Canobie – *Lessons learned from the battery fire*

Canobie - electric motor arrangement

System installed in 2009/2010:

- Thoosa 7000HT, marketed by ASMO Marine Propulsion Systems. Australian Agent: Blue Mountains Import Export.
- Package included: Motor and coupling; Throttle unit; Controller; 30A Charger; Link 10 Battery Monitor; Key Switch unit. Total weight 37 Kg.
- Motor type: Lynch motor, 48V DC, 7.4Kw.
- Battery Regeneration available (supposedly).

Canobie - *electric motor arrangement*

Electric motor unit

Compartment with charger and controller

Canobie- initial batteries- 2010 to 2018

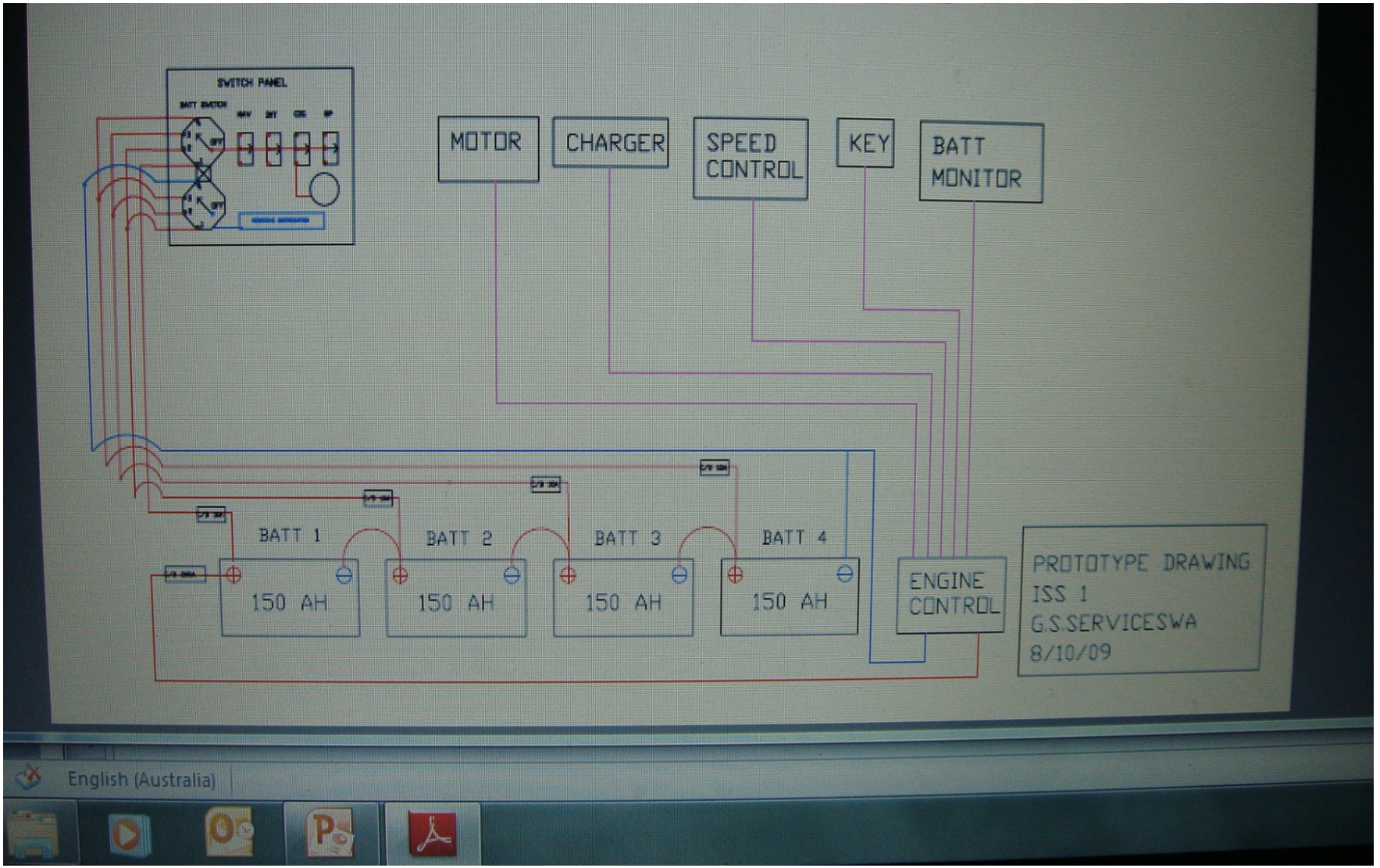
Initial Batteries:

- In 2010 I installed REMCO, Chinese manufacture, from Whitworths.; AGM (absorbed glass matt) sealed; 4 x 12V x 120Ah in series. Through a sailing mishap (excessive discharge in an emergency) these batteries lasted less than 3 years.
- I replaced them with similar manufactured AGM batteries, and these lasted approximately 6 years. Batteries were sized to give 2 hours motoring time at 30Ah, when discharging not more than 50% of capacity.
- I initially chose the 'cheap' Chinese batteries ($350 each!), expecting that technology advancements in lithium batteries would soon permit an upgrade.

Battery performance:

- The rule of thumb is that with each knot of speed the remaining battery capacity is halved.
- These 120Ah batteries were very sensitive to that. I get more like only 1- 1.5 hrs at 30Ah. 30Ah pushes the boat at a guessed 3.5 -4 knots. 40Ah throttle flattens the batteries very fast.
- Battery sizing. I should have gone for 200Ah batteries, but I was trying to save weight.

Canobie – *2010-2018 electric motor arrangement*



Canobie - *electric motor arrangement*

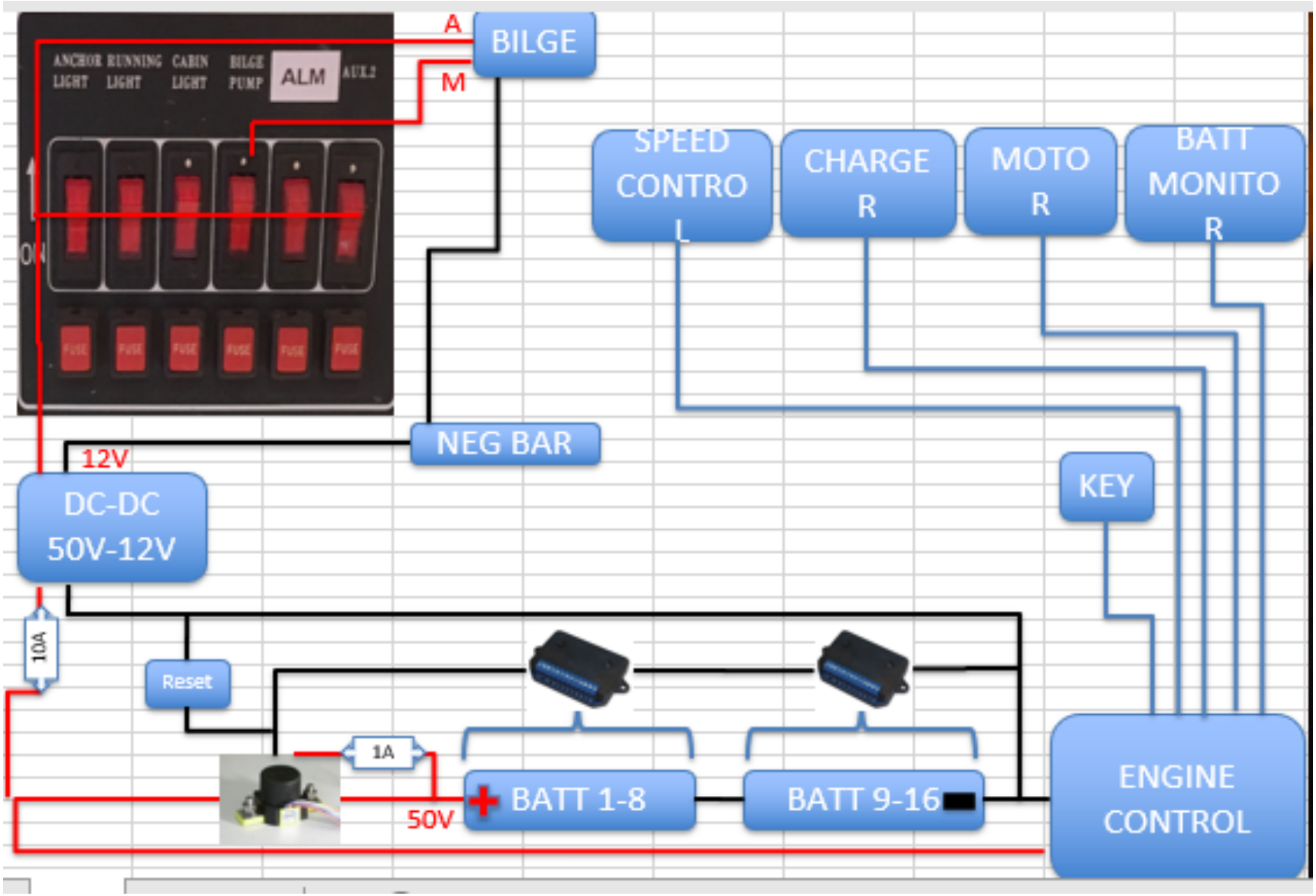
30A Charger

Unit concealed under cockpit

Canobie – *lithium battery arrangement*

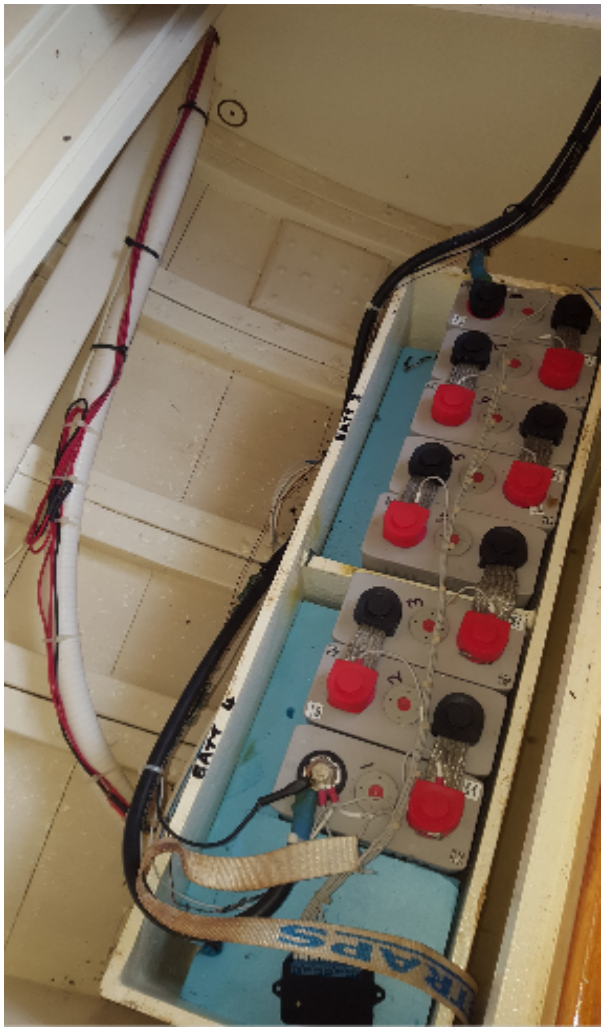
- In November 2018 Steve Humphries replaced the lead-acid AGM batteries with 16 x 3.2V lithium-iron-phosphate batteries. These were CALB Lifo batteries manufactured in China, and supplied by EV Works in Landsdale, WA.
- Whilst we knew there was some risk with lithium battery fires, we decided the way to go was to plan for a circuitry to control that risk. This was done with the advice from EV Works, who are currently converting mainly motor vehicles to electric propulsion.
- Two battery monitors (BMS”s) were installed connecting all 16 cells, with alarms and over-voltage and under-voltage signals to an inline solenoid cut-out switch. An alarm switch was added to the control panel.
- After testing and monitoring for a period of weeks I was advised that it was OK to leave the system on shore-charge (float) in the same was I had done for years with the AGM batteries. All the tests showed the charger cutting out satisfactorily, and not over-charging.

Canobie – *lithium battery circuitry*



Canobie – lithium battery fire

Canobie – fire damage



Canobie- fire events

- Smoke detected by passing yachties, late on 28 August 2019, whilst Canobie was unattended in her RPYC pen.
- Emergency response triggered by RPYC. Excellent mobilisation by the shore team.
- WA Fire Brigade arrived promptly with 3 trucks, the right tools and breathing apparatus. Toxic smoke prevented anyone without breathing apparatus getting on the boat.
- Fire quenched quickly. Digital thermometer showed that only the port side batteries were over-heated. Starboard side was isolated as a precaution.
- Smoke damage was through everything. Structural timbers were scorched only.
- The custom-made battery boxes prevented the fire propagating to a catastrophic outcome, through the restriction of oxygen.
- Club Marine, the insurer, and broker AJ Gallagher, were notified early the next day.

Canobie – the fire investigation

- Club Marine engaged two separate local investigators to examine the fire damage and report their findings.
- The 2nd investigator was a former electronics technician who specialised in forensic examinations.
- Steve Humphries and I were interviewed very thoroughly for nearly 3 hours, with the investigator challenging the circuitry and protection logic, looking for any hint of negligence.
- The final determination was that:

1. The fire initiated in the 3rd cell of the port side battery bank, caused by a short between 2 leaves of the lithium-iron-phosphate medium (normally separated only by a 3micron thick inert sheet). It was most likely a tiny spec of foreign material trapped during manufacture.
2. The offending cell over-heated when left on charge, because the BMS did not shut off the solenoid and charging power. The BMS did not have an over-temperature detection function. Later models do.
3. There is some conjecture as to whether or not the battery charger should also have shut off, at over-voltage.

- Club Marine agreed to meet all the expenses actually incurred in the subsequent repairs, without the scheduled excess amounts.

Canobie fire- acknowledgements

- The 2 observant RPYC yachties, following the Wednesday WAGS race.
- RPYC and its Emergency Response plan and execution.
- WA Fire Brigade.
- Club Marine Insurance.
- Mike Foster and Steve Humphries.

Canobie – survived the fire to celebrate her 107th birthday – 1 Nov 2019, and 10 years on the Swan River.