South Pole power considerations and anecdotes.

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This documents summarizes what I've been able to find out about power at the south pole and possible ways to reduce its consumptions. Not much is based on numbers but more discussions with station manager, power plant people, and first hand experience. This may be naïve or simplistic at times, but hey power consultant is not my field of expertise. Any numbers quoted are only for getting a qualitative idea and should be not used as definite values.

In general, there is a very clear consensus that the monitoring of where power is being used on station is very insufficient., thus making it impossible to pinpoint causes and locations of increased power consumption. Probably the best measure in improving future power consumption will be to understand it better and thus deploy a more comprehensive set of power monitoring tools.

Lights in the elevated station

All the lights in the elevated station are Sylvania fluorescent (OCTRON 3500K) 32W (this includes the rooms and hallways in berthings, the main hallway though the whole station, bathrooms, galley, and labs and offices. Just to give a few numbers. There are:

- 1-2 light bulbes per room (on as needed)
- ~30 light bulbs per wing (4 wings on station) (on all the time, no on-off timer)
- The wing which contains the gym and court (B4) are different (they have a light switch and are on only a needed)
- A4 wing is pretty much all off (no lights and minimal heating) as it is currently used for storage
- Bathroom lights (32 per wing except B4) are on all the time
- Long hallway (30 lights per floor) are mostly on all the time. Half of them on each floor are currently off and a handful have are on a motion sensor.
- Galley and kitchen (84 bulbs). On mostly during the day and off at night (on as needed)
- Gym: the gym is not on more than 3-4 hours a day. It has 70 lights plus some amount of heating (don't know how much). The gym is only used 2-3 hours a day max. The gym contributes significantly to the morale and well being of winterovers.

It seems like although the lighting on station may not contribute to a large part of the total station usage (don't know how much), lots of lights are on all the time unnecessarily(hallways, bathrooms) and would benefit in being placed on automatic 5-30mn motion sensor activated switches.

Heat on station

The heat on station comes from two sources (ignoring heat for the insulated doors and other electrically heated spaces (such as ARO)) :

- Excess heat from the power plant engines (jacket water runs through a heat exchanger at the engine and is then run to the station)
- Boilers in the station.

I don't know exactly what the proportion of these two is but it would be interesting to find out. Depending on the ratio of the two, it could be said that the heating on station is provided at no cost in power and only requires more or less fuel to provide more or less heating in the station.

Power plant

The power plant has 3 engines and one peaker. Only one engine runs at a time, the second is ready to be turned on in case of emergency and the third is in maintenance mode and they rotate throughout the season. The peaker is there to provide a little more power if more is needed.

(These numbers are for qualitative use only ok as they just come from discussion with power plant mechanics and engineer and should not be quoted for anything official).

The peaker comes on if the need is for more than 750kW. However because the peaker is known to be less efficient (I don't understand why) that the other 3 normal engines (and also does not have a heat exchanger to re-use its excess heat for station heating), power plant tries to keep it off and run the main engines at slightly higher power.

Power plant has been running at an average of 580 kW with min and max at 500 and 700 kW.

The engines are running with turbos which help boost the power by providing compressed air.

Question: what is the sea-level rating of the generators (I heard numbers like 1000kW) and given that they have turbos, why can't they be run at that full power (since turbos should be capable of providing air at sea-level pressure). Is it a fuel issue (not enough to run at full capacity), a cooling issue (generators cannot be cooled when run at that high capacity), or an environmental issue (station is not allowed to run them at that capacity). I don't know the answer but it would certainly be interesting to find out what is the limiting factor.

Suggestions for more power:

-Run the engines with 4 turbos (instead of 2) so as to be able to get more power from each engine. Problem is that that would require a complete rebuild of the engines which is a huge deal. Would require more fuel too.

Run two engines all the time. Problem is that it would require more fuel and would be quite risky because there would not be always a set of engines ready to be fired in case the primary ones failed.

Engines are running less efficiently because they are running on AN8 which is fuel which contains anti-freeze (thus allowing the fuel to only freeze at –87F as opposed to –37F without the anti freeze). I don't have a sense of how much more power could be generated if the engines ran on normal fuel (without anti-freeze) and if the gain in power would break even with the necessity to keep the fuel warm to prevent it from freezing. Just an idea.

Galley

No definite numbers for the power used by the galley but they certainly consume quite a but with all the stoves, hot plates and cooking equipment on from 4 AM till 7PM for the three hot meals. In addition, there are 2 fridge/freezers next to the galleys which use electricity to keep things cold when all that would been needed would be a heat exchanger to the outside air.

Green house

The green house is on a 17 hours cycle (17 hours on, 7 hours off). Note that its cycle is staggered to draw power when the rest of the station draws its least amount of power (at night (green house is one from 4pm to 9am). Recent measurements estimate is draws 16 kW in the on state and 3 kW in the off state. The green house has 10 high power lights which draw most of the power. Some of the excess heat of those lamps is recycles through their water jacket and back to heat the station through a heat exchanger. The green house provides enough freshies (salads, cucumbers, tomatoes) daily for the 64 winterovers and is the only source of fresh foods during the winter, and is definitely a significant source of good morale

Sauna:

The sauna is on a 3phase 600V, 60A circuit. The sauna itself is a Finlandia sauna (model number K/FLC-150) and claims a power usage of 15kW. The sauna is on at maximum only 1-2 hours a day at maximum. Probably has minimal impact on total station power usage.

LN2 plant.

The LN2 plant is currently in MAPO. The compressor part of the LN2 plant is a PLUSAIR HPS compressed air system, modelASD37. The liquifier part is from LINDE, model LINIT-5. A lot of its excess heat actually keeps MAPO warm. As an anecdotal evidence, when the LN2 plant was down for the past 1.5 weeks, the 1st floor of MAPO got very cold (near freezing) and the 2nd floor was also significantly colder (enough to need to wear ECW inside when spending considerable time in QUAD control room), and this despite turning on a couple of space heaters adding to 8-10kW.

Therefore significantly more heat will need to be applied to MAPO to keep it warm if the LN2 plant is moved to the cryo facility. Either that or the MAPO air handling system will have to become more efficient, as according to accounts of all MAPO users, it is currently very inefficient (ie dumps cold air in area that need to be warmed and warm air in those which need to be cooled), (see further paragraph on MAPO).

In addition, moving the LN2 plant to the cryo facility will create an increased fuel usage for transport, an increased strain on cryo tech and transport facilities, which is a factor that is often just disregarded. Snowmobiles and other transports do not or barely run when the temperatures drops below –80F.

For all the reasons, the suggestion to move the LN2 plant from MAPO to the cryo facility appears ill-advised, especially in light of the possible installation of a new feed to the Dark Sector.

The LN2 plant is running on 3phase 208V, 60A breaker, so we can assume is draws a maximum of 208*60*1.7=20kW. Currently, when producing LN2 for BICEP and QUAD, it is on a 60% duty cycle (according to Robert. However this number seems to high to me.BICEP and QUAD require 50l/day. The LN2 plant produces ~6l/hour=144l/day. It should thus only need to be on 30% of the time to produce enough for BICEP and QUAD. This needs to be checked). It should normally shut down (compressor and liquifier) when not producing LN2 but because of the start/stop issues (it brings down some AMANDA electronics and being off gets MAPO too cold), the whole plant stays on all the time. The compressor uses 99% of the power in the LN2 plant.

<u>Cryo facility</u>

The 3 chillers, the 3 compressors and the 3 cold heads use 25kW (recent measurements) each, totaling to 75kW continuous usage (a little more for lights and fans etc but those three things are the majority) for the cryo facility. The compressors are from Cryomech, model CP980-1981123. The chillers are from "Durachil from Polyscience", model DCA304D. Why are we using chillers which use a lot of power to cool the water circuit from the compressor when we have this formidable resource of cold air just next door ?

<u>MAPO:</u>

First and foremost, it seems obvious that MAPO is a huge heat sink. In many places (VIPER hallway, backdoor entrance to MAPO, DASI compressor room hallway and compressor room door), you can feel large drafts of cold air gushing through and even snow seeping though the cracks.

The simplest and most obvious statement one can make is that if the LN2 plant is removed from MAPO, the boiler providing heat to the building will not be able to maintain a normal room temperature anywhere in MAPO.

In addition (and anyone who has worked in MAPO will agree), the air handling in MAPO is inefficient. One clear example of that is the fact that the AMANDA room pretty much always needs cooling and to do that, cold air is taken from outside, goes through the QUAD area and gets mixed with warm air there (thus cooling the QUAD area quite a bit unnecessarily), and then gets delivered over the AMANDA electronics.

Computer room

All the computers in there (~30-40) use LCD screens which turn idle when not used.