

SPECIALISTS IN ELECTRONIC & ELECTROMECHANICAL ROOT CAUSE FAULT FINDING AND RESOLUTION

Problem - Traction inverters

In 2010 equipment was showing intermittent 'turn-on/off' faults repeatedly resulting in isolation. This had become a long-standing problem.

Equipment was being returned to the OEM, only to be returned 'NFF', despite the fault continuing to be present when returned to service.

Issue was compounded by 12 weeks lead time for repair, resulting in sets running without a full complement of working inverters.

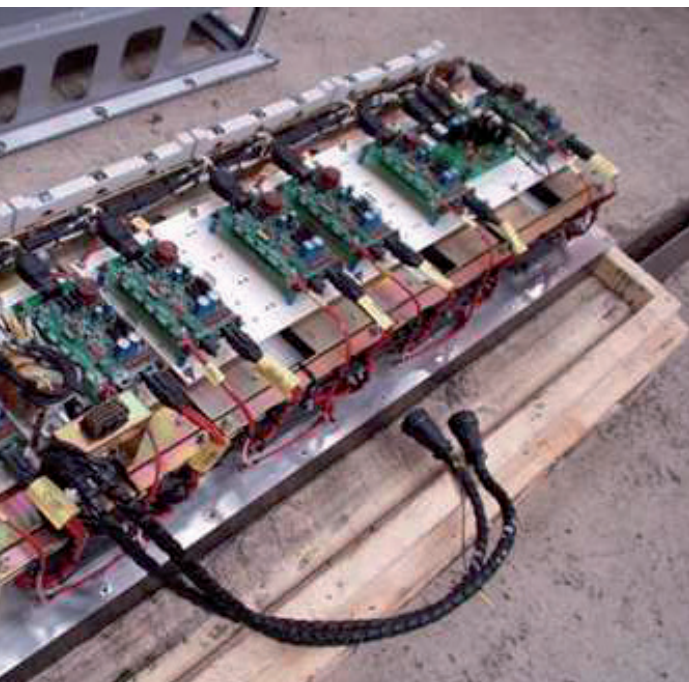
Objective - Discover the root cause

SET carried out two weeks of intensive reverse engineering and tests, which led to discovery of the root cause: a degrading internal connection within the main power switching devices (IGBTs), leading to false error detection.



Solution

- Custom test devised to detect the issue at an early stage.
- Failing IGBTs replaced with alternative batch.
- SET took over repair service from OEM



Result

- NFF rate dropped to near zero. The problem identified and corrected.
- Lead times reduced by an average of 80% to 2 weeks.
- Sets were running with full complement of working inverters.

Conclusion

By handing this particular issue over to SET the customer was able to take advantage of our experience in finding the root cause of intermittent failures. A nagging issue was resolved which improved operating efficiency.

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Problem - Traction inverters

Our customer had a problem with ageing Frequency Division Multiplexer (FDM) racks. Resulting in service delays. They were looking for assistance in scoping an overhaul programme to provide maximum benefit.

Challenges for SET

- Additional float stock was required to support the overhaul.
- Equipment contains various obsolete and custom components.
- Safety case was complex for fit, form and function replacement.
- 3 parties involved in the overhaul



Proposal

- Technical report produced, based on analysis of the design and historical repair data.
- Several costed options offered, along with rationale for each.

Result

- SET's proposal selected
- 20 fit, form and function units produced and approved for use.
- New design was independently audited and approved by SNC Lavalin.

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Problem - Automatic Voltage Regulators

- Existing supplier to our customer unable to meet delivery needs - Trains stopped.
- High re-failure rate with existing supplier.

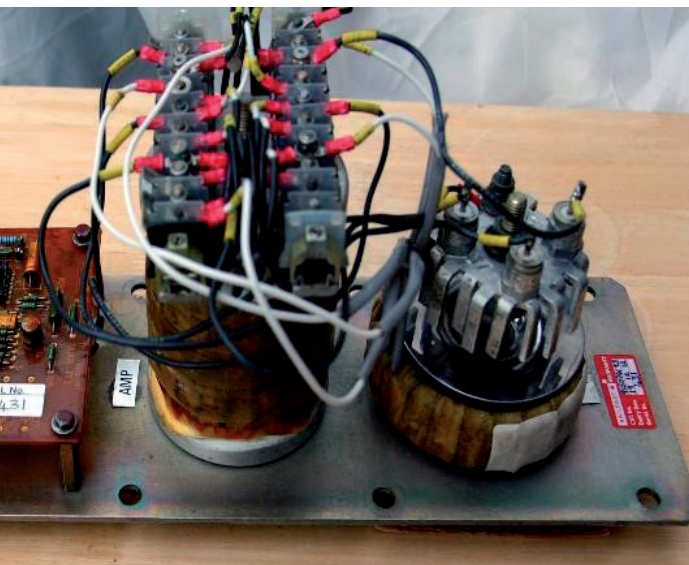
Challenges for SET

- Safety critical equipment with no test documentation.
- Ancient technology with little expertise remaining in Rail Sector.
- Rapid solution required.



Investigation

- Equipment reverse engineered to produce technical documentation and test procedure.
- Motor-alternator set built to provide required test environment and ensure that safety critical aspects could be fully verified.
- Weaknesses identified and overhaul programme devised.



Result

- Reliability 'very significantly improved'
- SET has become the customer's consultants on all issues regarding 158 charging.

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Problem - Traction inverter IGBT obsolescence

- Main power switching devices identified as 'sunset' part.
- Original part seen as 'weak'.

Challenges for SET

- Major high value component/assembly with potential for significant commercial impact.
- EMC implications.
- Ensuring new IGBTs would operate within safe limits during worst case conditions.
- Predicting the service life of alternatives.



Validation Programme

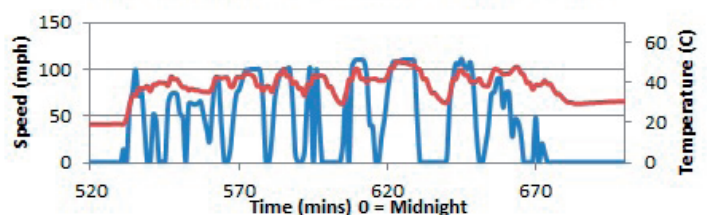
- Two alternatives validated via on-vehicle trials including EMC & Thermal.
- Lab tests to demonstrate operation within design limits.
- Duty cycle tests to predict service life.
- Close links established with component manufacturers to ensure all technical requirements & risks were understood. This also allowed SET models and predictions to be independently scrutinised.



Result

- Two validated alternatives with significant improvements in predicted service life compared to the original part.
- Comprehensive report.
- Aspects of SET's work were independently assessed and validated by Lloyds Register Rail.

Speed and Heatsink Temperature



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Problem - Hot Axle Box Nuisance Tripping

Hot axle box sensors failing partially – leading to triggering of alarm but without positive evidence of overheating. The cause and significance of this was uncertain. Service minutes were being lost.

Challenges for SET

Establishing whether axle box temperature was a contributory factor.

Understanding the mechanism by which the partial failure occurred



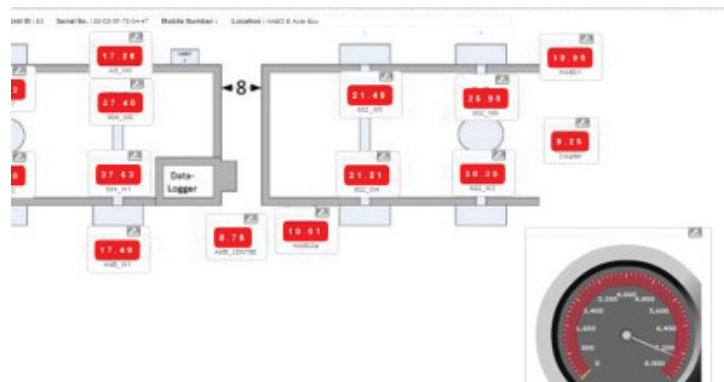
Investigation

Live data logging equipment installed on vehicle in targeted locations



Result

- Report with most likely cause identified
- The proposed cause was confirmed by the sensor manufacturer who modified his process to avoid further issues
- SET report highlighted other issues for further investigation



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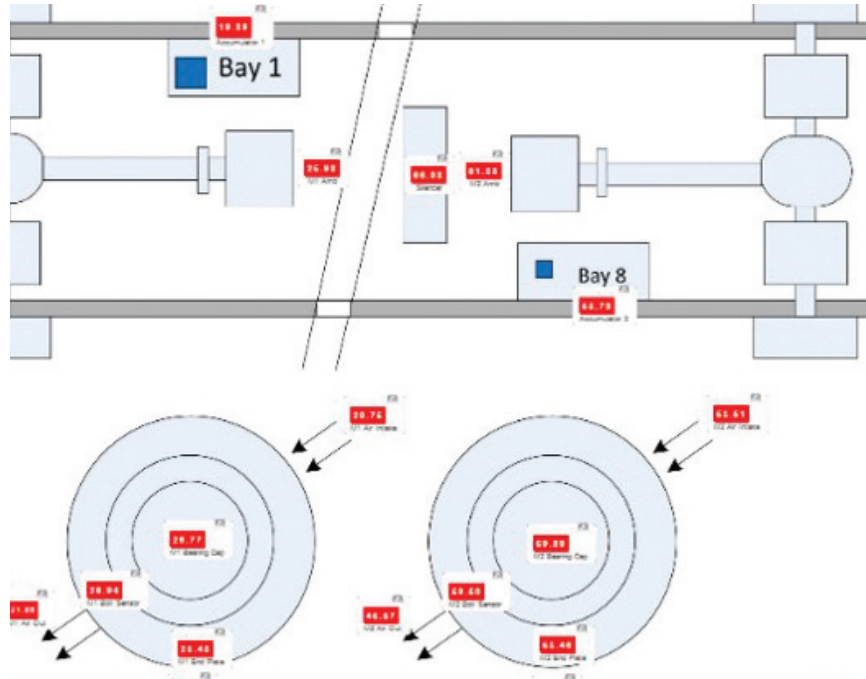
Problem - Traction Motor Bearing Failure

Bearing on the motor was failing prematurely in certain vehicle locations

There was uncertainty as to whether temperature was a contributory factor (this was the element SET was asked to investigate)

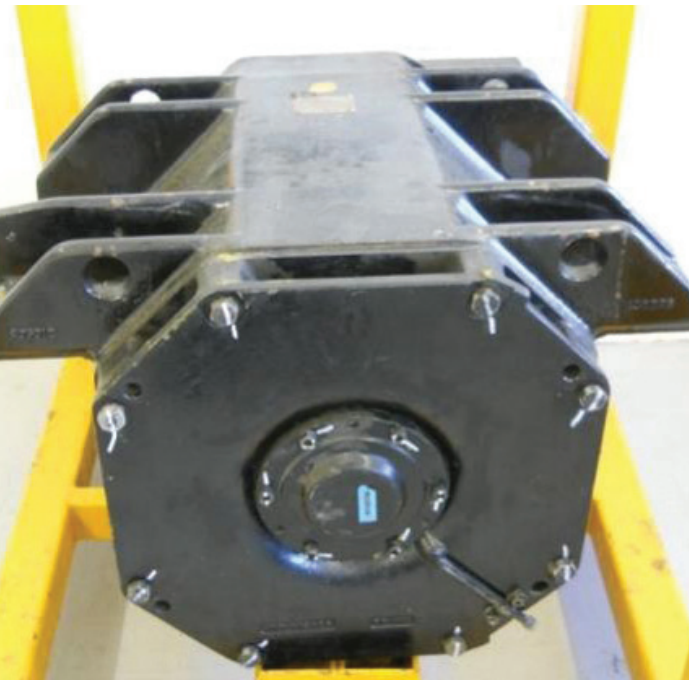
Challenges for SET

- Installing under-vehicle data-logging equipment
- Installing temperature sensors to multiple locations without mechanical fixings allowed



Solution

- Custom sensors produced for each location, and installation method developed to allow on-vehicle installation process
- Data logger enclosure with high impact resistance and additional robustness added by modifying underframe bay door



Result

- Exhaust silencer eliminated as contributory factor (an early theory based on proximity of exhaust to bearing cover)
- Inadvertent heating of motor air intake identified as an issue