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# FILLING GAPS IN REMOTE LOCATIONS WITH LOW POWER RWIS

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## Summary

Filling Road Weather Information Gaps on major roadways is nothing new. But what of the information gaps in very remote locations? To test its Gap Filling solution Campbell Scientific earned the support of the State of Alaska Department of Transportation, University of Alaska Fairbanks and the Arctic Infrastructure and Development Centre to undertake a two-year project. The first year of the project inspected the reliability of power supply, and consistent, reliable transmission of data. Sites for the first seasonal test were based on a hierarchy of need from the Alaska Department of Transportation and basic criteria including the availability of cellular communications. After a winter of use, results were extremely promising. The data was delivered consistently, ample power was provided by a small solar panel and a battery bank, and for the first time in Alaska the wildest and most remote parts of the state had Road Weather Information that increased the levels of safety on Alaska highways.

## Mini-RWIS: a Gap Filling solution

Campbell Scientific's mini-RWIS (road-weather information system) is a low-cost, low-power, quick-deploy road-weather station, which complements existing RWIS networks at a fraction of the cost of a traditional RWIS station. Adding mini-RWIS stations gives a denser network of road sensors. This provides a more complete picture of the entire road and improves the reliability of road-condition forecasts.

Mini-RWIS stations typically include a datalogger, communications and power module, all installed with an enclosure, and a flexible combination of sensors and cameras according to the specific needs of the network. An example is shown in Fig. 1. The mini-RWIS stations tested and deployed in this trial featured a RM Young wind sensor, a Campbell Scientific CCFC ultra lower power field camera, an Apogee infrared surface temperature sensor designed specifically for road weather stations, and a Campbell Scientific HygroVUE5 temperature and RH sensor.

*Fig. 1. mini-RWIS stations are self-sufficient, running exclusively on solar power and batteries to allow them to be placed anywhere you need them, regardless of existing infrastructure. They are easy to integrate, featuring embedded cell communication as well as NTCIP / Datex2 / Modbus compliance, making integration into an existing RWIS network simple.*

## Pre deployment testing at University of Alaska Fairbanks Cold Room

The meteorological, battery performance, and power data were used to analyze the operation of the mini-RWIS. In terms of the power profile, the mini-RWIS consumed the most power during communications and camera operation. Peaks in power consumption would be significantly higher by as much as 3 or 4 times when the heater for the camera lens is activated to defog/defrost the camera lens prior to taking an image of the roadway. During the first season of field testing the heater was not required.

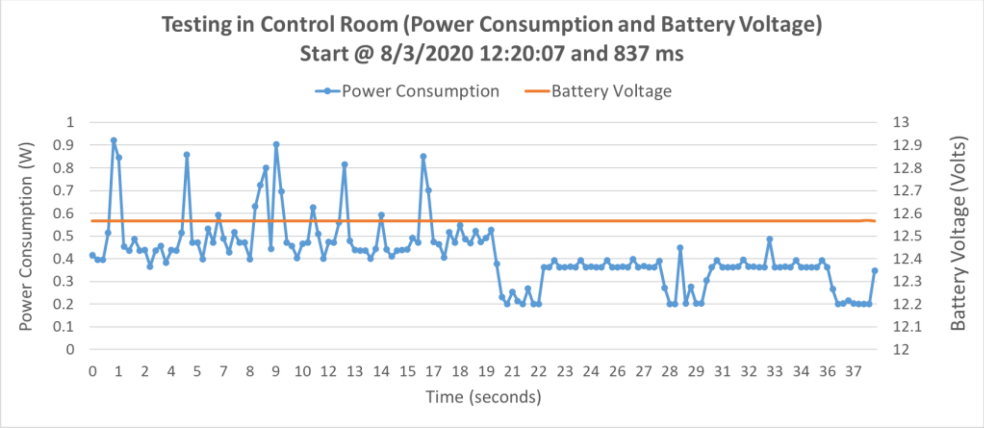


*Fig. 2. Power testing in a controlled environment. Measurements show system performance with camera heaters constantly off.*

## Test Unit Field Deployment

Environmental data (ambient air temperature, road surface temperature, humidity, and wind speed) and operational data (average hourly, daily, and monthly power consumption, battery state of charge (SoC) and voltage, and communication link activity) were obtained from three roadside sites (Chena Hot Springs Road MP 10, Seward Highway MP 98.5, and Seward Highway MP 113.4) where the mini-RWIS systems were installed early in 2021. The air temperature, power consumption, and communications link activity were used for analysis of their operation for different periods of time ranging from late January 2021 to mid-May 2021 as shown in the following sections.

## Installation and Measurements

Pictures from the deployment of the mini-RWIS system at Chena Hot Springs Road MP 10 are shown in Fig. 3. The average daily air temperature (Fig. 4), daily power consumption with air temperature (Fig. 5) and once per minute power consumption (Fig. 6), are shown for different periods from late January 2021 to mid-May 2021.

The results showed that the mini-RWIS station at Chena Hot Springs Road MP 10 was able to measure, record, and communicate the daily average air temperature, road surface temperature, humidity, wind speed & direction, while consuming on average about 1.3 watts of power. While not shown in the plots, battery SoC was maintained at or near 100% for the entire period analyzed. Peaks of about 6.5 watts were observed at hourly intervals in the once per minute power demand (see Fig. 6), which correspond to the communication link activity occurring once every hour.

## Seward Highway MP 98.5 and Seward Highway MP 113.4 sites

The mini-RWIS systems deployed at the Seward Highway MP 98.5 and Seward Highway MP 113.4 sites were identical to the system described in the previous section. The measurements showed nearly identical results as for the Chena Hot Springs MP 10 mini-RWIS, confirming the results described in the previous section.

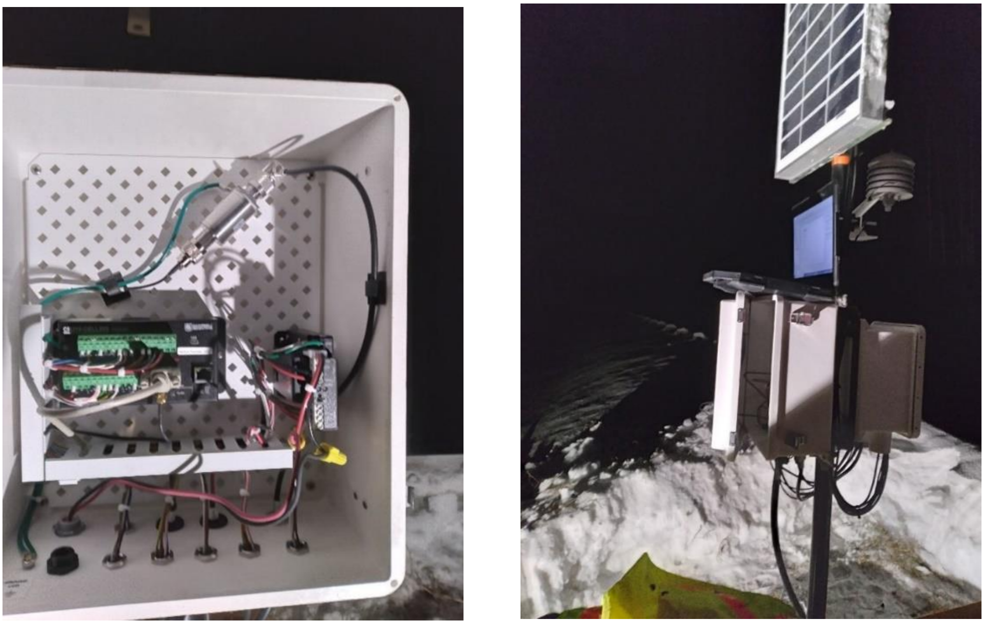

*Fig. 3: Installation of mini-RWIS system at Chena Hot Springs Road MP 10 on January 21, 2021. Left: pole-mounting with solar module and weather sensors. Right: mini-RWIS data logger mounted on pole.*

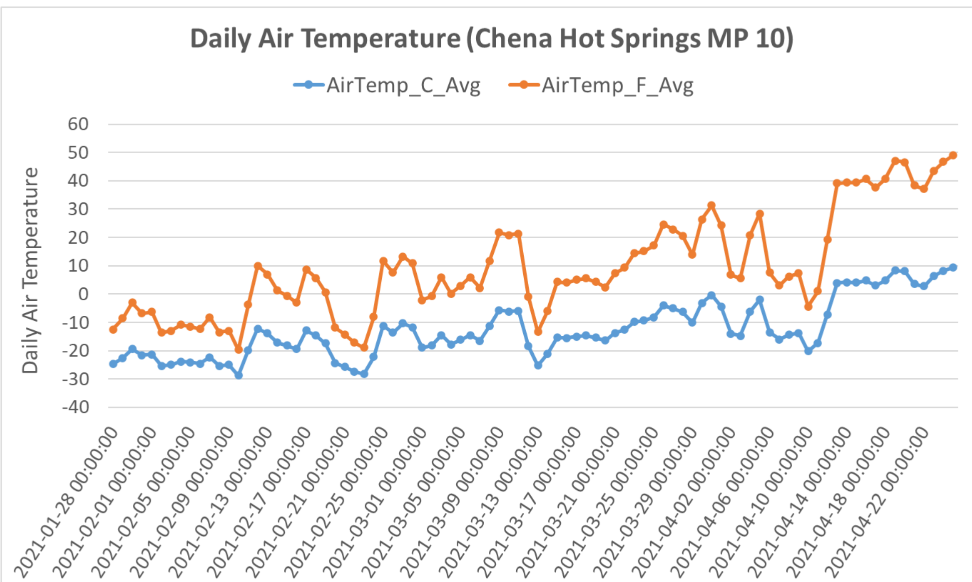


*Fig. 4: Plot of daily average temperature profile (℃: blue and ℉: orange) for Chena Hot Springs Road MP 10 mini-RWIS site from January 28, 2021 to April 25, 2021.*

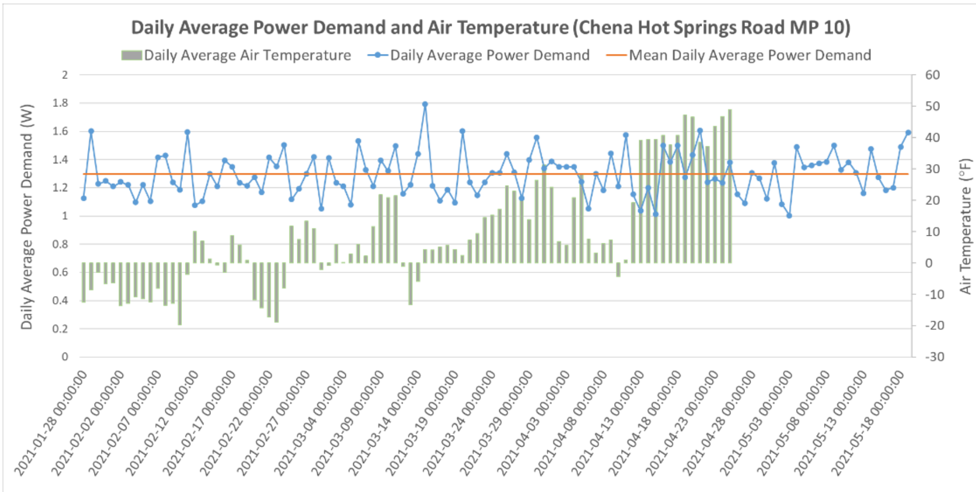


*Fig. 5: Plot of daily average power consumption (blue), air temperature (green), and mean power consumption (orange) for Chena Hot Springs Road MP 10 mini-RWIS site from January 28, 2021 to May 19, 2021.*

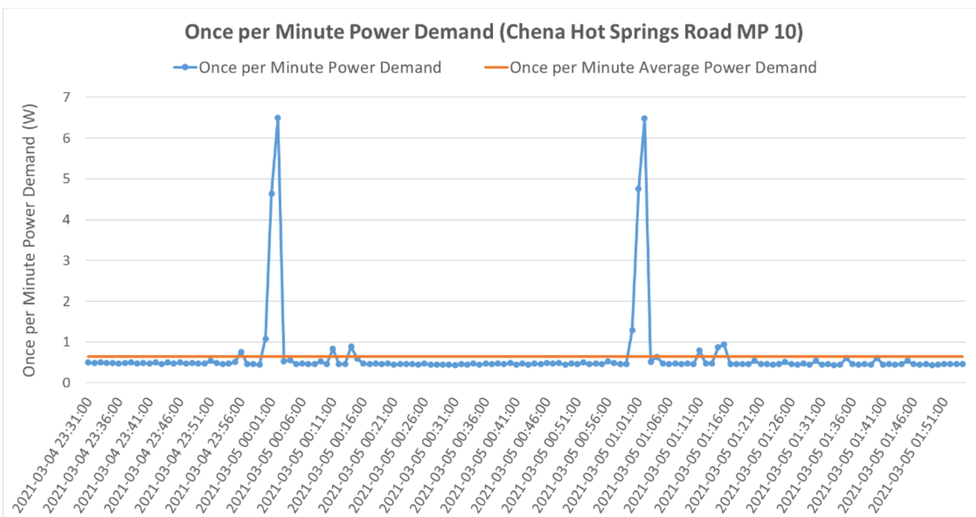


*Fig. 6: Plot of once per minute power consumption (blue) and mean power consumption (orange) for Chena Hot Springs Road MP 10 mini-RWIS site from March 4, 2021 at 23:31 to March 5, 2021 at 01:54. Peaks of 6.5 W are coincident with hourly data transmission.*

## Summary of results and conclusions

The mini-RWIS systems have proven to be reliable throughout the initial and field testing. All three of the systems have operated through the winter of 2021 without failures. The power system has proven to be extremely robust with an estimated power reserve of nearly double the minimum required. All instrumentation has performed without problems with hoar frost or rime ice. However, there have been occasional issues with moisture on the camera lenses which degrade the images. To date, the heaters have not been employed to correct this issue since the degradation has been occasional. This may change as additional systems are installed.

An additional 5 Campbell Scientific sites were commissioned during the 2021 summer. All 8 stations performed similarly to what was experienced with the first 3 stations over the first winter of the test and a follow up report will be prepared later this year.