

## Noise Reduction for 4WD Bus and Coach

### Engineering Test Report and Recommendations

Megasorber soundproofing provides cost effective solutions by reducing (1) the low frequency noise structure-borne noise as well as (2) the air-borne noise. The details of this soundproofing system are as follows:

**Background information:**

- Problem: high level of whining noise causing discomfort to passengers;
- Both body builder and the chassis manufacturer had tried to resolve this persistent noise issue, however, the noise issue continued.
- The vehicle owner contacted Megasorber for a solution.



Fig 1. The 4WD Vehicle

**Executive summary:**

Noise testing was conducted before (as received) and after installing the Megasorber soundproofing package, at cruising speeds of 80 km per hour (80km/h) and 100km per hour (100km/h). The test results are in the graphs below.

At cruising speed of 80km/h, it is evident that:

1. As received, the overall noise level is about 76 dB(A). The vehicle has a very high whining noise level at 800Hz. It is 12 dB(A) higher than the noise level at other frequencies. This whining noise is the main cause of passenger discomfort and headaches.
2. The Megasorber Soundproofing package has reduced the overall noise level from 76 dB(A) to 68 dB(A).
3. This package has also reduced the whining noise by 9 dB(A), ie. from 75 dB(A) to 66 dB(A). As a result, it has dramatically reduced the “annoying” factor.

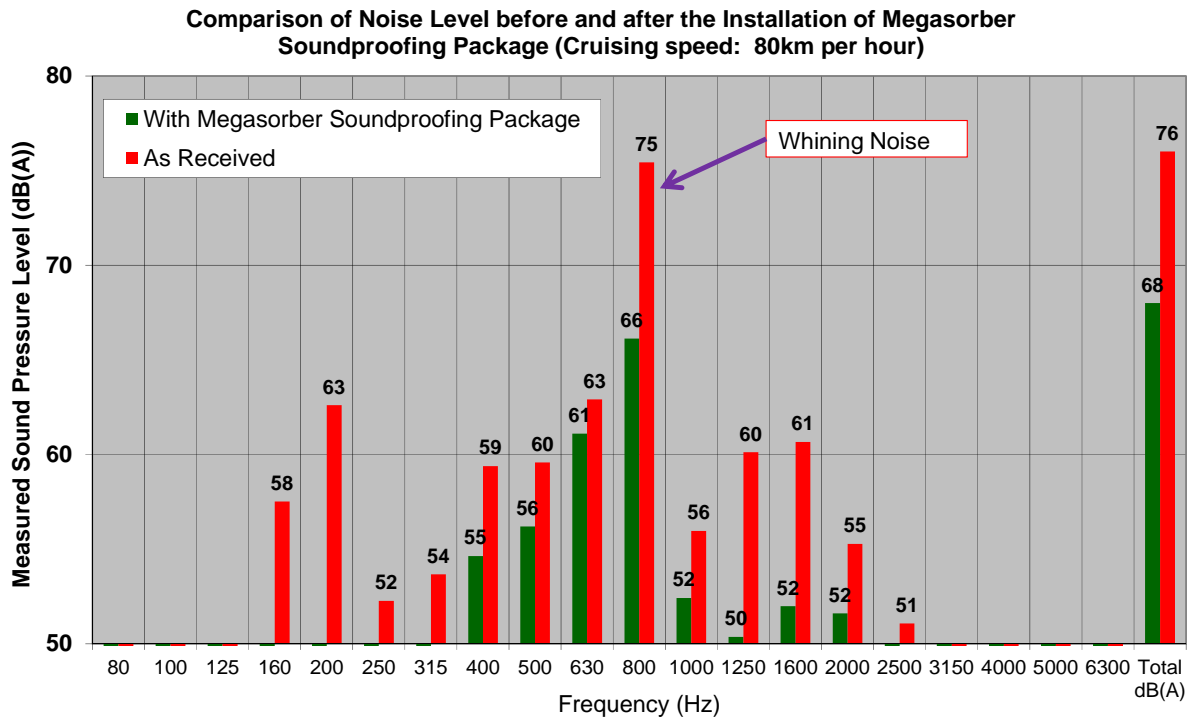


Fig 2. The noise level before and after the installation of Megasorber Soundproofing package (at 80km/h)

**100km per hour Cruising Speed:**

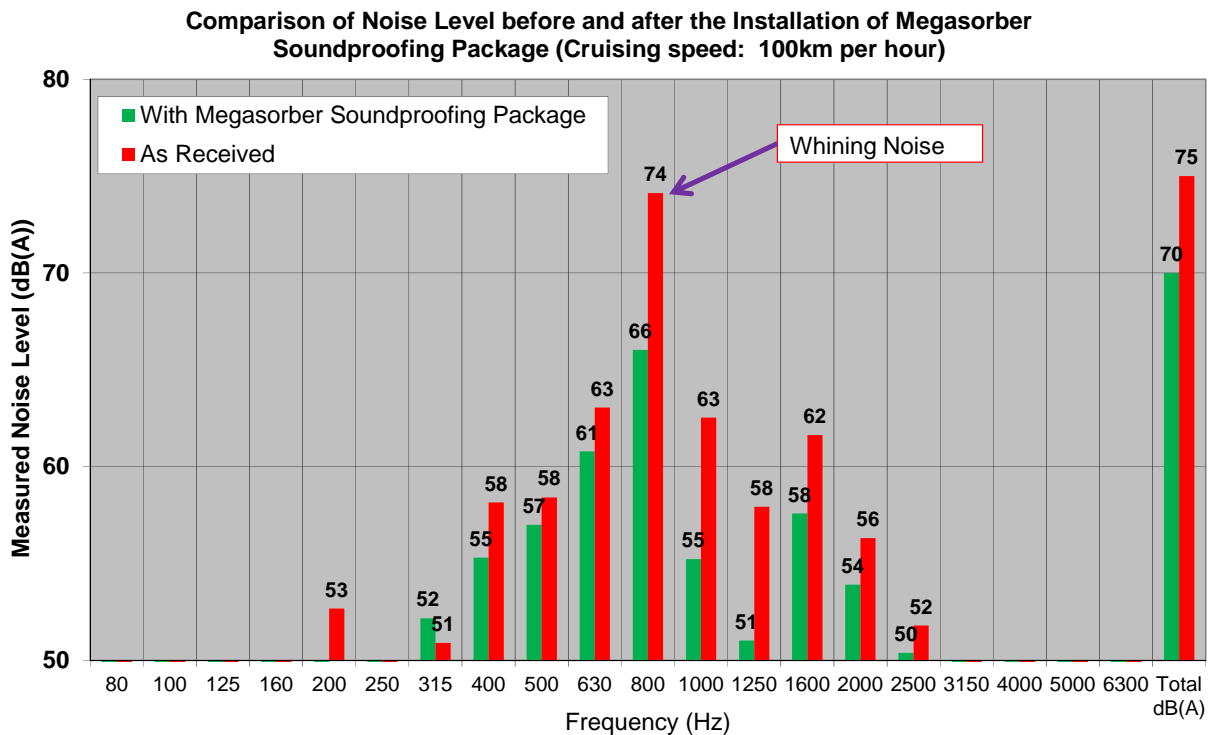


Fig 3. The noise level before and after the installation of Megasorber Soundproofing package (at 100km/h)

At cruising speed of 100km/h, it is evident that:

1. As received, the overall noise level is about 75 dB(A). The vehicle has a very high whining noise level at 800Hz, which is 11 dB(A) higher than the noise level at other frequencies. This is the main cause of passenger discomfort.
2. The overall noise level has been reduced from 75 dB(A) to 70 dB(A) after the installation of the Megasorber Soundproofing package;
3. The specific whining noise has been reduced from 74 dB(A) to 66 dB(A).
4. The noise level at 800Hz is about 5 dB(A) above the noise level of the other frequencies. This has reduced the "annoying" factor dramatically.

In summary, the Megasorber Soundproofing package has reduced:

- the overall noise level by 5 to 8 dB(A).
- most importantly, it has reduced the whining noise significantly, eg, about 8 to 9 dB(A).
- as a result, the whining noise is no longer a concern to passengers.

### **Details of the Megasorber Soundproofing Package and the Noise Measurement Results:**

The Megasorber soundproofing package was installed in two separate stages and noise testing was conducted for each stage. The noise tests were conducted under the following conditions:

- Seats were removed;
- Underside – the old insulation was removed;
- Only one double seat was put back so that the measurement could be carried out;
- All holes and openings were covered or sealed;
- Acceleration: from 65km/h, 70km/h, 80km/h, 90km/h to 100km/h;
- Deceleration: from 100km/h, 90km/h, 80km/h and down to 65km/h;

The Megasorber Soundproofing package is as follows:

1. *Megasorber DIS8*: 2mm thick self-adhesive vibration isolation and damping sheet;
2. *Megasorber D14*: 2mm thick self-adhesive vibration damping sheet;
3. *Megasorber FG50*: 50mm thick acoustic foam with a fireproof sound absorbing Soundmesh G8 facing;

The above soundproofing system has been implemented into the target areas. In order to evaluate the effectiveness of each component, the above systems were implemented in two separate stages.

#### **Stage one: Megasorber DIS8 only.**

1. Megasorber DIS8 system: floor, front panel and side panels.

The DIS8 was applied onto the substrate first. Then a top layer of 3mm thick steel plate was adhered on the top of the DIS8.

Areas treated with the DIS8:

- The whole floor board;
- The side walls: from the floor up to 280mm above.
- The front wall;
- Back step areas;

A Schematic Drawing of Installation of Megasorber DIS8 Floor System

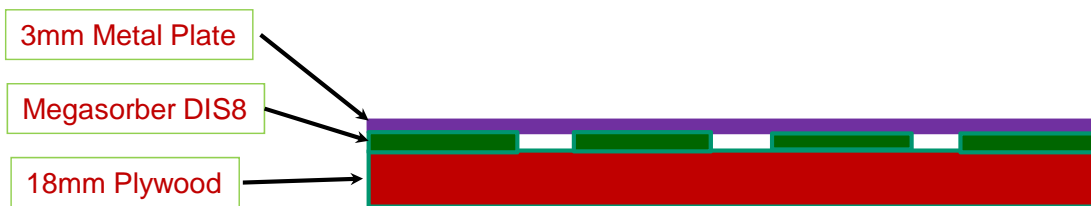


Fig 4. The schematic drawing of Megasorber DIS8 floor system.

The noise measurement before the installation of Megasorber DIS8:



Fig 5. The noise measurement before the installation of Megasorber DIS8.

After the installation of Megasorber DIS8:

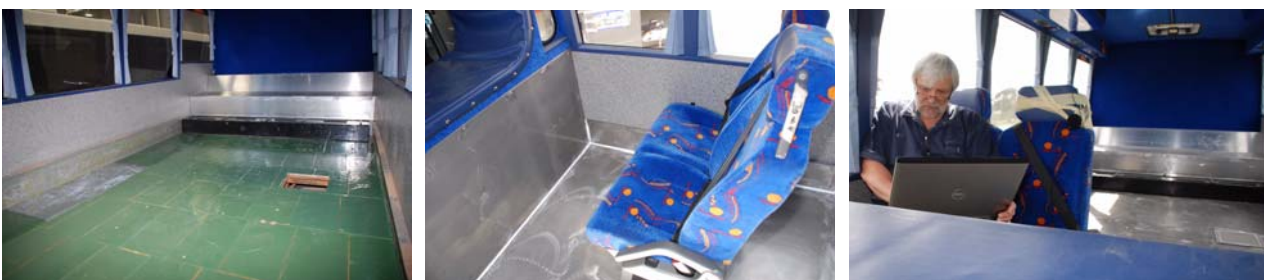


Fig 6. The noise measurements after the installation of Megasorber DIS8.

The key functions of the DIS8:

- Provides excellent isolation, hence increases the STC rating of the system;
- Provides excellent vibration damping, hence reducing the structure-borne noise effectively.

The test results before and after the installation of the DIS8:

- Acceleration:
  - 1) The primary whining noise is located at 800Hz, with a noise level at 87 dB(A).
  - 2) The second harmonic of this whining noise is at 1,600Hz, with a noise level at 80 dB(A).
  - 3) The application of DIS8 has reduced the primary whining noise by 6 dB(A) and the secondary whining noise by 10 dB(A).
  - 4) The application of DIS8 has reduced the overall noise by 7 dB(A) from 88 dB(A) to 81 dB(A).

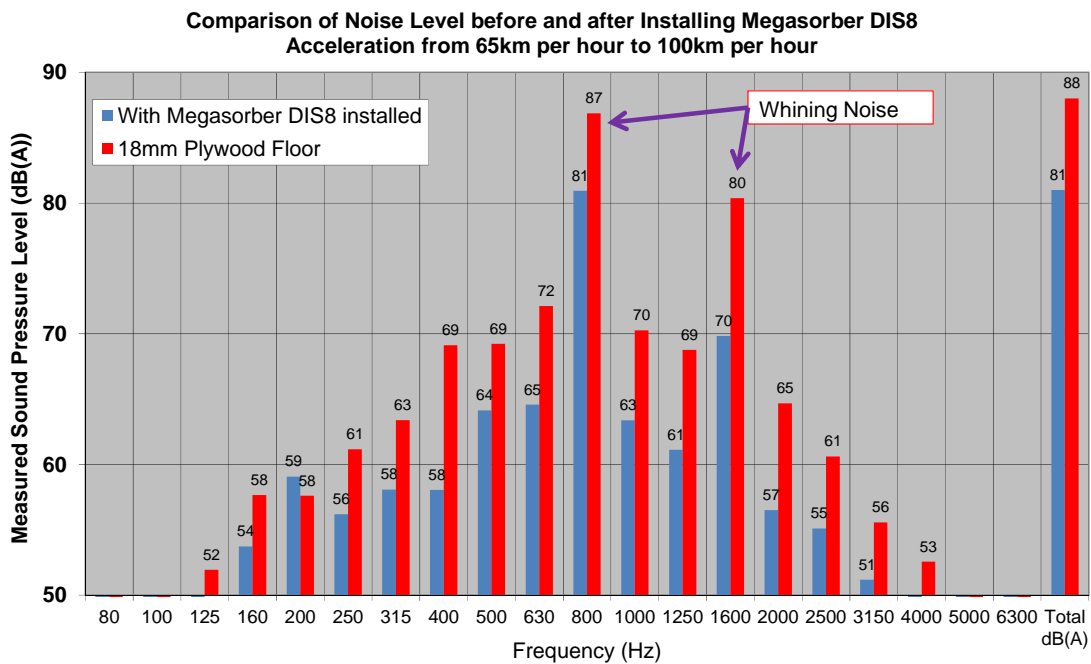


Fig 7. The noise measurement results before and after the installation of Megasorber DIS8 (Acceleration)

- Deceleration:
  - 1) The primary whining noise is located at 630Hz, with a noise level at 83 dB(A).
  - 2) The second harmonic of this whining noise is at 1,250Hz, with a noise level at 86 dB(A).
  - 3) The application of DIS8 has reduced the primary whining noise by 21 dB(A) and the secondary whining noise by 6 dB(A).
  - 4) The application of DIS8 has reduced the overall noise by 8 dB(A) from 88 db(A) to 80 dB(A).

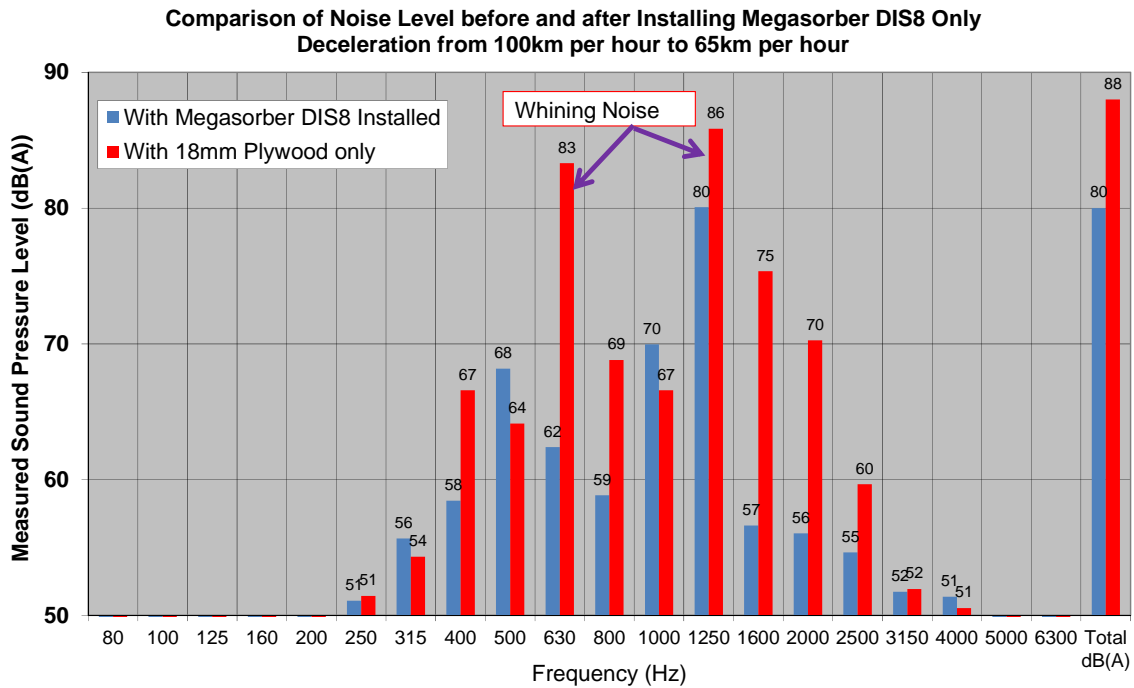


Fig 8. The noise measurement results before and after the installation of Megasorber DIS8 (Deceleration)

• Summary:

- 1) The frequency of the whining noise varies during the acceleration and deceleration;
- 2) During both acceleration and deceleration, there is a ‘whining noise’ second harmonic;
- 3) The application of DIS8 has effectively reduced both the primary and secondary whining noise;
- 4) DIS8 system has reduced the overall noise level by 7 to 8 dB(A).

**Stage two: Megasorber D14 and Megasorber FG50 only.**

1. Underside of the floor: the cavity was filled with one layer of Megasorber FG50 first. The chassis metal beam was then covered with a second layer of FG50. Expanded metal mesh was used on the FG50 to protect and prolong the life.

A Schematic Drawing of Installation of Megasorber FG50 under the floor

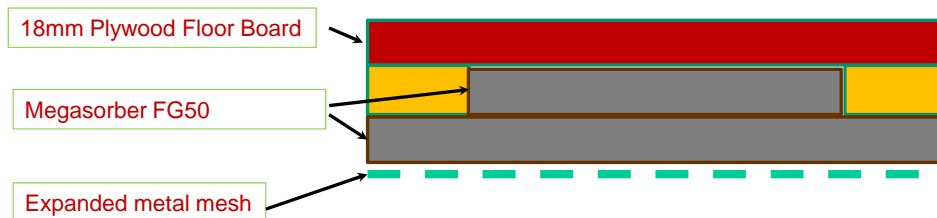


Fig 9. A schematic drawing of Megasorber FG50 installed under the floor board

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Fig 10. The installation of Megasorber FG50 with expanded metal mesh under the floor board

2. Above the transfer case: 3mm steel plate was added across the chassis right above the transfer case. The underside of the steel plate was lined with Megasorber FG50.

Therefore the above system proved to be simple and easy to implement, even though there are even better options.

A Schematic Drawing of Installation of Megasorber FG50 above the Transfer Case

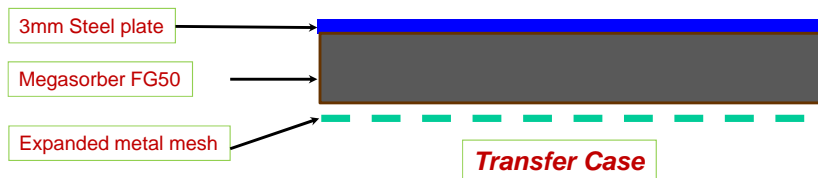


Fig 11. The installation of FG50 with expanded metal mesh above the transfer case.

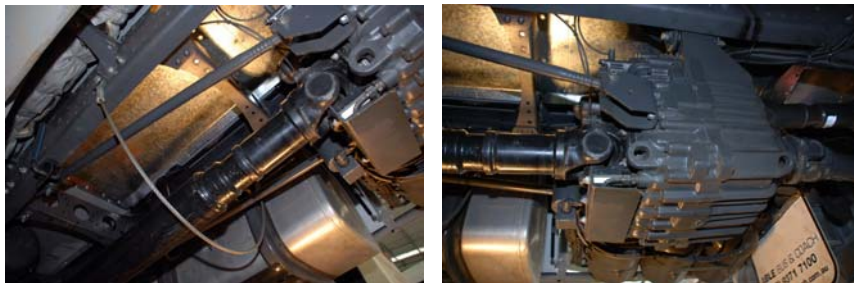


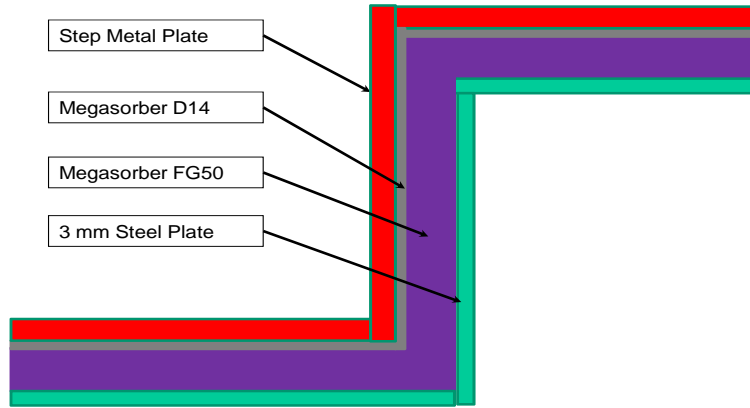
Fig 12. The installation of steel plate above the transfer case.



Fig 13. The installation of Megasorber FG50 with expanded metal mesh above the transfer case.

- Step case: Megasorber D14 was applied onto the metal plate; Megasorber FG50WR was installed, with 3mm thick steel plate placed on top. All edges were sealed. Refer to the schematic drawing below.

Soundproofing Treatment of the Step Area



- Megasorber D14 for the damping treatment of the metal panels: Megasorber D14 was applied onto the metal plate near the transfer case, as well as on the back wall panels.

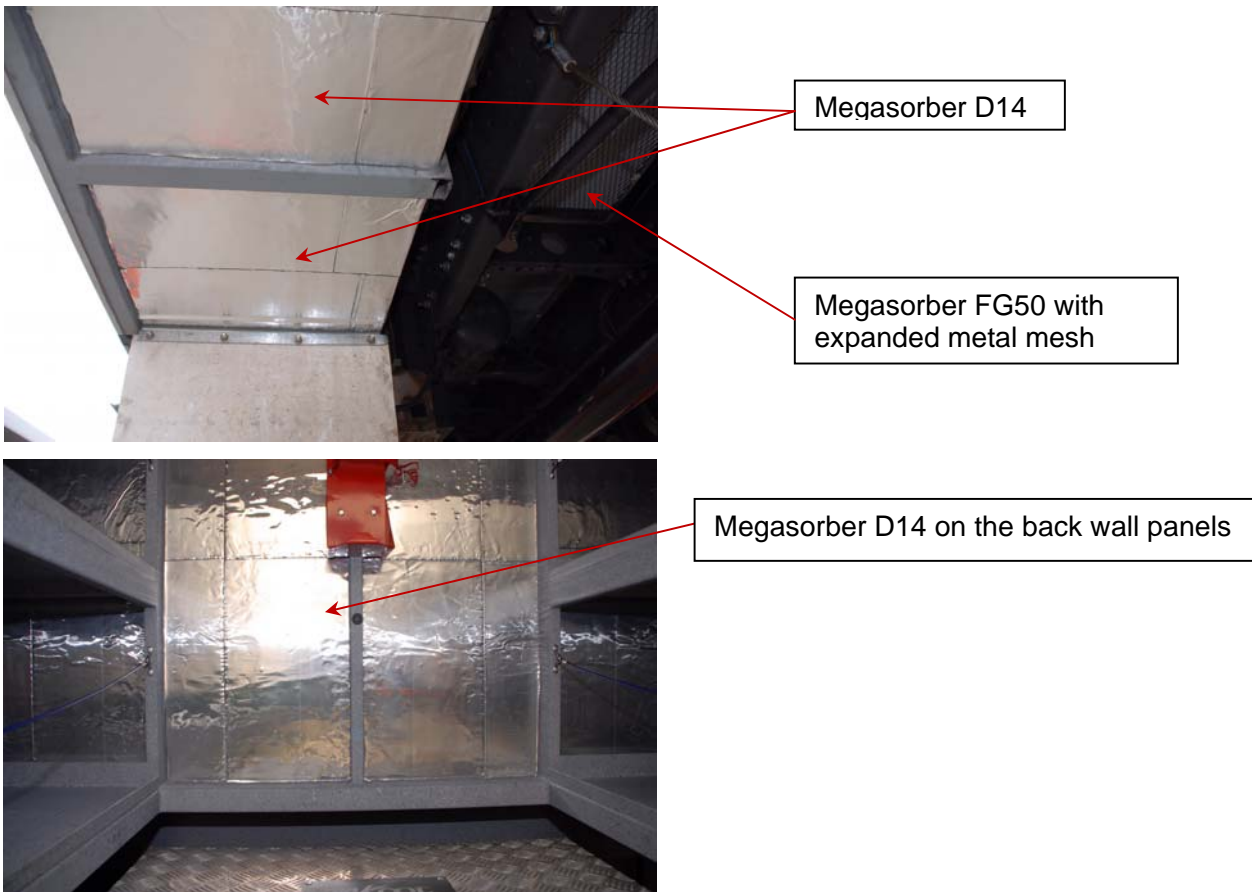


Fig 14. The installation of Megasorber D14 on various metal panels.



**The test results after the installation of the Megasorber FG50 and D14:**

- Acceleration:

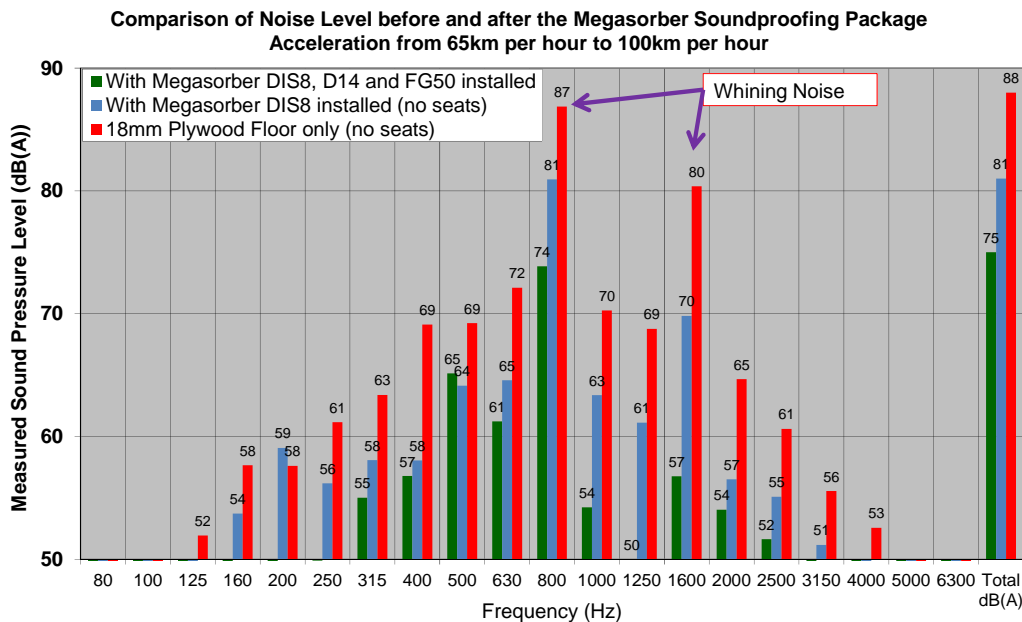


Fig 15. The test results before and after the installation of Megasorber Soundproofing package (Acceleration).

- 1) The primary whining noise is reduced by further 7 dB(A), from originally 87 to 81 to 74 dB(A);
- 2) The second harmonic of this whining noise is reduced by further 13 dB(A);
- 3) The overall noise level is reduced by another 6 dB(A), ie. from 81dB(A) to 75 dB(A).

- Deceleration:

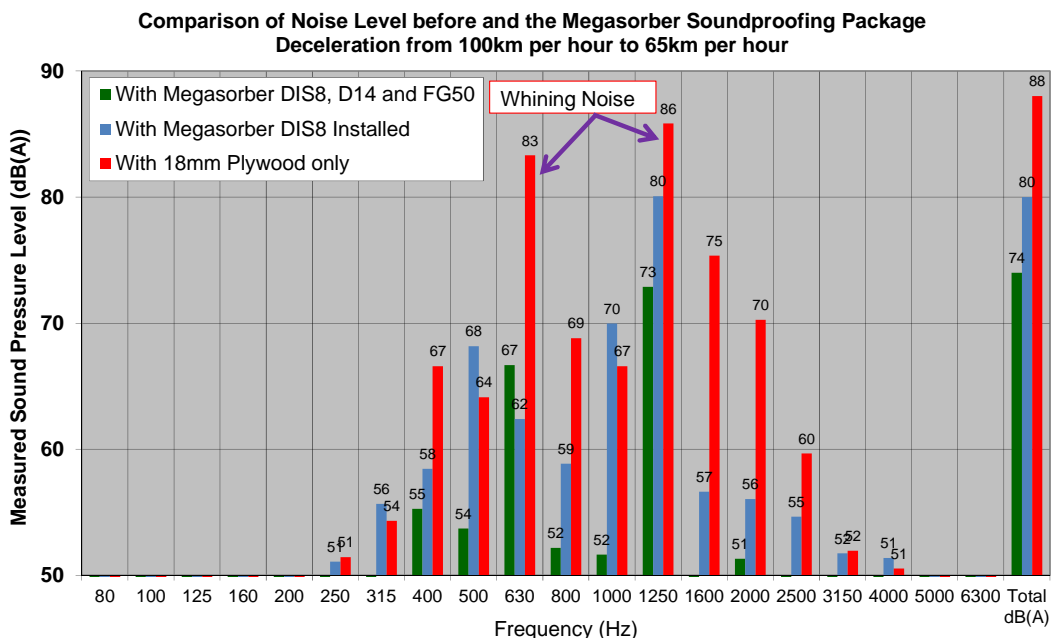


Fig 16. The test results before and after the installation of Megasorber Soundproofing package (Deceleration).

- 1) The primary whining noise somehow increased by 5 dB(A); but still reduced overall from originally 83 to 62 to 67 db(A);
- 2) The second harmonic of this whining noise was reduced by further 7 dB(A);
- 3) The overall noise level is reduced by another 6 dB(A), ie. from 88 to 80dB(A) to 74 dB(A).

- Summary:

- 1) The implementation of Megasorber D14 and FG50 has further reduced the whining noise;
- 2) It has also further reduced the overall noise by about 6dB(A).
- 3) We envisage that there will be even more noise reduction due to some installation of the seating. It is estimated that this will be another 2 to 3 dB(A) noise reduction.

**Conclusion:**

- 1) The implementation of Megasorber soundproofing packaging has effectively reduced the whining noise. It has also significantly reduced the overall noise level.
- 2) The biggest improvement is achieved by the Megasorber DIS8 system, which has reduced the whining noise as well as the overall noise significantly.
- 3) The implementation of Megasorber FG50 and D14 has further reduced the whining noise as well as the overall noise level.

**The feedback from the vehicle owner:**

**From:** John Barnett [mailto:john.barnett@aptouring.com.au]  
**Sent:** Friday, 7 December 2012 2:12 PM  
**To:** Harvey Law, PhD  
**Cc:** John Bromley; Rob Tandy; James Usher; Warwick Rock; Robert McGeary  
**Subject:** RE: Final noise testing

Afternoon Harvey,

The test went extremely well and everyone was very impressed with the results. We had our owner Geoff and also Rob McG and Rob T on board, together with the operations staff from Broome and everyone agreed that the vehicle is now extremely quiet in general and the problem frequencies, while still present, are no longer a concern. The vehicle is now ready to go into service.

Thanks,

**John Barnett**  
International Operations Manager



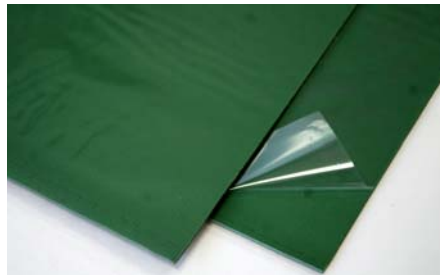
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**Further technical information:**

***Key features of Megasorber DIS8***

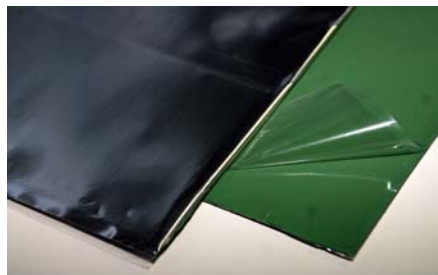
**Megasorber DIS8** is a light weight, self-adhesive, vibration isolation and damping material with release paper on both sides.

Megasorber DIS8 provides high viscous damping and isolation properties over a wide temperature range. When sandwiched between two panels, DIS8 forms a ‘vibration isolation and constrained layer damping’ system providing excellent vibration damping to reduce the low frequency structure-borne noise as well as dramatically increasing the sound transmission loss.



***Key features of Megasorber D14 (or Megasorber DT2S)***

- (1) **Megasorber D14** is a 2mm thick self-adhesive vibration-damping sheet with the latest built-in adhesive technology. It is design for metal plate thickness up to 3mm thick.
- (2) **Megasorber DT2S** is a 3mm thick self-adhesive vibration-damping tile. This is designed for vibration damping of thick metal plates, typically up to 12mm in thickness.



(a) Megasorber D14



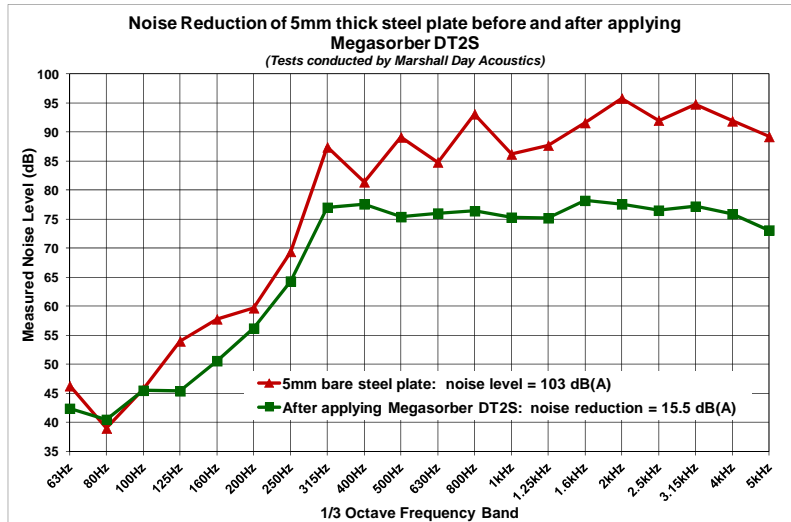
(b) Megasorber DT2S

*Fig. 1. Megasorber D14 sheet and Megasorber DT2S damping tile*

Megasorber D14 is a light weight self-adhesive vibration damping material. It is designed to provide maximum damping without adding much weight.

Megasorber D14 is widely used as a vibration damping material, an acoustic sealer to seal holes and openings as well as heat shield patches. The aluminium foil provides excellent heat reflection. D14 dampens vibrations over a wide temperature range.

The typical noise reduction is about 8dB(A) to 10dB(A) after the application of Megasorber sound dampening materials for most applications. However, for a large and freely suspended panel, the typical noise reduction is about 15 to 20 dB(A). Following are example of Megasorber DT2S applied onto 5mm thick steel plate:

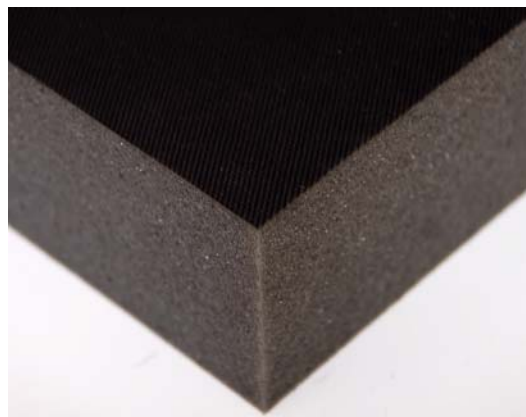


To view the test and hear the noise reduction before and after applying DT2S, please click the video link :

<http://www.youtube.com/watch?v=vddZN05FF1k&feature=channel>

### Key features of Megasorber FG50

Megasorber FG50 is 50mm thick acoustic foam with a fireproof sound absorbing Soundmesh G8 facing:



Megasorber FG50 deploys a patented sound absorption technology: a unique fireproof sound absorbing material **Soundmesh G8** (United States Patent No. 8167085). Key features of **Soundmesh G8** are as follows:

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1) **The unique sound absorption mechanism:**

Soundmesh G8 is a smart material with a solid membrane in appearance, but has a ‘microporous’ design to allow the noise to filter through. Whilst allowing the noise through, Soundmesh G8 breaks down the sound waver into little components and traps the noise inside. This noise is then absorbed by the foam or polyester behind the Soundmesh G8. Figure below shows how the sound is absorbed by this smart material.

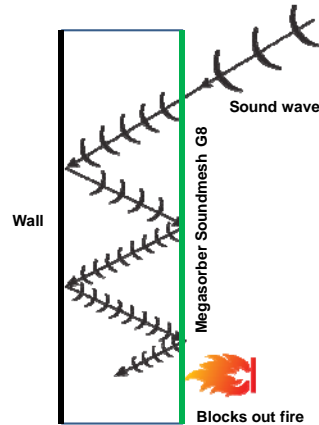


Fig. 7. Sound Absorption Mechanism of Soundmesh G8

Tested were conducted on the foam and polyester with and without the Soundmesh G8 facing, at RMIT University independent laboratory. The sound absorption test results are shown in Figure 4 for both 25mm thick acoustic foam and 25mm thick polyester.

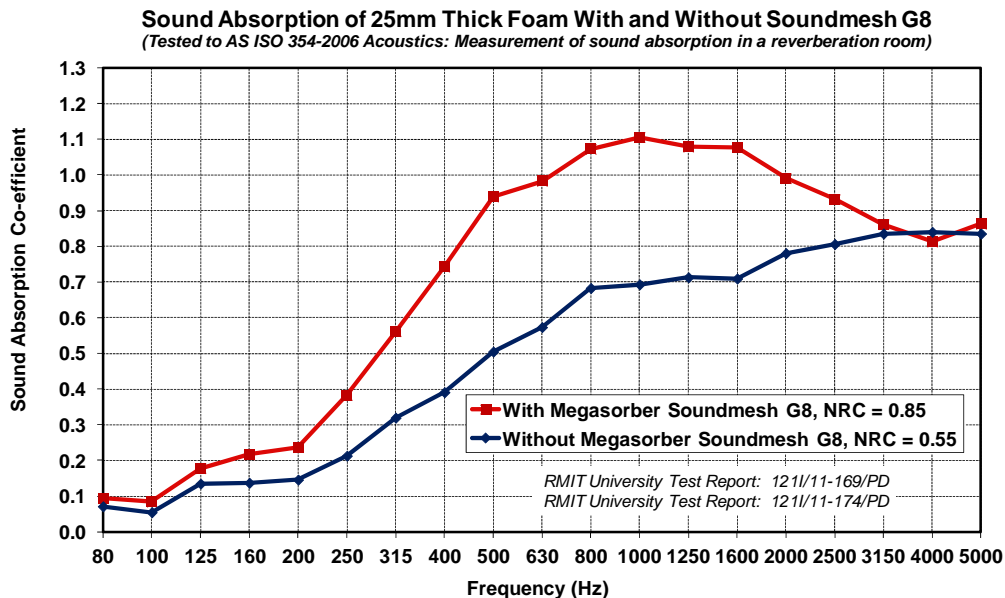
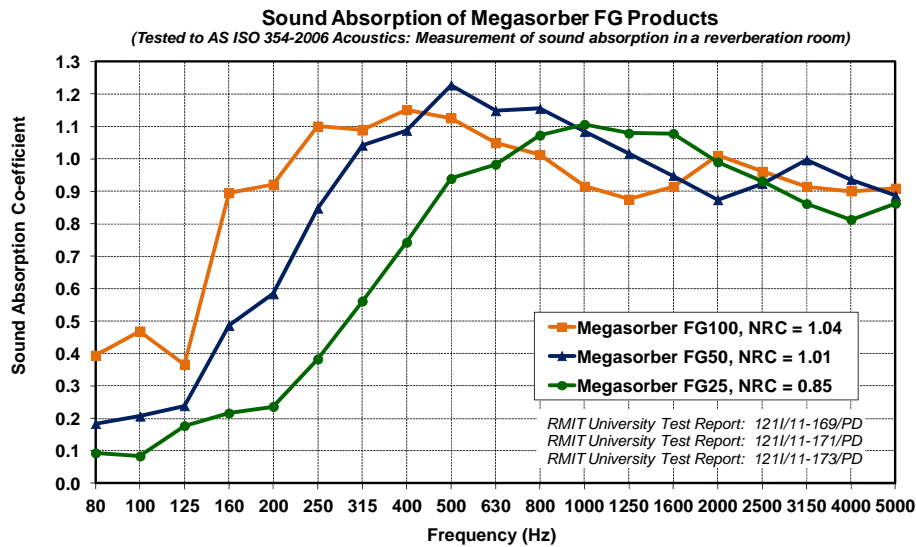


Figure 4. Sound absorption co-efficient of 25mm foam with and without Soundmesh G8 facing

It is evident that:

- Soundmesh G8 has boosted the sound absorption capacity / noise reduction co-efficient (NRC) from 0.45 to 0.72 for the foam.
- Soundmesh G8 increases the sound absorption without increasing the density of the base material.

2) **High sound absorption:** Megasorber FG50 has a peak sound absorption between 200Hz to 2,000Hz, which makes it one of the most suitable materials for this application.



3) **Fireproof** sound absorbing ‘Soundmesh G8’ facing, with temperature resistance up to 550°C. It is one of the few acoustic materials that pass AS/NZS 3837 Group 1 rating, making it ideal for any public building applications.

The photos below show that after the exposure to naked flame (Photo 1), Soundmesh G8 does not burn (Photo 2). It also prevents the foam behind it from burning (Photo 3).



(1) Exposure to naked flame



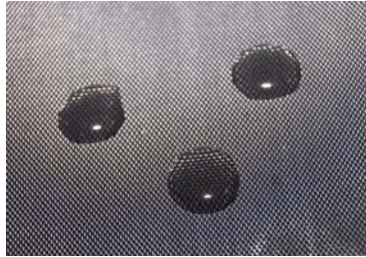
(2) Soundmesh G8 does not burn at all



(3) Soundmesh G8 blocks out the fire

- 4) **Long service life:** the product has a Soundmesh G8 facing that is extremely tough and durable.
- 5) **High temperature resistance:** Soundmesh G8 has a temperature resistance up to 550°C.
- 6) **Optional Water Repellent Facing (FG50WR)**

The facing material repels water and any other fluids. The photo below shows that the water drops bead up on the surface of Soundmesh G8.



The above is for general guidance only. Please contact us for a customised solution. If you require further information, please visit our website [www.megasorber.com](http://www.megasorber.com) or contact us.

**Dr. Harvey Law**

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