

# In From the Cold

## A Kiwi Engineer in Canada

Just how loud is it in the middle of nowhere? Expat Kiwi JEROME PARKINSON (GIPENZ) had the chance to find out first-hand during recent fieldwork inside the arctic circle. He talks about the technical challenges he encountered on the job, and some of his experiences of engineering in Canada.



**I'M AN ENGINEER FROM NEW ZEALAND**, currently working as a consulting acoustical engineer in Calgary, Alberta. The company I work for was engaged to carry out a noise impact assessment for an oil and gas project in the Northwest Territories of Canada. Part of this assessment included setting up equipment to measure and record ambient noise levels – equipment that would have to function unattended for multiple days, at various remote locations in temperatures potentially as low as -40°C.

Back in 2001 I set off for Vancouver with a one-year working holiday visa for Canada. I spent the first four months of 2002 snowboarding in the interior of British Columbia then travelling on the west coast. With summer approaching and funds running low it was time to use the “working” part of my visa. Finding engineering work in Vancouver without a solid network or Canadian engineering registration proved difficult; but I came across an opening for an acoustical engineer in Calgary. My ME degree from the University of Canterbury specialising in acoustics, and consulting engineering experience at Process Developments Ltd of Lower Hutt, helped secure the position.

My employers, HFP Acoustical Consultants Corporation, agreed to sponsor me for new working visas when necessary. So I've been working in Calgary since June 2002 – an excellent and interesting experience so far.

### Engineering in Canada

My general impression is that engineers have a high profile here. This may be particular to Alberta, however, reflecting the large number of engineers working in the oil and gas industry.

When people find out that I'm an engineer they often ask why I don't wear a pinky ring. When you become registered here as a Professional Engineer you get an iron ring which is worn on the little finger of the working hand. Apparently the ring symbolises pride in their profession, but also reminds them of humility, and their ethical and professional obligations. (You can read about it at [www.ironring.ca](http://www.ironring.ca)).

Unless you're registered with a provincial engineering association you can't call yourself an engineer and, as I understand it, you risk prosecution by such an association if you do so. Also, for at least four years after graduation, graduate



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Left: The author and equipment at site 1.

Above: Thumbs up – a successful first site.

Previous page: Inuvik, Northwest Territories.

engineers get an EIT (Engineer In Training) post-nominal – motivation enough to get the paperwork sorted out and apply for registration!

### Environmental extremes

The logistics of working in very remote places and extremely cold climes are daunting. Many things that you're used to always working just don't. Pen ink freezes, batteries give out, digital cameras don't work, electrical and audio cables won't bend, LCD displays black out and most plastic becomes brittle. And you have to operate instruments and assemble equipment wearing thick insulative gloves and clothing.

For ambient noise monitoring we had to design a system that would provide heat and power for our instrumentation, silently, without affecting the ambient measurements, and at temperatures as low as  $-40^{\circ}\text{C}$ . The sites were accessible only by helicopter and adverse weather conditions could leave our equipment stranded for days. Furthermore, for safety reasons, helicopters were permitted to fly only during daylight hours – of which there were approximately four per day in late November.

One of the locations was a two-hour return flight by helicopter away, leaving only two hours to assemble, calibrate and start the equipment – difficult enough in the extreme cold without the time constraint. So, as well as providing heat and

power silently and unattended for multiple days at very low temperatures, the equipment had to be portable and quick to assemble.

At an early stage we decided to provide a complete backup of mission-critical instrumentation to reduce the chance of losing data. This meant two sets of sound-level meters and digital audio storage devices, along with a meteorological station. The power requirements of the instrumentation were reasonably small; but the power required to maintain the instruments at a temperature of  $10\text{--}15^{\circ}\text{C}$  when the ambient temperature is  $-40^{\circ}\text{C}$  was not. The power demands of the instruments and electric heating blanket were estimated at 150Ah per 24 hours at modest ambient temperatures. To operate the equipment for multiple days at extremely low temperatures and allowing a modest reserve, we estimated a total energy requirement of 450–600Ah. This equates to approximately 700kg of lead-acid or gel cel batteries! This was impractical given the transportation and time constraints.

Next we considered storing the instrumentation in a tent and heating the enclosed space with a propane-powered catalytic heater. A 5kg propane tank would last several days and a small number of batteries could then be used to power the instrumentation. A heated space would also offer shelter for the field crew and ease the setup and calibration of instrumentation. However, noise from the heater and potential

wind noise from the tent fabric were considered significant. Pitching the tent on ice and in a strong wind, the time required to heat the tent space and the risk of the heater melting the ice or setting fire to the tent were also potential problems. After many proposed solutions, including exotic low-temperature batteries and igloos, we found an answer.

### Working solution

The final system made use of a thermopile – essentially a large number of thermocouples connected in parallel – along with batteries to heat and power the instrumentation. A small amount of electrical power can be generated by heating dissimilar metal connections in a thermocouple. More power can be generated by heating a larger number of connections. Heat is typically provided by combusting methane or propane. Commercial units can produce 15–500W electrical power, and reject 20 times as much waste heat through an array of cooling fins.

Thermopiles are often used to provide small amounts of electrical power for remote locations and low-temperature applications such as communication repeater stations. A compact thermopile was selected, which produced 15W of electrical power and 300W of clean heat, and weighed only 20kg. The electrical power was used to top up the two gel cell batteries that powered the instruments, and the heat to warm the whole equipment package.

The next task was to design and fabricate an insulated enclosure for the instruments and batteries. Heat from the thermopile cooling fins was directed into the enclosure through a side opening and controlled with a simple vane above the fins. The enclosure consisted of a steel box lined with 100mm of insulation and finished with a plywood interior. A lid provided access to a removable instrument tray located in the top part of the enclosure. The lower part of the enclosure contained the batteries and propane tank.

Field tests indicated that the system could maintain a +60°C temperature differential over the ambient air temperature. An internal temperature-controlled ventilation

system was incorporated into the enclosure to limit the interior temperature to 20°C. Unfortunately during the field tests the ambient air temperature didn't drop below -5°C, so the system could not be fully tested until its first use. Finally, although the thermopile was relatively quiet (41dBA at 1m) the noise from combustion and capacitor discharge were significant given the ambient measurements to be undertaken; so a close-fitting, acoustically-insulated enclosure and exhaust muffler were fabricated.

### The middle of nowhere

Most of the field-work was based out of Inuvik at 69° North in the Northwest Territories. In late November when we arrived, access to the town of approximately 3000 people was by aeroplane only. The town can only be reached by car or truck when the rivers are flowing, so that barges can cross, or when they're sufficiently frozen for vehicles to be driven across. While the town is unusual in its location, isolation and cultural makeup, in some ways it seemed no different from any small town. It has hotels, bars, cafes, KFC and Pizza Hut, and everyone knows everybody and their business.

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Equipment prior to assembly at site 2, approximately 69.5° N.

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## Project Objective and Rationale

To establish the existing noise environment as a basis for assessing the incremental noise impact of the proposed project. Noise sources could include wildlife, wind, aircraft and snowmobiles.

## Technical Brief

To assess the noise environment at locations potentially impacted by the proposed project during representative conditions in summer and winter.

**Temperature range:** -40 to +30 °C

**Access:** Helicopter

**Ground conditions:** Snow, ice

**Data:** 24 hours of 1 minute average sound levels  
24 hours of continuous audio recording  
24 hours of meteorological data

**Locations:** Remote – potentially inaccessible for multiple days

**Daylight:** Approximately 4 hours/day

## Equipment

### Sound Level Meter

Type 1 precision integrating sound-level meter with real-time one-third-octave band filters.

Parameters stored: 1-minute average sound levels, spectra and statistics (Overall  $L_{eq}$ ,  $L_{min}$ ,  $L_{max}$ ,  $L_5$ ,  $L_{10}$ ,  $L_{50}$ ,  $L_{90}$ ,  $L_{95}$ ,  $L_{99}$ , octave band  $L_{eq}$  and  $L_{max}$ , one-third octave band  $L_{eq}$  and  $L_{max}$ )

Dynamic range: 100 dB

Noise floor: 16 dBA

### MP3 Recorder

Real-time conversion and storage of audio signal in MP3 format.

Sampling frequency: 128 kbit/s

Data storage: Continuous audio (equates to approximately 1.2 gigabytes / 24 hours)

Memory: 20 gigabytes

### Digital Meteorological Station

Parameters measured: Temperature, wind speed, wind direction, barometric pressure, dew point temperature, relative humidity and rainfall

Data storage: 5-minute averages of these parameters

### Thermoelectric Generator

Converts heat directly into electricity without employing any moving parts.

Fuel: Propane or natural gas

Power output: 15 Watts at 12 Volts

Clean waste heat: 300 Watts



Roughly half of the people in Inuvik are of native descent, while the rest are mostly employees of the oil and gas industry. The native people have a hunting-based culture. Despite the cold, they are more active and venture much further afield in winter than summer. Travel is easier when the ground is frozen, whereas in summer much of it is swamp.

While we were in Inuvik it was unseasonably warm, reaching record high temperatures for the time of year at -10°C. This made it easier for us to set up our equipment at the first site but we still had no time to spare. After we left the fog rolled in and we were unable to return for three days – a good first field-test for our equipment. On our return we were pleased to find critical instruments operating and an enclosure temperature of 16°C.

We were aware that the ambient noise levels could approach the noise floor of the sound-level meter system. Captured data was analysed and during periods with no wind-noise a 16dBA

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noise floor was constantly attained. A different microphone and pre-amplifier setup would have been required to lower the instrumentation noise floor.

We carried out measurements at several other sites, improving the system and our setup times. The temperature fell no lower than -20°C during the fieldwork so we couldn't test the system to its design limits. Finally, we packed up the equipment and left Inuvik on 6 December – the last day with the sun up for a whole month. We are now preparing to return for a summer measurement programme. While we don't expect problems with low temperatures or lack of daylight (the sun will be up 24 hours a day) there may be swarms of mosquitoes, black flies and curious bears to contend with.

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