Don't Be Reluctant;
Build Redundant

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What is Redundancy?

Why is it important?

One Manapouri Unit

The entire Ohau A station

Versus

Manapouri incident 2016

350MW lost in one minute

- Ramp down at 1 MW/sec across six units

- South Island Frequency dropped to 49.46Hz

- Clutha increased generation by 40MW

- Waitaki chain increased generation by 90MW

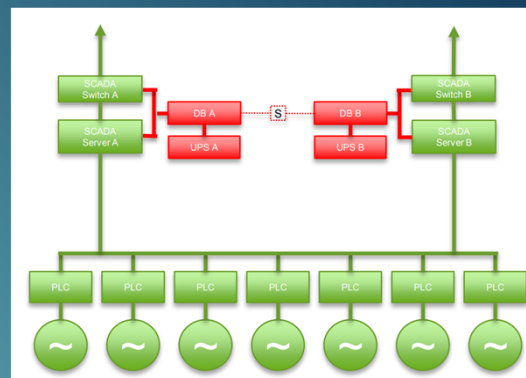- HVDC dropped to 120MW North from 790MW

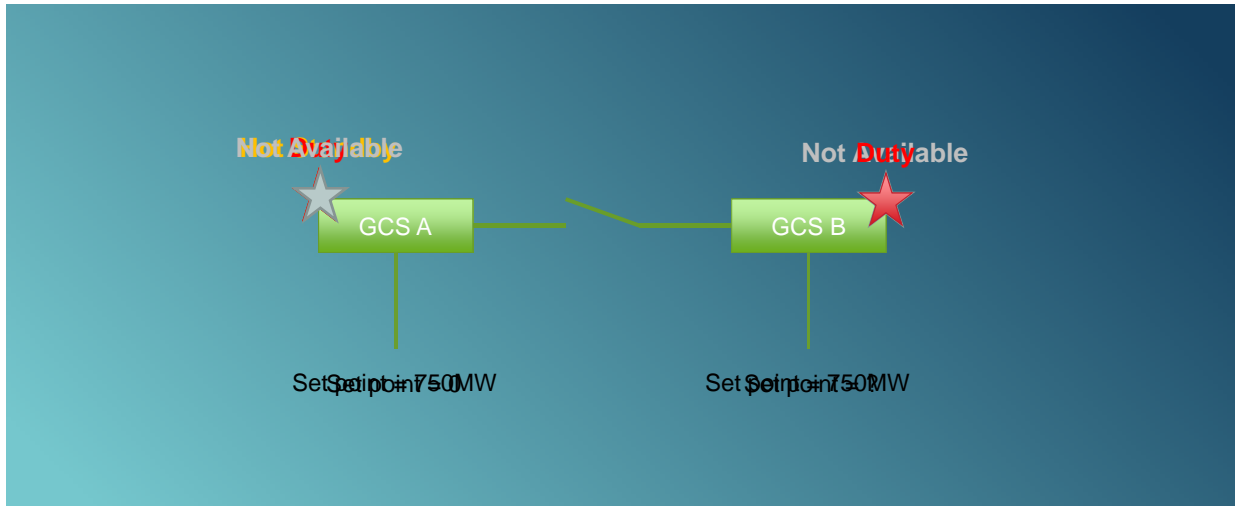# What was the plan?

<u>Original Plan:</u>

It's a 24V system, just work on it live

<u>Contractors Plan:</u>

Work on each side de-energised
(Avoid the large fault current from shorting the battery)

What went wrong?

Not Available

Not Available

GCS A

GCS B

Set point = 750 MW

Set point = 750 MW
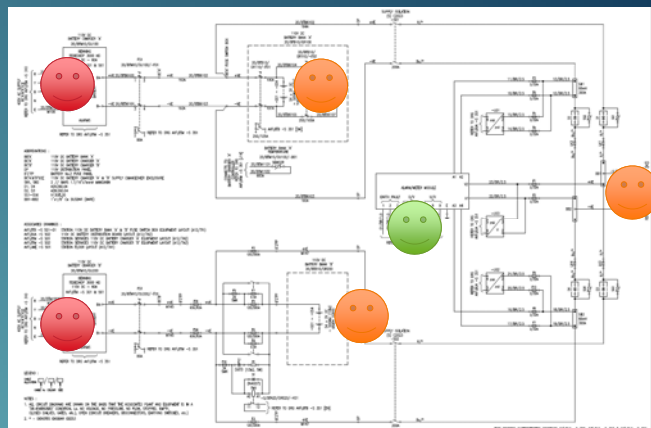
Another Example?

Type redundancy at Aviemore

Station voltage levels:

24V DC =

110V DC =

400V AC =

Also 11kV – 220kV

80 MVAr into a 60MVA machine?

Aviemore type redundancy

What was the plan?

- 400V outage, intending
for the 110V DC to take over

- No type redundancy in the batteries,
and both banks failed

400V circuit breakers (1988)

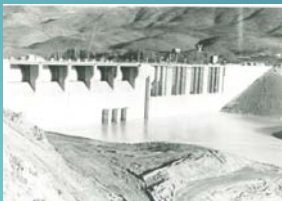---

80 MVAr into a 60MVA machine?

Aviemore type redundancy

What happens during a unit trip?	What actually happened?
- Head gates close	✓
- Excitation stops	✓
- HV Circuit breakers open	✗

How you *can* fit 80MVAr into a 60MVA machine

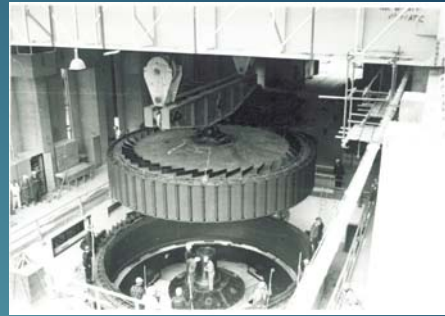Dense on the electrical theory but bear with me…

Aviemore stator being lowered into place

Aviemore Rotor being lowered into place

How about a mechanical example?

(I'm electrical so this'll be a struggle)

Remember that massive balls up at Aviemore?

Also caused our auxiliary machine to run at 200% overspeed for 1.5 hours

Should look like:

So after all that how do we incorporate redundancy?

What types of redundancy can we shoot for:

Hard options:

- Don't jump into new technology

- Consideration of ways the plant can be used (or abused)

- Type redundancy

- Supply redundancy

- Even just doubling up*

Manapouri Power Project
West Arm Powerhouse Contract

Excavation in progress in machine hall. View looking West towards
emergency exit, with transformer vault excavations on right and ramp from
access tunnel to Elev. 6.0 in left foreground.
July 1967

meridian

So after all that how do we incorporate redundancy?

What types of redundancy can we shoot for:

Easy options:

- Normally open switches

- Location redundancy

- Keeping mechanical systems

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So why can't smart just mean smart?

Just do it; build redundant

Questions?