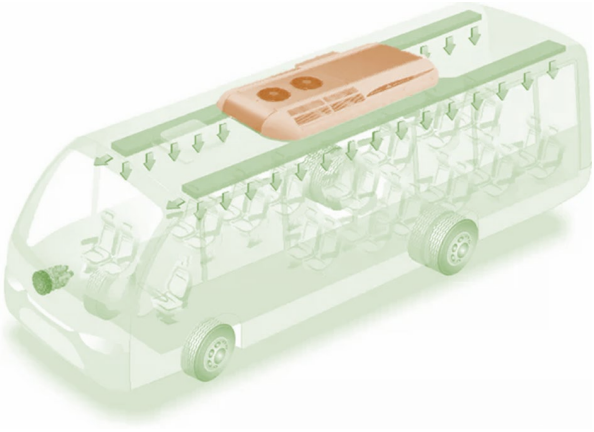
POWERING FUEL SAVINGS, EMISSION REDUCTION, & COOLER TRANSPORT SERVICE ENERGY SAVING ESTIMATE REPORT

Powered by GMG GRAPHENE

THERMAL-XR® powered by GMG Graphene is a coating system for restoring and improving energy efficiency to refrigeration and air conditioning coils. The process coats and rebuilds lost thermal conductivity by leveraging the physics of GMG's Graphene to increase the heat transfer rate, resulting in efficiency improvement, and reductions in both energy and CO_2 emission for customers.



Graphene Manufacturing Group Ltd (GMG) has conducted a mobility trial on a passenger bus to ascertain operational improvements when **THERMAL-XR®** powered by GMG Graphene is applied to the condenser coil of the vehicle's air conditioning system.

The bus airconditioning coating trial was designed to record any improvement reduction that **THERMAL-XR®** has on:

1. **Pull Down Rate of the Bus's Air Conditioning System.**
2. **Fuel Usage; and**
3. **Emission Reductions Post-Test.**

SAVINGS RESULTS

The Time Reduction of the Pull-Down Test highlights an improvement in both driver and passenger comfort.

The Fuel Savings show a direct correlation that the bus's HVAC system is operating more efficiently with less compressor operating time.

The Australian Government's National Greenhouse Accounts, factor that every litre of fuel saving is equivalent to an emission reduction saving of 2.7 kg CO_2-e/GJ.

	Pull Down Test 45°C to 22°C	Fuel Used
Baseline Trial	24 minutes	12.70 litres
THERMAL-XR Coated Trial	18 minutes	12.36 litres
Improvement Reduction	**6 minutes less ▼** **25% ▼**	**0.34 litres less ▼** **2.7% ▼**
Emission Reductions	**2.7 kg CO_2-e/GJ.**	

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TEST DESIGN SUMMARY

Two separate data sets were collected on the same bus to record both a baseline result without **THERMAL-XR®** coating on the coil, and one set inclusive of the coating, to compare results.

In a controlled temperature environment, the pull-down rate of the air conditioning unit was measured whilst the bus was in idle over a two hour period.

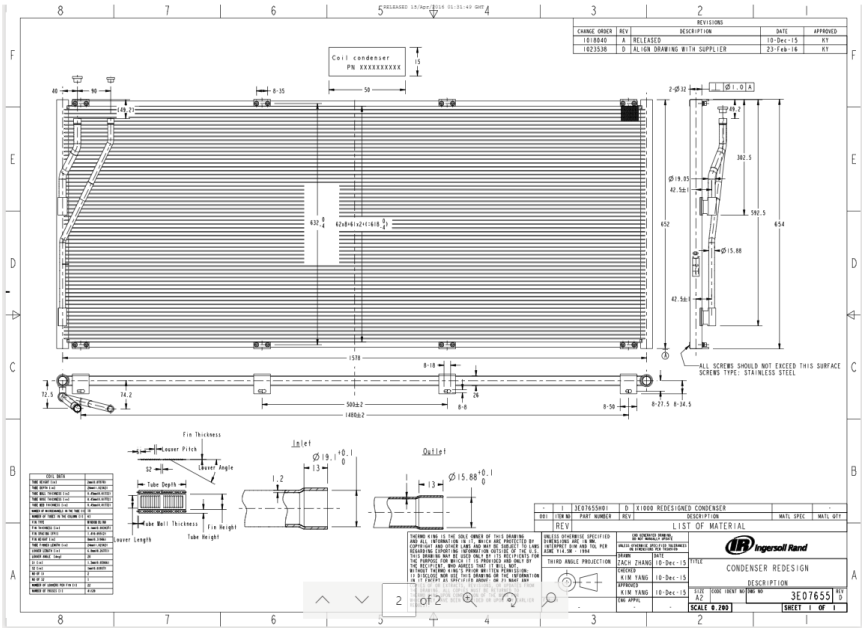
In parallel, fuel consumption during both trials were also recorded by a Volvo Automotive telematics system.

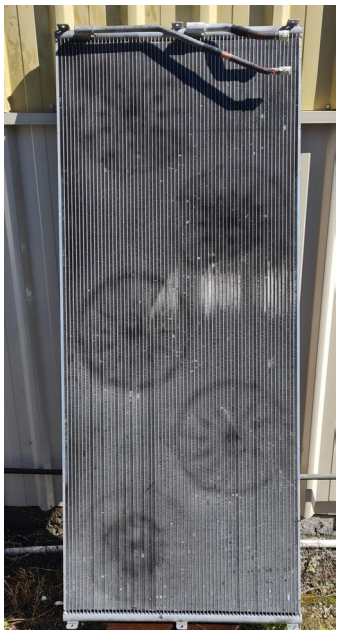
Activity	Timeline
Baseline Trial	06 May 2021
Bus continued standard operation	07 May to 12 May 2021
Condenser coil removed and coated with Thermal XR	13 May 2021
Bus continued standard operation	15 May to 20 May 2021
Thermal XR coating Trial	21 May 2021

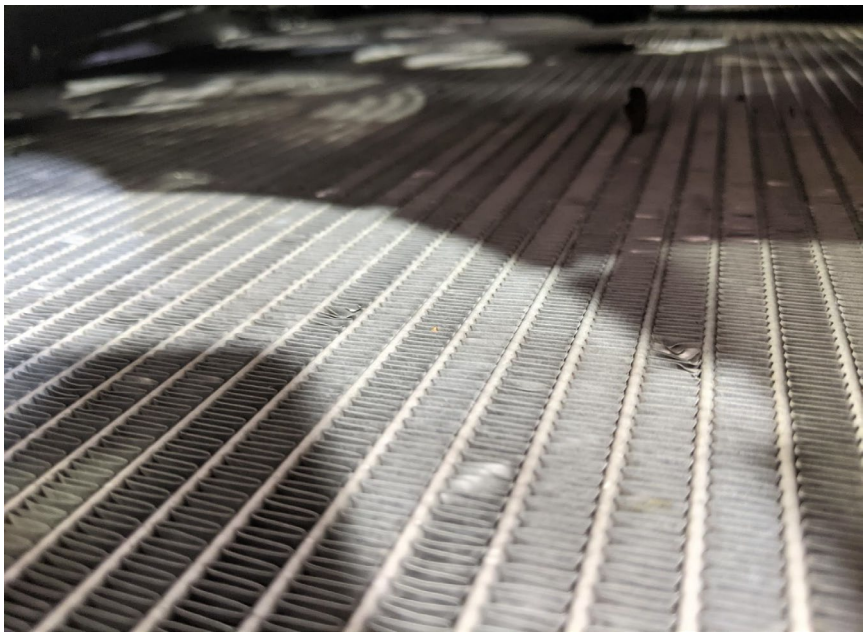
EQUIPMENT SUMMARY

- Volvo B7RLE Bus
- The bus has average operation time of 250 hours per month and normal operating conditions are within a Capital City passenger routes.
- The bus has a X1000 Ingersoll Rand redesigned condenser coil. The coil had approximately 13,000 hours of operation at time of test.
- A Thermo King DAS (Data Acquisition System), standalone data recorder, (not connected to the AC system) with TK Wintrac 5 software was used to download the data for the Pull Down Test.
- A proprietary Volvo Telematic System recorded the fuel data.
- Temperature controlled environment was conducted inside a Spray ‘n’ Bake paint booth Model TNT-3-20/6.

X1000 INGERSOLL RAND REDESIGNED CONDENSER COIL







TEST SPECIFICATIONS - PULL DOWN TEST IN A HEATED BOOTH

The test specifications for this trial were specific to the customer for their standard Air Conditioning (A/C) testing for Internal Combustion (Diesel, CNG, etc.), Hybrid, or Full Electric drivetrain buses.

The purpose of this test is to demonstrate the cooling capability of the A/C system and to ensure the system is well balanced and comfortable for the driver and passengers in all operational and environmental conditions likely to be experienced during normal bus operations.

According to the Bureau of Meteorology, Brisbane, Australia has historical recorded ambient temperature range from 2°C minimum to 42°C maximum. Testing of an empty bus in a heated booth will not take into consideration the heat generated from a full passenger load (including driver), nor the effects of solar radiation through the windscreen and windows. Hence, for the purposes of simulating realistic operational conditions, allowing for passenger heat load and solar radiation, testing was conducted at a nominal 45°C set booth temperature (i.e. 42°C ambient + 3°C to simulate passenger and solar loading) with an objective to achieve the nominal 22°C set temperature inside the bus within 30 minutes.

TEST PROCEDURE

Temperature sensors were connected to a datalogger and placed in locations described below.
Red locations indicate interior measuring points, and green indicates an exterior ambient measuring point.

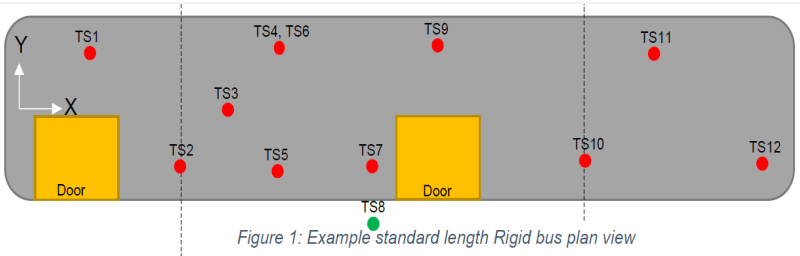


Figure 1: Example standard length Rigid bus plan view

Figure 2: Example standard length Rigid bus side view

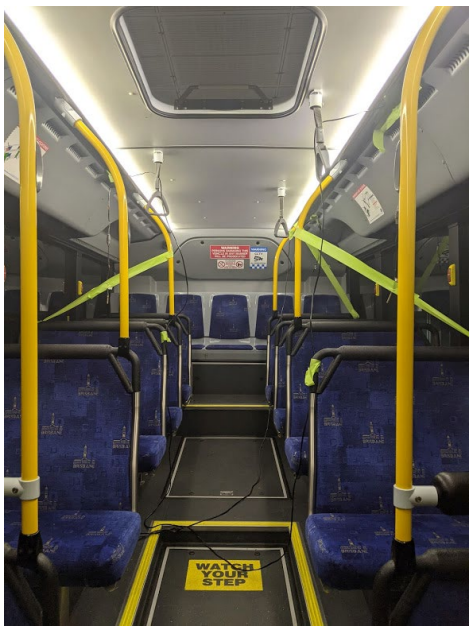
The bus was placed centrally and entirely within a heat chamber, with all systems turned off and heat soaked at 45°C (as read by sensor location T8) for a minimum of 1 hour. All doors, roof hatches and windows (including driver's window) were open during the heat soaking process.

Once fully heat soaked at 45°C, all doors, roof hatches and windows were closed. The engine was started, and revolutions increased to 1200. The A/C system was turned on with a 22°C set temperature. A datalogger recorded the time to reach this set temperature.

Once all internal temperature sensors have stabilised at set temperature, all passenger doors were opened for a period of 1 minute, then closed for 4 minutes to simulate a normal buses operation of stopping to collect passengers. This sequence was repeated for until duration of test concluded after two (2) hours.

A Thermo King DAS (Data Acquisition System), standalone data recorder, (not connected to the AC system) with TK Wintrac 5 software was used to download the data for the Pull Down Test.

SPRAY N BAKE PAINT BOOTH MODEL TNT-3-20/6



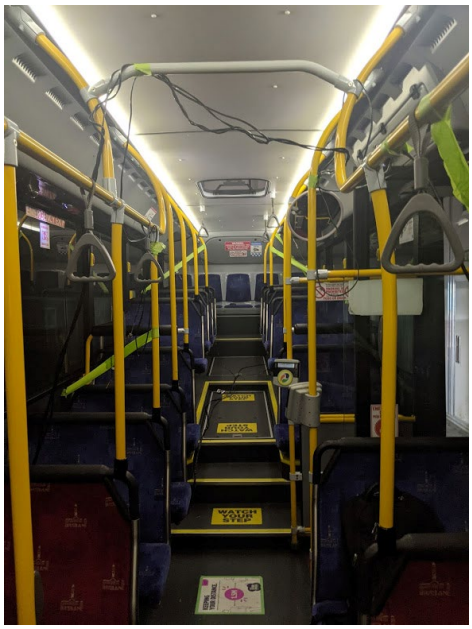


TABLE OF RESULTS

	Fuel Used First hour (Litres)	Fuel Used Second hour (Litres)	Total Fuel Used (Litres)
Baseline Trial 6th May – Pull Down Results	6.68	6.01	12.7
THEMAL-XR® Coated Trial 21st May – Pull Down Results	6.47	5.88	12.36
Improvement Reduction **Improvement (%)**	**0.21▼** **3.10%▼**	**0.13▼** **2.20%▼**	**0.34▼** **2.70%▼**

Emission Saving Calculations

During normal operations, the bus averages 250 hours per month on various city passenger routes. Applying the above fuel usage data against the $C0_2$ emission data for this vehicle type (Euro iv or higher), the emission savings were calculated as follows:

2.7% Diesel fuel saving with THEMRAL-XR® Coated trial = 1.4 MTreduction of CO_2 per year.

	Fuel Combusted	Energy Content Factor GJ/kl	Emission Factor Kg CO_2-e/GJ (relevant oxidation factors incorporated)		
Heavy Vehicles conforming to Euro Designs Standards			**CO_2**	**CH_4**	**N_2O**
Euro IV or higher	**E IV Diesel Oil**	**38.6**	**69.9**	**0.07**	**0.4**

Source: National Greenhouse Accounts Factors 2020

Test	**Litres Used in 2 hour Trial**	**Average hrs/month**	**Months/ Year**	**Fuel Use kl/Year**	
Baseline Trial 6th May – Pull Down Results	12.7	250	12	19.1	
THEMAL-XR® Coated Trial 21st May – Pull Down Results	12.36	250	12	18.5	
Eiv Diesel oil	**Volume kilolitres/yr**	**CO_2**	**CH_4**	**N_2O**	**T of CO_2-e/yr**
Baseline Trial 6th May – Pull Down Results	19.1	51.40	0.05	0.29	51.7
THEMAL-XR® Coated Trial 21st May – Pull Down Results	18.5	50.02	0.05	0.29	50.4

Annual Reduction (tonnes of CO2) /Per Bus	**Reduction**	**1.4 mt** **2.7%**

TABLE OF RESULTS

Test conducted 06/05/2021 in spray booth

Probe Key:

	TS1	Drivers seat rear point	TS7	1m forward of rear door nearside
Test Device: TK DAS	TS2	Front wheel axle centreline	TS8	Ambient sensor Vehicle midplane
Logger ID: X1000	TS3	Return air grille	TS9	Rear door centreline offside
Serial number: 00000077790	TS4	Wheelchair offside area	TS10	Rear axle centreline nearside
	TS5	Wheelchair nearside area	TS11	1m rear of axle offside
	TS6	A/C evap blower outlet in duct	TS12	Rear seat nearside

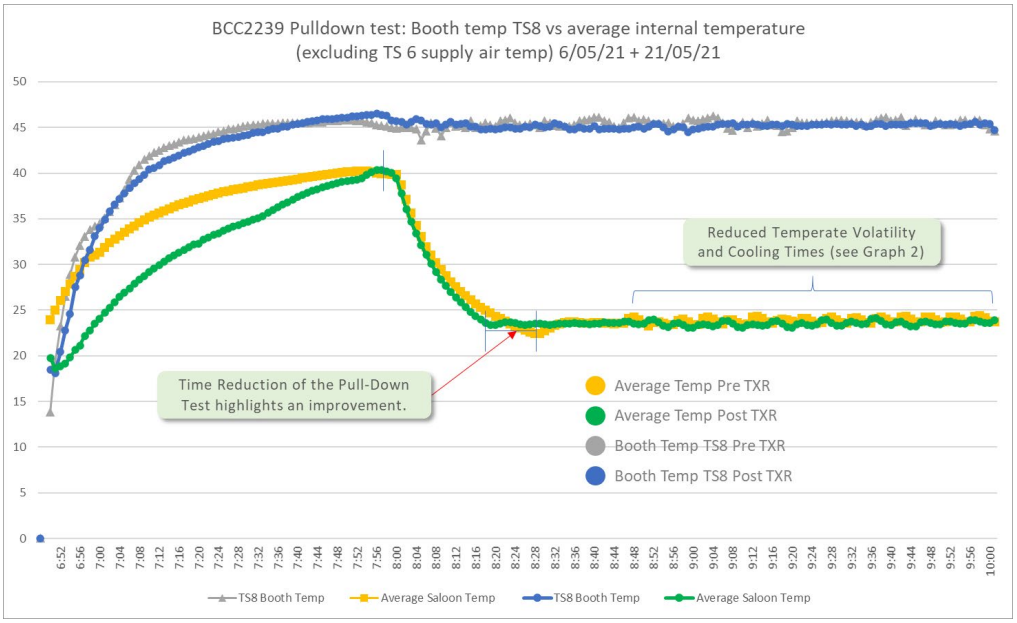
Date & Time	Time	TS8	TS1	TS2	TS3	TS4	TS5	TS6	TS7	TS9	TS10	TS11	TS12	Average Saloon Temp	Notes
	9:00														Test Started
6/05/2021 9:00		*44.9*	*41.2*	*39.5*	*39.6*	*39*	*39.4*	*35*	*39*	*39.4*	*40.4*	*40*	*40.2*	*39.3*	
6/05/2021 9:01	9:01	45	39.8	38.4	37.5	38.4	38.3	28.3	38.3	38.8	39.3	39.3	38.9	37.8	
6/05/2021 9:02	9:02	45	37.9	36.7	34.9	37.3	36.8	24.6	37.1	37.8	37.6	37.7	37.3	36.0	
6/05/2021 9:03	9:03	45	36.3	35.1	32.8	36.2	35.3	22.5	35.8	36.7	36.1	36.3	35.8	34.4	
6/05/2021 9:04	9:04	44.8	34.8	33.5	31.3	35.1	34	21.1	34.5	35.6	34.8	34.9	34.6	33.1	
6/05/2021 9:05	9:05	43.6	33.6	32	30.1	33.9	32.7	19.9	33.3	34.5	33.5	33.7	33.4	31.9	
6/05/2021 9:06	9:06	44.6	32.5	30.9	29.1	32.8	31.4	18.7	32.3	33.4	32.3	32.5	32.4	30.8	
6/05/2021 9:07	9:07	45.5	31.7	29.9	28.3	31.9	30.4	17.9	31.3	32.4	31.3	31.5	31.6	29.8	
6/05/2021 9:08	9:08	44.9	30.8	28.9	27.7	31	29.6	17.2	30.5	31.5	30.5	30.6	30.8	29.0	
6/05/2021 9:09	9:09	44.1	30.1	28.2	27.1	30.3	28.7	16.3	29.8	30.7	29.7	29.7	30.1	28.2	
6/05/2021 9:10	9:10	45	29.5	27.5	26.6	29.5	28	15.7	29.1	29.8	28.9	28.9	29.5	27.5	
6/05/2021 9:11	9:11	45.5	28.8	26.8	26	28.8	27.3	15.2	28.5	29.1	28.3	28.3	28.9	26.9	
6/05/2021 9:12	9:12	45.1	28.3	26.3	25.6	28.2	26.8	14.8	28.1	28.5	27.7	27.6	28.4	26.4	
6/05/2021 9:13	9:13	45.2	27.8	25.8	25.2	27.6	26.2	14.3	27.7	27.9	27.2	27	28	25.9	
6/05/2021 9:14	9:14	45	27.2	25.3	24.8	27.1	25.7	13.9	27.2	27.4	26.7	26.5	27.6	25.4	
6/05/2021 9:15	9:15	45.7	26.8	24.8	24.4	26.6	25.2	13.6	26.8	26.8	26.3	26.1	27.2	25.0	
6/05/2021 9:16	9:16	45	26.3	24.4	24.1	26.2	24.7	13.3	26.4	26.4	25.8	25.7	26.9	24.6	
6/05/2021 9:17	9:17	45.2	25.9	24.1	23.8	25.8	24.3	12.9	26	25.9	25.5	25.3	26.6	24.2	
6/05/2021 9:18	9:18	45.5	25.5	23.7	23.5	25.4	24.2	12.7	25.6	25.6	25.1	24.9	26.3	23.9	
6/05/2021 9:19	9:19	45.3	25.1	23.3	23.2	25.1	24	12.5	25.3	25.2	24.7	24.6	26.1	23.6	
6/05/2021 9:20	9:20	45.1	24.8	22.9	22.9	24.7	23.9	12.2	24.9	24.8	24.5	24.3	25.8	23.2	
6/05/2021 9:21	9:21	45.7	24.4	22.7	22.7	24.4	23.6	12.1	24.6	24.5	24.3	24	25.6	23.0	
6/05/2021 9:22	9:22	45.8	24	22.4	22.4	24.1	23.2	11.9	24.3	24.2	24	23.8	25.4	22.7	
6/05/2021 9:23	9:23	46	23.8	22.1	22.2	23.9	22.7	11.7	24	24	23.8	23.5	25.2	22.4	
6/05/2021 9:24	*9:24*	*45.5*	*23.4*	*21.8*	*21.9*	*23.6*	*22.3*	*11.5*	*23.9*	*23.7*	*23.5*	*23.3*	*25*	*22.2*	*setpoint*

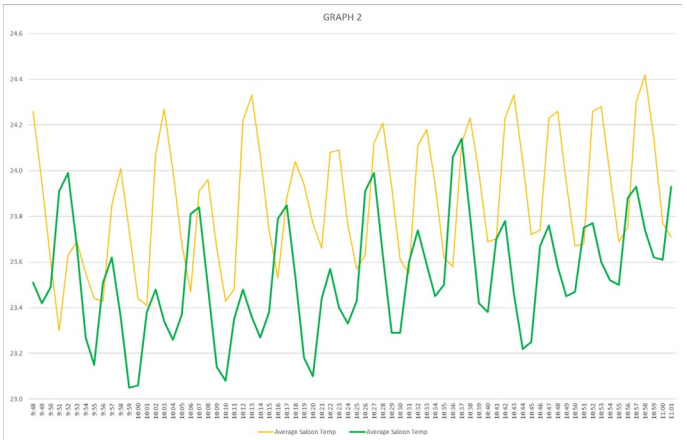
Test conducted 21/05/2021 in spray booth

Probe Key:

	TS1	Drivers seat rear point	TS7	1m forward of rear door nearside
Test Device: TK DAS	TS2	Front wheel axle centreline	TS8	Ambient sensor Vehicle midplane
Logger ID: X1000	TS3	Return air grille	TS9	Rear door centreline offside
Serial number: 00000077790005	TS4	Wheelchair offside area	TS10	Rear axle centreline nearside
	TS5	Wheelchair nearside area	TS11	1m rear of axle offside
	TS6	A/C evap blower outlet in duct	TS12	Rear seat nearside

Date & Time	Time	TS8	TS1	TS2	TS3	TS4	TS5	TS6	TS7	TS9	TS10	TS11	TS12	Average Saloon Temp	Notes
														39.1	Test Started
21/05/2021 8:00	*8:00*	*45.7*	*40.6*	*38.9*	*38.7*	*38.9*	*38.7*	*35.6*	*39.5*	*38*	*40.4*	*40.4*	*40.2*		
21/05/2021 8:01	8:01	45.6	37.9	36.8	37.5	37.8	37.1	30.7	37.4	37.1	38.6	38.6	38.9	*37.1*	
21/05/2021 8:02	8:02	45.3	36.7	35.4	34.7	35.7	35.1	26.1	35.9	35.8	37.2	36.9	37.3	*35.2*	
21/05/2021 8:03	8:03	45.6	35.6	34	32.3	34.6	34	23.6	34.7	34.9	35.6	35.2	35.8	*33.7*	
21/05/2021 8:04	8:04	45.9	34.3	32.6	30.6	33.5	32.9	22	33.5	34	34.3	33.7	34.5	*32.4*	
21/05/2021 8:05	8:05	45.8	33.1	31.3	29.3	32.3	31.8	20.6	32.3	32.9	33	32.3	33.2	*31.1*	
21/05/2021 8:06	8:06	45.4	32.1	30.1	28.2	31.1	30.9	19.6	31.3	31.9	31.8	31.1	32.1	*30.0*	
21/05/2021 8:07	8:07	45.3	31.2	29.2	27.3	30.1	29.9	18.5	30.4	31	30.8	30	31.1	*29.0*	
21/05/2021 8:08	8:08	45.5	30.3	28.3	26.6	29.2	29.1	17.5	29.5	30.1	29.8	29	30.2	*28.1*	
21/05/2021 8:09	8:09	45	29.6	27.4	25.9	28.3	28.3	16.7	28.7	29.2	28.9	28.1	29.4	*27.3*	
21/05/2021 8:10	8:10	45.3	28.9	26.8	25.3	27.5	27.6	15.9	28	28.4	28	27.3	28.6	*26.6*	
21/05/2021 8:11	8:11	45.6	28.2	26.1	24.7	26.9	26.9	15.4	27.4	27.8	27.3	26.6	28	*25.9*	
21/05/2021 8:12	8:12	45.3	27.7	25.5	24.3	26.3	26.4	14.9	26.8	27.1	26.7	25.9	27.4	*25.4*	
21/05/2021 8:13	8:13	45.4	27.1	24.9	23.8	25.7	25.8	14.3	26.3	26.5	26	25.3	26.9	*24.8*	
21/05/2021 8:14	8:14	45.5	26.5	24.4	23.4	25.2	25.3	13.8	25.8	26	25.5	24.8	26.4	*24.3*	
21/05/2021 8:15	8:15	45.1	26	24	23	24.7	24.8	13.5	25.2	25.5	24.9	24.3	26	*23.8*	
21/05/2021 8:16	8:16	45.1	25.6	23.5	22.5	24.2	24.3	13.1	24.8	25	24.5	23.9	25.6	*23.4*	
21/05/2021 8:17	8:17	44.8	25.1	23.1	22.2	23.8	23.8	12.9	24.4	24.5	24	23.5	25.3	*23.0*	
21/05/2021 8:18	*8:18*	*44.8*	*24.7*	*22.7*	*21.9*	*23.4*	*23.4*	*12.7*	*24*	*24.1*	*23.7*	*23.2*	*24.9*	*22.6*	*setpoint*





ABOUT GMG

GMG is an Australian based clean-tech disruptive company listed on the TSXV (TSXV:GMG) that produces graphene and hydrogen by cracking methane (natural gas) instead of mining graphite. By using the company's proprietary process, GMG can produce high quality, low cost, scalable, 'tuneable' and no/low contaminant graphene – enabling demonstrated cost and environmental improvements in a number of world-scale planet-friendly/clean-tech applications. Using this low input cost source of graphene, the Company is developing value-added products that target the massive energy efficiency and energy storage markets.

The Company is also in the early stages of pursuing additional opportunities for GMG Graphene, including developing next-generation batteries, collaborating with world-leading universities in Australia, and investigating the opportunity to enhance the performance of lube oil, biodiesel and diesel fuels.

For further information about **THERMAL-XR ®,** please contact:

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