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Electronics/Electrical Systems and Civilian Armoured Vehicles

Ian Marriott – Managing Director

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Aim

- To introduce and discuss the possibility of electrical system performance being altered by the mechanical armouring process and to:
  - Highlight those areas that may be effected by up-armouring vehicles
  - Look at a specific case study – Batteries, Power and Heat
  - Discuss current electronics seen on the Toyota LC300 vehicle

Armouring – Customer Requirements

OEM Vehicle Development

- OEM investment including:
  - millions in R&D spent
  - years of development
  - supplier base R&D
  - reliability data from billions of hours
  - continuing R&D
  - homologation and testing

Customer Requirements

- An OEM vehicle that:
  - is resistant to threats - Armoured
  - blends in
  - is comfortable
  - is safe
  - is reliable
  - is multi role
  - is legal

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To Achieve This?

- Requires the complete interior removal
  - approximately 80% of wiring, ECU's, control systems and displays
- External skin may be changed with hatches etc
- Specific armour is installed to the cockpit and other areas
- Internal space is altered:
  - may reduce the internal dimensions
  - may have to alter cross members, fixing points, locations of parts
- Then put back together

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Consequences

- All the previous OEM information is now in doubt
- OEM test and development and R&D data may not be valid
- Vehicles parameters have changed – Centre of Gravity, braking distances, momentum etc
- System performance may not be within design limits
- Cooling Issues

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Changes

- System operating ranges
- Positioning of sensors & ECUs
- Weight and loading increased in different locations
- Wiring harness locations different to OEM
- Earth points and bonding now through armour

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System Effects

Possible Systems Effected

- SRS & Seatbelts
- Brake Force and Balance
- TCS and Stability
- Sensors
- Radio Frequencies
- Antennas
- EMC
- Electrical Power

Case Study – Battery Issues

Power issues in Kabul on LC200 Toyota Landcruisers

Fleet of 17 vehicles over 35 dead batteries per year

In field assessment and recommendations

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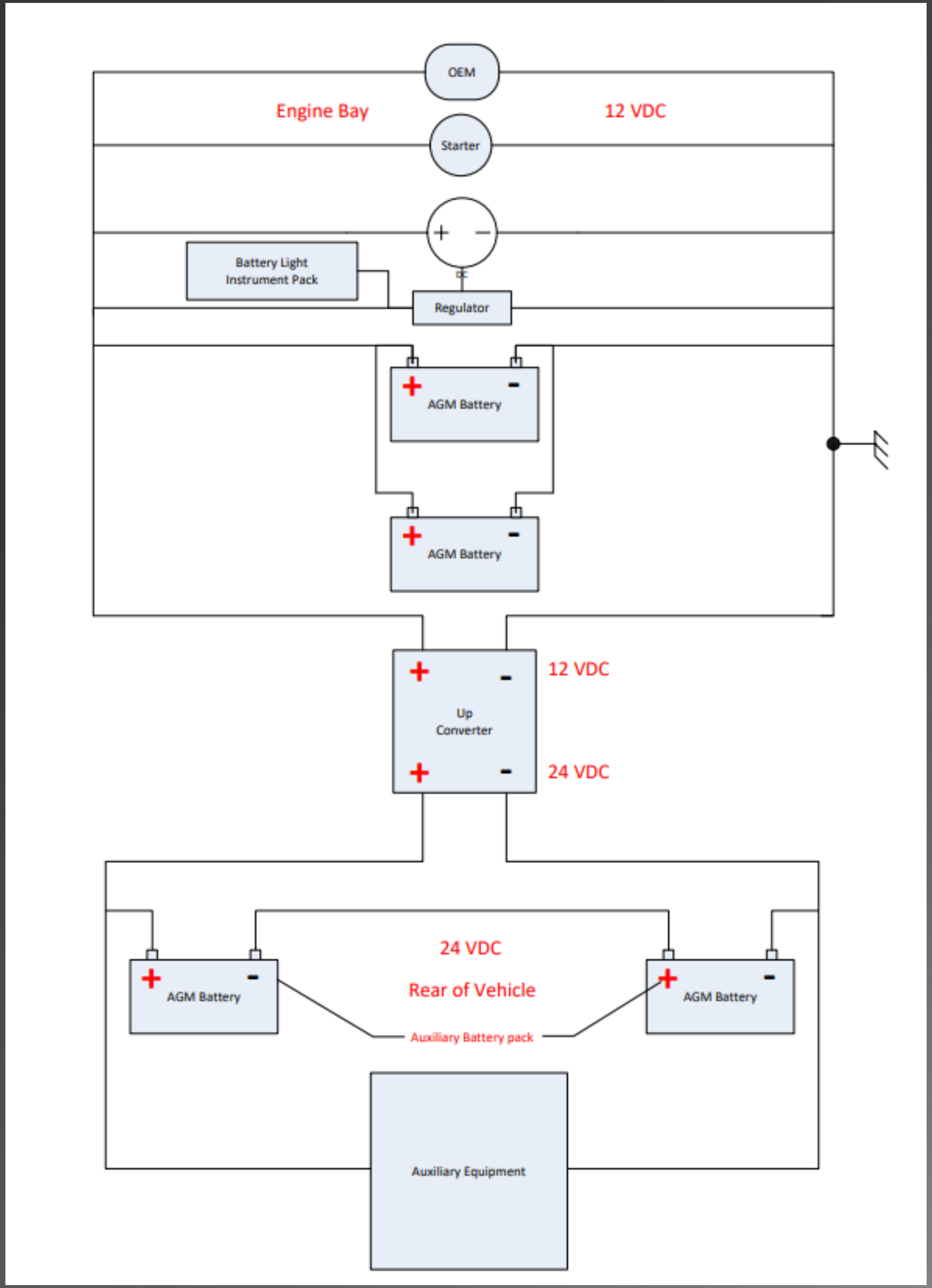

Case Study – Load Balance

- Batteries power the vehicle
- Alternator keeps the batteries charged
- Battery reacts quickly – High Power >500 CCA
- Alternator reacts slowly and lower power – depends on rotational speed and type
- Primary, Secondary and Auxiliary Batteries in banks

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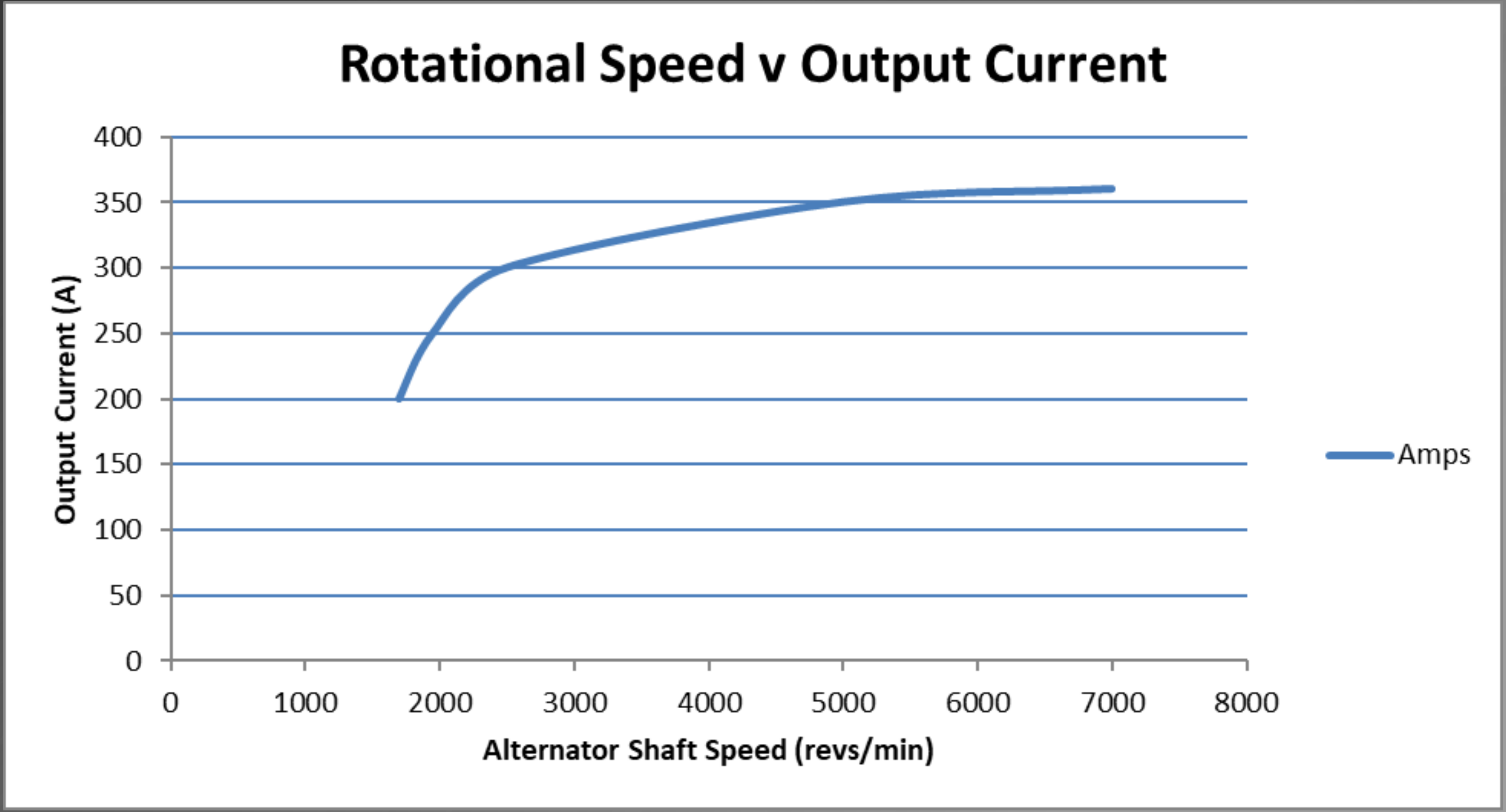
Case Study – Alternator Output



Case Study - Assessment

Customer Report

- No output power
- Cars don’t start
- Battery Management System no working
- Unable to get spares
- 35 batteries a year

Initial Inspection

- Deformed outer casing
- Voltage down to 5 VDC on cranking, <10 VDC at rest
- Three batteries found broken on initial inspection
- Mission profiles examined
- Temperature labels attached

Root Cause - Batteries

Batteries Overheating

- Reaching 100°C
- Mission profile involved 6 hours at idle with 20 km driven
- Some cars parked with bonnet in sun
- Often running even when in garage area
- High altitude of location 1791m (11th Highest Capital City) – Solar Loading
- Batteries gassing
- Some batteries not the same in dual installation
- Some had battery armour protection

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Root Cause – Power Generation

- OEM alternator output at 50 Amps idle maximum
- Load required at idle >120 Amps for 5 hours
- No High Idle System
- Batteries strained during mission profile adding to issues
- Load Balance issues

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Solution

- Cant change the mission profile
- Load Balance calculations checked with End Users Mission Profiles
- Installed upgraded Alternators and High Idle Kits
- Removed some battery armouring, recommended battery tray design
- Moved out of sun and added other coverings when out of garage
- Rotate batteries to new charging area
  - 2 weeks in car 2 weeks in bay
  - Trickle charging continuous at 21°C
  - 5 stage chargers
  - Additional test equipment – Battery Load Testers

Power Generation – Comments

- Alternators rated at idle
- Must match mission profile demands
- Not enough power means batteries deep cycling continuously
  - Increases stress on batteries
  - Batteries unable to cope with rapid changes in power
- Charging voltage out of ideal charging range at temperature
- Idle power may need a matched High Idle Kit
- LC200 needed approximately 70 Amps at Idle in some circumstances

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Battery Comments

- Batteries don't like heat
  - Accepted range -40 to 55°C max
  - Increase temperature less voltage needed on charge
  - Pressure increase deforms softened cases
  - Capacity permanently reduced
  - Cells can fail
  - Gas produced and released at approx. 2.5 Bar
  - This is hydrogen no confined boxes
- Don't mix battery technologies
- AGM – Gel – Liquid Lead Acid?

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Outcome

Following year 2 battery failures

LC300 Electronics

Vehicle can be stopped from starting with very low power

More CAN and LIN based computer control intelligence

New systems i.e. electrical brake operations

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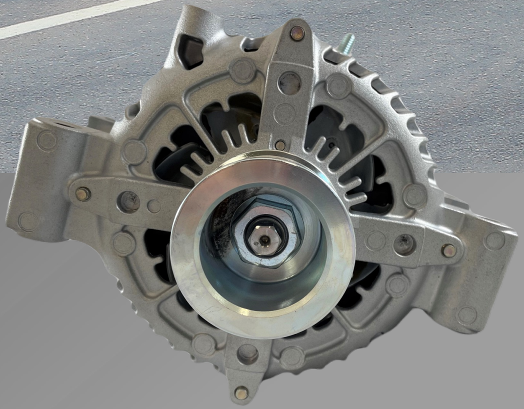
LC300 Electronics

Lighter, reaches speeds when armoured above tyre limits

Less space, New Dual Battery Configuration

Increased alternator output – may still not be enough



Questions

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