS configurations and methods now widely used had not even been conceived 13 years ago, so it may be a little hazardous to try some future projections, but here COES (pardon the pun). A much smaller, lighter weight RAWS is probably achievable now. The present very portable RAWS likely will be succeeded by one even more portable. Perhaps we could call it an ultraportable. A suitcase size or perhaps briefcase size system could probably be developed. The major obstacles would be the sensors and something to hold it in place in case of high winds. Batteries will tend to limit the reduction in weight, but again we need something heavy to hold it in place anyway. These ultraportables could be used as standard electronic/sensor packages and simply be attached to other tower structures where the twenty foot wind sensor height is needed by using extender cables.

Programming could be simplified by selecting a few standard configurations and simply using a single digit number and ENTER for programming. For self-timed stations on a preset schedule, there will always be a need for entering the transmission time, transmission interval, and the present time--coordinated to GMT.

Programming might also very well be accommodated without a special programming test set. Voice recognition circuits are advancing and we could likely include enough vocabulary in the DCP so that we could simply tell it what

time we want it to transmit, how often, and even any special instructions. The DCP would recognize what we said, set itself up and then repeat back to us how it had programmed itself as a final check. There could also be some self-diagnostics included so if a unit has a malfunction it could tell us the probable cause (unless, of course, its voice box was the problem).

The DCP's could be designed to always transmit data rather than voice. That would speed up the transmission time and reduce frequency congestion. The interrogating transceiver would have a small integrated circuit memory which would store the data, and a voice synthesizer to tell you what the weather measurements are. The transceiver could also or optionally be connected to a data terminal for display, secondary storage, and processing of the data as well. Personal transceivers may include a data storage/display capability by 2000 anyway.

DCP's could calculate the fire danger rating for the area based on measured and stored data. They could also calculate the fuel moisture content. An algorithm has been developed which could be adapted to the RAWS (Deeming 1983). Based on results to date it doesn't seem too likely that anyone will develop a good reliable. accurate fuel moisture sensor with any reasonable mean time before failure (MTBF) in the next 13 years.

Whether by radio or satellite link, the weather from several ultraportables located strategically around the tire or from more permanent RAWS likely will be available at the ICP and presumably could be entered directly into the fire spread and prediction models which will be developed and in vogue by 2000 (Burgan and Shasby 1984. Rothermel 1983). The computers for the models could be located at the ICP or some other location--it won't matter, for as I've been saying for the last 10 years, it is absolutely certain that in 10 years we'll have full satellite communications (voice/data/video) available from ICP's to any other location.

Not necessarily a RAWS (but related to satellite communications) prediction: there will be small satellite terminals capable of receiving the GOES weather pictures either direct or relayed from another ground terminal with better resolution than is now available.

Other sensors could be added to RAWS such as visibility, particulate, and acid rain sensors.

Motion or proximity sensors could be used if vandalism becomes a problem.

Advances in very large scale integrated circuits (VLSI), microprocessors, and digital signal processing should permit virtually any level of processing desired to be accomplished within the small portable RAWS or at some other convenient location. Availability of mobile/handheld satellite communications similar to the cellular radio (mobile telephone) services available in the larger urban areas now will permit access to any remotely located station about as simple as dialing a telephone number. The response could be in either voice or data.

Maintenance costs could be greatly reduced by providing a minimum amount of self-test circuitry which could be interrogated remotely and in most cases isolate the problem to the DCP, a sensor, or a cable. The needed part could be shipped to the field for replacement of the failed part without the need for field diagnosis by an experienced electronics technician. Reprogramming, if necessary, could be accomplished before a new DCP is shipped, or remotely.

In summary, the ultimate weather reporting system might enable us to know what the weather is doing now, what it has done in the past, and what it will do at any time in the near future at any location of our choice. Coupled with other inputs, the present and future fire location and activity could also be predicted to a high degree of accuracy.

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