REPORT ON THE FIELD TESTS WITH THE REMOTE CONTROL FIRE WEATHER STATION

Part I - Gy. Pèch

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Computing Devices of Canada

FOREST FIRE RESEARCH INSTITUTE
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ABSTRACT

Computing Devices Commercial Group, in co-operation with the Canada Department of Forestry, Forest Fire Research Institute, undertook the design, assembly and field test of one developmental model remote, automatic reporting, forest fire weather station system. The equipment consisted of one Master and one Satellite Station which was field operational and suited for basic design and accuracy proving. Final design, operational modification and packaging to be considered subsequent to field tests.

The design, assembly and field test were successfully completed prior to September, 1968. Minor technical and operational problems were encountered with either on-site corrections or solution documentation for subsequent incorporation.

The Company has since reviewed and revised the basic technical and operational design, established specification, and has initiated a program which will result in production Systems for summer 1969 user delivery.

REPORT ON THE FIELD TESTS WITH THE REMOTE CONTROL FIRE WEATHER STATION

PART I - FIELD TESTING

By: Gy. Pech

Between June 10 and August 1, 1968, field trials were conducted by the Forest Fire Research Institute, Department of Forestry and Rural Development, with the recently developed remote control fire weather station. Our objective was to test the accuracy of the telemetered weather information against weather data obtained with instruments calibrated by the Meteorological Services of Canada.

A detailed description of the remote control fire weather station, hereafter referred to as the system, is given by the manufacturing company in Part II of this report. It is sufficient to briefly mention here that the system consists of a master and satellite station. Air temperature, relative humidity, wind speed, and rainfall are measured at the satellite station. The data is digitized and is communicated to the master station via radio signal upon command. At the master station the radio signals are decoded and are printed out on a teleprinter.

The following specifications applied to the meteorological sensors of the system:

air temperature:	accurate to 3°F between between 20 and 120 F.
relative humidity:	accurate to 3.5% between 10 and 99% at temperatures between 40° and 120° F.
wind speed:	accurate to 2 m.p.h. between 3 and 18 m.p.h. and to 10% between 18 and 99 m.p.h., to be averaged over 5 to 6 minute periods.
rainfall:	accurate to 0.01 inch between 0.00 and 9.99 inches.

The master station was housed in the radio transmitter building at the Petawawa Forest Experiment Station, Chalk River, Ontario, while the satellite station was located some 40 yards northeast of the Wilberforce Fire Lookout in a large, flat, open field near Bethlehem, Ontario. The distance between the two radio antennas along the direct line of sight was 25 miles. Both

stations were at 700 feet elevation with no obstruction between the antennas.

Standard recording and non-recording weather instruments were exposed at the satellite station, adjacent to the meteorological sensors of the system, to serve as controls (see photographs 1-3). The make, type, accuracy, and date of calibration of each control is listed in Table 1.

During the tests the satellite station was inspected every day to change the daily charts on the thermo-hygrograph and siphoning rainfall recorder drums, to mark correct time and date on the wind recorder, to inspect all instrument pens for ink and the standard raingauge for rain, and to take wet and drybulb interrogation at 0800 hours E.S.T.

Since the time lag of the various air temperature and relative humidity measuring sensors varied between a few seconds for the system's thermistor bead to 3-4 minutes of the Pernix humidity element, the comparisons are only approximately valid for times when temperatures and humidities fluctuated rapidly. To partially overcome this problem, wet and dry bulb readings were taken five minutes before and after the hour in addition to the measurement at 0800 hours, and the average of three readings were compared against the thermohygrograph trace. Another problem, inherent in using slow moving charts, was to establish the correct time to the minute on the thermo-hygrograph chart that had 15 minute divisions per 3mm. To minimize this error time marks were made on the chart, at known times twice a day, often in the morning only.

Table 2 summarizes the results of the test.

The pairs of observation accepted for the comparison varied widely as a function of which control instrument or remote sensor circuiting was in a working condition at the times when all coding, decoding, and teletyping facilities functioned well. For a number of weeks one or two control instruments were malfunctioning, also, the rented teleprinter broke down once for a few days. None of the problems experienced with the remotely sensed information originated from the remote sensors.

On the basis of the somewhat scanty information complied in Table 2, our conclusion is that the remote sensors provided reliable and accurate information. We would recommend that the electronics of the system be further improved to match the high quality weather information, obtained with the sensors, with reliable day-to-day operation.

Table 1. Meteorological instruments used as controls in the field tests of the remote control fire weather station. June - July 1968

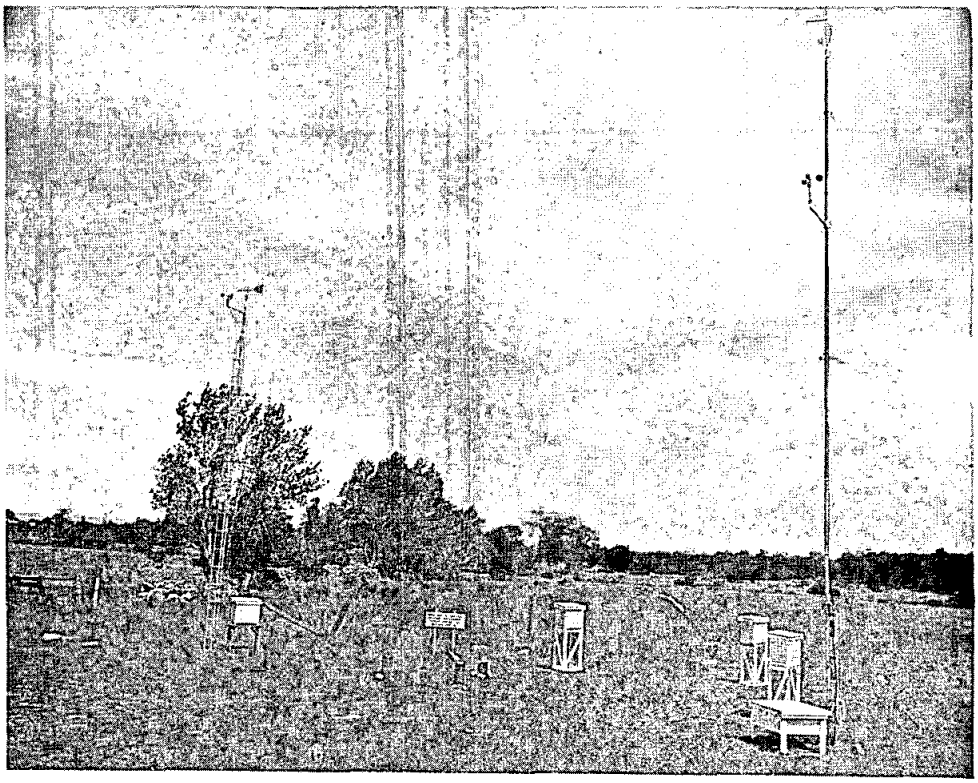
Instrument Make	Type	Accuracy	Date of Calibration	Agency
Lambrecht	No. 252 thermo-hygrograph with Pernix humidity element	Temp. ± 0.5°F Rel. hum. ± 2% at 70°F	June 2, 1968	M.S.C.[1]
Negretti-Zembra	Mercury thermometers used ventillated as wet and dry bulbs	± 0.1°F	May, 1968	M.S.C.
Science Associates	Three cup wind vane assembly	± 1 m.p.h. between 2 and 100 m.p.h.	January 1968	Factory
		± 1 m.p.h. between 2 and 50 m.p.h.	June 25, 1968	C.D.C.[2]
Casella	Natural siphoning type, 8-inch orifice, recording raingauge	± 0.01 inch	January 1968	Factory
M.S.C.	Standard, 3-inch orifice, rain-gauge	± 0.01 inch	Sept. 1966	M.S.C.
M.S.C.	10-inch orifice, tipping bucket raingauge	± 0.01 inch	June, 1968	M.S.C.

[1] *Meteorological Services of Canada, Calibration Laboratory, Toronto*

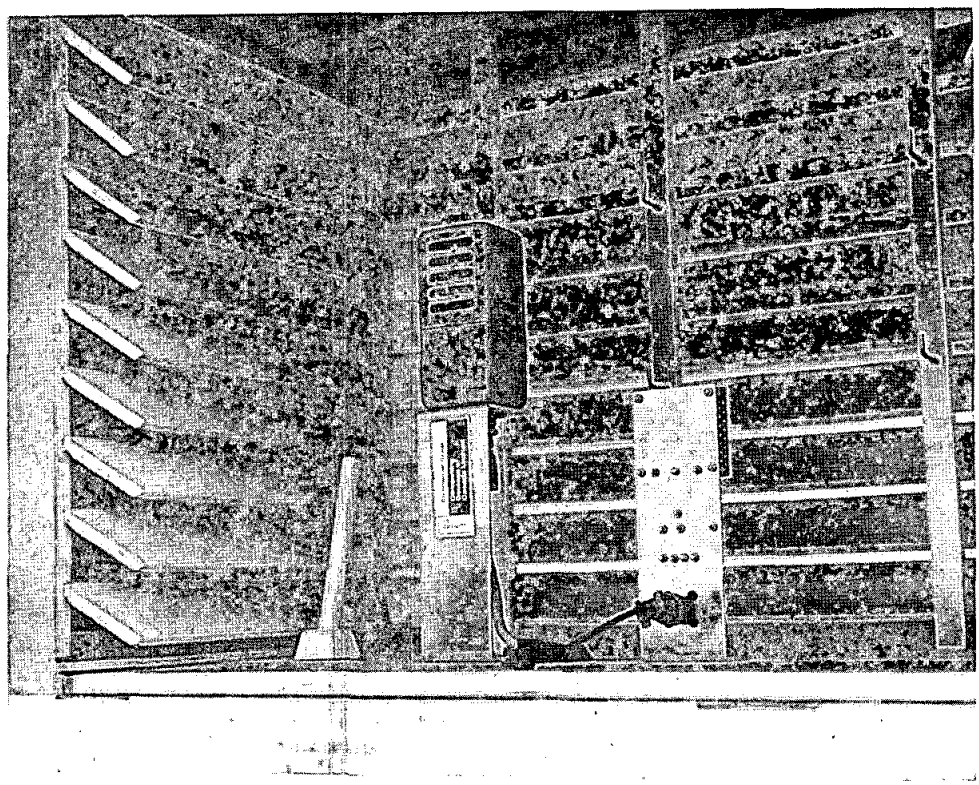
[2] *Computing Devices of Canada Limited, Ottawa*

Table 2. Comparison of remotely sensed weather measurements to those obtained with control instruments at the field tests of the remote control fire weather station, June - July, 1968

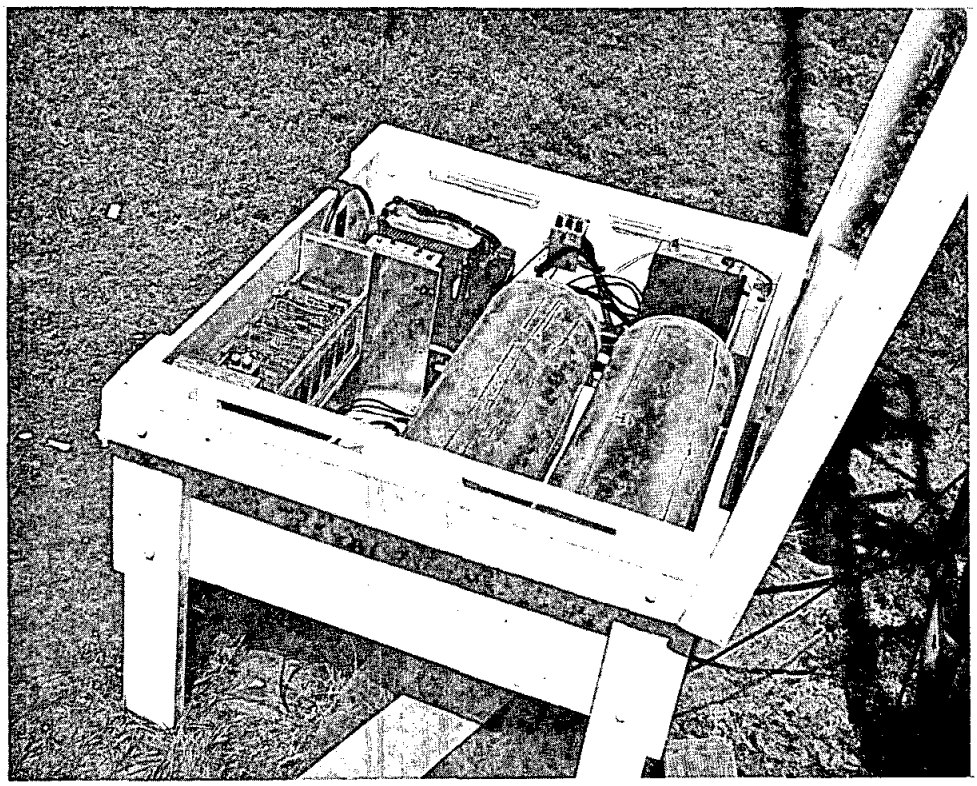
	Air Temperature	Relative Humidity	Wind Speed	Rainfall
Control instruments:	thermo-hygrograph charts	thermo-hygrograph	Wind assembly charts	3 gauges
No. of observation pairs:	70	45	50	1
Remote data - control data, average:	0°F	0%	0.8 mph	0.00 in.
Largest difference:	-3°F	+4, -3%	5 mph	
Occurring:	once	both twice	once	
Smallest difference:	0	0	0	
occurring:	14 times	26 times	21 times	



Photograph No. 1. Remote Control Fire Weather Station in the field near Bethlehem, Ontario, July 1968. Contents of Steveson screens from left to right: wind recorder, wet-drybulb assembly, thermo-hygrograph, and remote sensors for air temperature and relative humidity. Box in foreground is shown on photograph No. 3.



Photograph No. 2. Relative humidity (left) and air temperature (right) sensors of the Remote Control Fire Weather Station in a Stevenson Screen at field location. July, 1968.



Photograph No. 3. Radio receiver-transmitter, data receiving a coding apparatus, and two batteries at the satellite station of the Remote Control Fire Weather Station. Test model, July, 1968.

COMPUTING DEVICES OF CANADA

PART II - DEVELOPMENT PROGRAM SUMMARY

By: D.J. Mossop

DEVELOPMENTAL SYSTEM TARGET SPECIFICATION

System Description

The Developmental System consisted of one Master Station and one remote Satellite Station.

The Satellite Station incorporated four sensors, electronics, power supply, and radio data link equipment. It had to function in the field over a two month test period at a selected, unprotected site 25 miles (25 mile test range - 50 mile practical range) from the Master location. The Master Station was located in a building, operated from 115V AC power, and consisted of radio data link equipment, electronics and control unit, and a teleprinter. The Master interrogated the Satellite automatically at a pre-set time, or manually on demand. The Satellite information was automatically recorded on the Master teleprinter in a set format.

Sensors - Per agreed-upon Department requirements:
See Part I

Satellite Power - DC Battery

Radio Data Link - VHF/FM operating in 150 - 170 Mhz band.

Packaging - as required to facilitate field tests.

Satellite Operational Enviroment - conditions experienced in Canadian forested areas May - October, i.e. the range of weather parameters to be measured except for Air Temperature - operational +32° to +120°F. Storage -40° to +120°F.

Recording - teleprinter alpha-numeric copy. Printer to record Time, Date, Satellite Identification Number and Sensor Measurements.

FIELD TESTS

The operational testing and recording was carried out by Department personnel. The equipment tested was designed and

assembled per the foregoing target specifications with the following exceptions:

(a) Clock Read-Out - provided at Master to facilitate date/time set-up.

(b) Pre-set Interrogation - only one pre-set time allowable per 24 hour period without resetting.

(c) Voice Channel - provided to facilitate test, servicing at Satellite.

(d) Wind Speed - averaged over a 6 minute period.

In general, the company was pleased with overall results of the field tests. Problems encountered were of a minor nature and were corrected on site or, when considered insignificant relative to test intent, were investigated with solutions documented for subsequent incorporation.

The basic technical approach and recorded system accuracies were commensurate with target specifications. Some difficulty was experienced initially with the acquisition of an accurate rainfall sensor and then with the original rainfall measurement electronics. Upon investigation it was found that certain components in the latching circuitry were marginal in their operation and, with ageing, went out of tolerance. Rather than make temporary quick fixes, a module of new design was assembled. However, Engineering personnel were unable to complete it for installation prior to test termination.

The actual drain on Satellite batteries is determined by the number of daily interrogations. The installation, test and servicing activities placed excessive demands on the selected power source and necessitated replacements. However, the power requirement was determined and will be allowed for in production equipment.

It was observed that:

(a) Certain Master Station operational procedures required revision

(b) More than one pre-set automatic interrogation per day was desirable,

(c) Simplification of manual interrogation mode necessary,

(d) Simplification of time/date reset necessary.

It was decided that the Master Station would be re-arranged and made capable of withstanding a higher ambient temperature. It was also determined that the interrogation, transmission and recording cycle was unnecessarily long.

Further field tests results and observations are reflected in the Production System specifications described in the next section.

PRODUCTION EQUIPMENT

Following the design, development and field test program, and with the incorporation of detailed requirement information obtained from Provincial forest protection officials, the Company has established a final design and is completing a program which will result in the availability of production systems in the summer of 1969. They are to be known as "Datran" Remote, Automatic Reporting, Fire Weather Station Systems.

General System Description

The system collects, transmits and records meteorological data sensed in remote forested areas during the May October period. Year round operation available on request.

A system consists of one Master Station with one or more associated, time-shared, Satellite Stations. This concept emphasizes the Company's basic design approach which relates practicabity with economy.

Satellite Station

Consists of weather sensors, electronic circuitry and data transmitting/receiving equipment. Transmits the sensor data collected on receipt of a command from the associated Master Station.

The sensors measure:

(a) Rainfall: to the nearest 1/100" transmitted as a three digit number between 0.00" and 9.99".

(b) Relative Humidity: accuracy shall be better than 3 1/2% over the 10% to 99% range between 40 F and 120 F. Two digits shall be transmitted.

(c) Wind Speed: accuracy shall be 2 mph between 3 to 18 mph, and 10% between 18 to 99 mph. Windspeed shall be averaged over a six-minute period and two digits shall be transmitted.

(d) Air Temperature: accuracy shall be better than 3°F from 32°F to 120°F. Two digits shall be transmitted.

(e) Provision shall be made for expansion to six sensor channels i.e. the addition of wind direction and barometric pressure.

The Station can be installed in isolated areas exposed to the elements. It is operational over the air temperature range +32° to +120°F with storage capability over -40° to +120°F.

Data Communications

Basic system Data Transmission is by radio link with the telephone or teletype communications on request.

Radio equipment may be VHF/FM or HF/SSB with related masts and antenna determined by Station site selections. Transmission range 25 - 125 miles.

On request, considerations shall be given to user selected or provided transmitting/receiving equipment.

Master Station

Consists of integral data transmitting/receiving equipment, operator control panel, electronics cabinet, and recording printer.

The data output is displayed in printed alpha-numeric form. The basic Master Station can also drive standard teletype or electric typewriter equipment.

System Operation

On command from a Master Station, the windspeed logic at all associated Satellite Stations is activated. Following a six minute averaging period, automatic follow-on instructions from the Master initiate all Satellite sensor interrogation, data transmission and recording cycles.

Master Station commands may either be introduced automatically at 1-4 preset times daily or manually, on demand. In the manual mode, the averaging period may be bypassed. Associated Satellite Stations with a common Master may be interrogated as a group in automatic sequence, or individually via manual selection.

Excluding the averaging period, single Satellite Station interrogation, data transmission and recording time is less than 10 seconds.

Recording Format

The output record has the following format:

D 183	T 1215	S 01	R 012	H 55	AT 83	WS 12
D 183	T 1216	S 02	R 010	H 57	AT 81	WS 11
(1)	(2)	(3)	(4)	(5)	(6)	(7)

where (1) Julian Date (July 1)
(2) Time, hours and minutes
(3) Associated Satellite Station Identification Number
(4) Rainfall, inches, tenths, hundredths
(5) Humidity, percent
(6) Temperature, degrees F
(7) Windspeed mph (six minute averaging period)

Conclusion

Satisfactory design, initial development and field test programs followed by a promising survey of the Canadian market requirement has resulted in the final design and production of a "Datran" Remote, Automatic Reporting, Forest Fire Weather Station System suited to a Canadian forest protection needs.

The Company wishes to acknowledge the excellent guidance and co-operation extended by the Canada Department of Forestry, Forest Fire Research Institute, and the assistance of forest protection officials across the country.