
Bulletin: 247

Event: Geothermal61

Date: Thursday, 02 March 2006 (GMT+12:00) Auckland, Wellington

Field Trip Name: Wairakei Geothermal Power

Weather: Fine and warm again

Field Trip Place: Wairakei power Station

Where's Donald: Taupo

Diary number of total: 3 of 4

Hi Everybody

Another glorious day here in the heart of the Taupo Volcanic Zone. At 8.30am we were with Elizabeth Whitelock, our minder on this industrial site and Chris Morris our guide and expert for today regarding all things turbine or generator.

I soon realised that what we were about to see was unique because every geothermal power station in the world has its own special features, steam and problems so the turbines have to be individually designed. It is not just 'one size fits all'. I also had a great explanation of why Wairakei was a 'base load' station. You cannot store electricity so it must be made as it is needed and this varies during the day. If the demand was a steady 1500 Watts every hour, Wairakei could supply 100 000 houses which is roughly all of Christchurch. However homes can demand 12 000 Watts at times. It is then that Wairakei must call on other generators to meet this demand, usually from hydro power stations, which can start up quite quickly.

We headed with Chris and Elizabeth onto a protective mound besides the Binary power plant. This gave us a great view over the station and allowed us to see where we would go today. It was to be Station A building, Station B building, lunch, Binary Plant and then an audioconference back here.

Picking up ear protection we strode across the car park to Station A and straight up several flights of stairs. We passed the two Intermediate Pressure turbines which run on steam at 2 Bar of steam pressure. Bar is a handy way of measuring pressure. 1 Bar is atmospheric pressure at sea level. 2 Bar is the pressure inside you bike or car tyres. The High Pressure machines that once lived here are no longer used however. The 12 Bar of steam pressure dropped away during the first decade of the Wairakei power station operating. Two units sit retired here on the floor and two are busy at Ohaaki power station where they can get the pressure they need.

Up another flight of stairs and we were amongst the 4 Low Pressure machines. It was odd that such massive heavy machines were not sitting at ground level. Chris helped with, 'The condensers need to go underneath the turbines. They suck the steam through by having pressure close to 0 Bar, or a vacuum. We get 50 percent of our electricity from the use of condensers. The height of the turbine and condensers above the Waikato River needs to vary with each type of turbine, that's why you see each type on a different floor level'.

We headed along the high walkway into the Station B building. In front were three magnificent Mixed Pressure machines the nearest of which was in a thousand bits. It was G11. Mixed Pressure means they run on 3.5 Bar steam then 1.1 Bar steam. Way down below my feet lay the 80 tonne centre shaft and blades of the turbine, called the rotor. It was sitting on a huge lathe and having a detailed medical exam complete with ultra sound scan of each component. The massive top casing that usually hid the rotor was parked in a corner with the thick steel strops still attached, as if waiting for the crane to come and take it back home.

We climbed a 15m vertical ladder to just under the roof and peered carefully over the edge. There way below was a splendid view of the secret innards of turbine 11. Chris explained how each set of rotor blades sat between two diagrams in the casing with only half a millimetre gap. When you think it always spins at 3000 revs per minute and the tips of the blades are doing 1000 kilometres per hour, you start to think that half a millimetre is not very much. Apparently it takes 45 minutes to

stop spinning when the steam supply is shut off. Chris reminded us of one important point, ' One set of blades and a diaphragm before it are called a stage. Having many stages like this, was the great step forward by Charles Parsons in steam turbine design. The steam passes through the diaphragm and the pressure drops, this accelerates the steam so it turns the next blade more efficiently. The forward steam movement becomes blade spinning movement. The next diaphragm starts it all over again. Heat energy has become pressure, pressure has become movement, and in the generator it becomes electrical energy'. I watched as 4 guys intently measured every part with a vernier callipers, micrometer and calculator before recording every bit of data. Tiny, tiny measurements of a big, big machine.

We climbed down and peered into the condenser which was a huge green painted vessel about the size of a two storey house. The condenser condenses steam to water but the scale of it surprised me. For every 1kg of steam 40 kg's of cold Waikato River water was needed. That equals 3.5 tonnes of river water per second that needs to be sprayed in there.

A quick lunch and we headed into the sparkly new Binary Plant that has only been running for a year. This clever plant produces 14 Megawatts of electricity from water that is too cold to drive a steam turbine. The trick is that you use the 123 degree water to heat Pentane which boils at only 35 degrees. The Pentane gas zooms up to a pressure of 8 Bar of pressure which is plenty to turn turbines and generator rotors. The water has done its job and heads away at 87 degrees. The 35 000 litres of Pentane however is recycled continuously. To recycle it must be cooled which is what the 84 massive fans help with. However Chris did tell us to turn our cell phones off around the binary plant, it was because pentane burns easily. In fact explosive comes to mind.

We headed up onto the mound and sat in the sun in time for our audioconference with Ashburton Borough. Have a listen to this to see how Chris heats his water at home and why his children are prevented from long showers by geothermal power.

Tomorrow its off to look at the environmental and electrical issues that go on here. It will be fascinating. Do join us

Cheers

Donald

Competition clues

- 1.I am a liquid used in the Binary plant
- 2.I boil at a lower temperature than water
- 3.I burn easily



Wairakei power station. Station A is on the right and Station B is on the left. The administration centre and control room is in the foreground



G1 and G4 are the two Intermediate Pressure turbines and generators. Note the spare generator rotor under the blue cover and spare turbine rotor to its right.



The row of Low Pressure turbines that sit high up in Station A. Their generators and exciters are to the right



The rotor of Mixed Pressure turbine G11 sits in the lathe in the floor below undergoing inspection



With the top casing and rotor of the MP turbine removed it is easy to see in side. The generator is green in the top left.



Scaring the old sealant away from the top of a diaphragm. A set of rotor blades fits in the gap between each.



The condenser of turbine 11 is painted green to show it carries fresh water. The turbine's rotor can be seen on the right sitting in a lathe



Chris explains how generator 16 is driven by the two, pentane gas driven, turbines



The white clouds are water vapour but the steam, just above this silencer, is colourless



Our audioconference from the bund surrounding the binary plant and inside the Contact Energy logo