

10 March 2005

Subject: Motor Vehicle Modification Application (Electric Conversion)

Dear Sir or Madam:

Please find below detailed information of vehicle modifications made to 1999 Toyota Echo 2-door hatch, registration number 828HUV (VIN JTDJW133200010642) for conversion from conventional petrol engine to electric motor with traction batteries.

I now understand that this information should have been provided in draft format **before** modifying the vehicle but that due to a misunderstanding, I believed that the application was to be made *after* the modification. I accept full responsibility for this mistake and any ramifications that may occur because of it.

However the conversion project's mission was to have minimum structural impact on the "donor" vehicle as to not compromise any of the original vehicle's safety and design parameters.

Therefore I welcome any safety design issues that may arise from this application no matter how major or minor and look forward to working closely with Queensland Transport Vehicle Safety representatives from this point on.

Components removed;

- Petrol engine (1.3ltr).
- Fuel tank.
- Exhaust system.
- Cooling system.

Components installed;

- 23 HP (nominal) DC electric motor.
- 10 x 12V traction batteries.
- Electric motor power controller.
- 12V electric brake booster vacuum pump and reservoir.
- 12V, 250W electric heater for windscreen demister.

Issues

1. Motor replacement.

1.1. Motor power rating; It is difficult to compare manufacturer's specifications between internal combustion engines and electric motors as they are rated differently. During Test-drives the vehicle felt to have slightly less power, since the electric conversion.

1.1.1. Petrol engine ratings;

1.1.1.1. 63 kW @ 6000 rpm.

1.1.1.2. 122 Nm @ 4400 rpm (SAE).

1.1.2. Electric motor ratings;

1.1.2.1. 1 hour rating = 23 HP (17kW) @ 89V.

1.1.2.2. 80 ft lb (108 Nm) @ 5000 rpm.

1.2. Motor mountings.

1.2.1. All three existing motor and gearbox mounts were **not** modified for the conversion. An aluminium adaptor plate was fabricated for the motor to bell housing mating (fig 1) and a 6mm mild steel bracket was fabricated so that the rear of the motor would fit the existing engine mount and maintain the original motor/gearbox alignment within the engine compartment.

1.3. Motor coupling.

1.3.1. A coupling was designed to fit the original flywheel with its original bolts to the electric motor output shaft (fig 2). This was precision machined from high quality 4140 steel by BHSS who have extensive experience making and repairing transmission and clutch components.

1.4. Loss of vacuum source for power assisted brakes.

1.4.1. Removal of the internal combustion engine meant that the vacuum source for the power assisted brakes was removed. A 12V DC Thomas electric vacuum pump (commonly used in electric vehicle conversions) was fitted along with a 2.5 litre high-pressure-PVC vacuum reservoir. The vacuum pump is activated by the ignition key-switch "on" position and is regulated to approximately -13" hg by a Hobbs Series 5000 vacuum switch.

1.5. Loss of heat source for windscreen demister.

1.5.1. A 250 Watt 12V DC ceramic heating element was used to replace the original petrol engine cooling system heating core in the cabin air ducting system.

2. Traction battery installation.

2.1. Battery mountings; In the interests of safety **none** of the batteries are mounted within the passenger shell. Nor has any cutting or modification been made to the body shell or chassis rails to accommodate the batteries. Most of the bolt anchor points are the manufacturer's original mounting positions using high tensile grade eight bolts and nuts.

2.1.1.1. The five front traction batteries are mounted on 5mm galvanised steel angle rails bolted to the chassis rails using 6 **existing** bolt-mounting points (4 on the chassis rails and 2 on the front-end sub-frame). There were an additional 4 bolt-mounting points added by drilling through the two front-end upright members (on the ends of the chassis rails) for additional support. (see enclosed A4 drawing)

2.1.1.2. The rear battery rack (5 batteries = 120 kg) is mounted to a bracket that uses the 4 **existing** petrol tank bolt-mounting points (50 kg capacity) and another 4, now unused, rear seat mounting points (>200 kg capacity). (see enclosed A4 drawings)

2.2. Battery restraints.

2.2.1. Each front (under-bonnet) traction battery is held down with a 20mm woven polypropylene strap and buckle which are rated at 280 kg capacity. Polypropylene was chosen because battery electrolyte does not chemically deteriorate it.

2.2.2. The five rear traction batteries are held down into the battery rack with a 12mm mild steel threaded rod (inside vinyl tubing) running down the centre of the length of the rack with four mounting posts. Two aluminium corner protectors protect each battery from abrasion against the restraining rod.

2.3. Increased Kerb weight; Due to the weight of the batteries it will be necessary to change the vehicles passenger capacity from five to two seats;

2.3.1. Original Kerb weight = 950 kg.

2.3.2. Add 240 kg (10 x 24 kg) for traction batteries = 1190 kg. (Confirmed by registered weighbridge.)

2.3.3. Add 2 x 85kg for the modified 2 seater configuration = 170 kg + 1190 kg = 1360 kg.

2.3.4. Manufacturers Gross Vehicle Mass = 1375 kg.

2.4. Electrical safety.

2.4.1. Cabling. All high voltage cabling is double insulated and where exposed to any possible abrasion is mounted inside a least one layer of PVC conduit.

2.4.2. There are three means of high voltage electrical isolation;

2.4.2.1. Electronic solenoid activated by the ignition key-switch.

2.4.2.2. Manual double-pole disconnect switch.

2.4.2.3. 500 amp fuse.

2.4.3. There is also a motor controller safety circuit that requires the ignition key-switch to be on **and** the accelerator pedal micro switch to be activated before the controller provides any power to the electric motor.

I am confident that you will find this conversion to be of a professional standard and maintain the vehicles original safety standards. However, if not, I welcome the unreserved communication of any concerns from your staff.

About myself; I'm 42, I have had 13 years experience as a fitter machinist in heavy industry, 3 years as a business machines technician and 10 years as a telecommunications technician and technical specialist. I have trade level certificates in diesel fitting and electronics.

Yours Sincerely,

Shaun Williams
Enclosures (5)