

Ampreg™ 21FR / 3X Hardeners

FIRE RETARDANT EPOXY WET LAMINATING SYSTEM

- Indicative FST performance evaluated FAR Part 25 (60s flame applied)
- Range of working times using blendable hardeners
- Ideal for wet laminating large composite structures
- Good cure progression from ambient only cures
- Low Toxicity Hardener Formulations
 - Improved Hazard Labelling
 - CMR & SVHC Free**
 - Reduced Environmental Hazards

INTRODUCTION

Ampreg™ 21FR resin / Ampreg™ 3X Hardeners has been optimised for the manufacture of large composite structures using hand layup, and vacuum bagging techniques, whilst offering improved health & safety through the careful selection of low toxicity raw materials.

Ampreg™ 21FR resin / Ampreg™ 3X Hardeners has been designed to give excellent mechanical and thermal properties from both ambient temperature cures, and moderate temperature postcures (50°C). This system is available with the full range of Ampreg™ 3X Hardener speeds, from Fast to Extra Slow and in a wide range of formats from small pack sizes to drums and IBCs.

SYSTEM PROPERTIES AT 25°C		150g POT-LIFE*	PAGE
Ampreg™ 21FR Resin	Product Information, Instructions for Use and Health & Safety		2
	Ampreg™ 3X Fast Hardener	00:30	4
	Ampreg™ 3X Standard Hardener	01:16	5
	Ampreg™ 3X Slow Hardener	02:48	6
	Ampreg™ 3X Extra-slow Hardener	06:15	7
	Ampreg™ 3X Ultra-slow Hardener	06:55	8

**working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampreg™ systems at 25°C. Please refer to the corresponding page of this document for specific testing methods used.*

**** CMR = Substances classified as Carcinogenic, Mutagenic or toxic for Reproduction
SVHC = Substances of Very High Concern**

PRODUCT INFORMATION

AVAILABILITY

The product is available in a number of formats, please contact your local customer support representative for more information.

TRANSPORT & STORAGE

The resin and hardeners should be kept in securely closed containers during transport and storage. Any accidental spillage should be soaked up with sand, sawdust, cotton waste or any other absorbent material. The area should then be washed clean (see appropriate Safety Data Sheet).

Adequate long term storage conditions will result in a shelf life of 2 years for both the resin and hardeners. Storage should be in a warm dry place out of direct sunlight and protected from frost. The storage temperature should be kept constant between 10°C and 25°C, cyclic fluctuations in temperature can cause crystallization. Containers should be firmly closed. Hardeners, in particular, will suffer serious degradation if left exposed to air.

COMPONENT	UNITS	10 – 25°C
Ampreg™ 21FR Resin	months	12
Ampreg™ 3X Hardeners	months	24

INSTRUCTIONS FOR USE

The product is optimised for use at temperatures between 18 and 25°C. At lower temperatures the product thickens and may become unworkable. At higher temperatures working times will be significantly reduced. Maximum relative humidity for use is 70%.

MOULD RELEASE

Smooth metal and GFRP mould tests have shown that suitable release can be obtained by use of 5-6 waxings of a carnauba based wax e.g. Polywax. Use PVA for less well prepared or more complex surfaces. The highest quality surface can normally be generated by using semi-permanent release systems like TR 920 (TR Industries) or PMR EZ (Chemlease).

Before the application of the release agent onto a new mould it should be sealed and primed, this is also true if an old mould have had its released agents stripped and a new system applied. It is suggested that a complete system is purchased from a single manufacture to ensure there are no compatibility issues. A low VOC (Volatile Organic Chemical) option is water based systems like chemlease 5051W or 5016W which will not generate class A surface finish but will help to reduce VOC release in moulding areas. Whichever mould release is proposed it is recommended that a test laminate is laid up under production conditions and time scales, in order to ensure an adequate and effective part release.

MIXING AND HANDLING

Accurate measurement and thorough mixing are essential when using this system, and any deviation from the prescribed mix ratios will seriously degrade the physical properties of the cured system. The resin and hardener must be stirred well for two minutes or more, with particular attention being paid to the sides and bottom of the container. As soon as the material is mixed the reaction begins. This reaction produces heat (exothermic), which will in turn accelerate the reaction. If this mixed material is left in a confined mixing vessel the heat cannot disperse and the reaction will become uncontrollable.

APPLICATION

The mixed system is usually applied by foam roller from a roller tray. Accurate fibre volume fractions can be obtained by applying a known weight of mixed resin / hardener to each fabric / fibre layer. As a general rule of thumb, resin weight per square metre must be no more than, and preferably less than, the area weight of the fabric being wet out. If the laminate is particularly thick, it is recommended that slower hardeners are used for laminating the first layers and faster hardeners in the later layers. In this way the whole thickness laid down remains workable for approximately the same time. For further advice, please contact Gurit Technical Support.

HIGH RH DURING LAMINATION

Although the recommended ambient relative humidity remains <70%, Gurit has successfully carried out testing at 90% relative humidity using the Fast Hardener which showed no significant drop in ILSS. For the testing carried out by Gurit, subsequent plies were applied within 5 mins of each other and vacuum & heat was applied directly following full lamination. As mechanical properties are highly dependent on the processing method, Gurit recommends that a test laminate is manufactured and evaluated in representative conditions in order to ensure that the required performance is achieved.

BONDING TECHNIQUES & PEEL PLY

It is recommended to use nylon peel ply for any secondary bonding applications. Peel Ply is typically used on laminate surfaces which need to be left to cure or partially cure before further laminating or bonding operations. The peel ply serves two functions - preventing the surface from becoming contaminated and / or damaged, and providing a 'textured' surface that can reduce the level of preparation required for the secondary laminating or bonding operations. After curing and just prior to bonding, the Peel Ply is stripped off leaving a clean, dust and grease free surface, with an already 'textured' surface which makes the 'keying' process less time consuming. Gurit recommends the use of its Stitch Ply A peel ply, or suitable Tygavac product. Any proposed peel ply should be tested prior to use to ensure that it not only releases adequately from the laminated surface but also does not leave any residues behind which may impair adhesion. If in doubt please contact Gurit Technical Support.

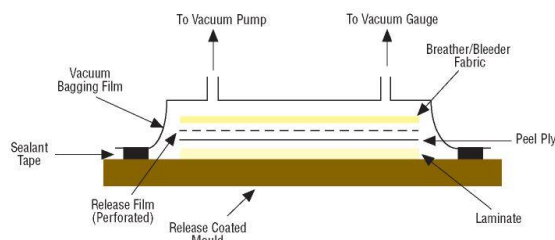


Figure 1

VACUUM BAG TECHNIQUES

Consolidation of the laminate can be obtained either by hand using paddle rollers or by vacuum or pressure bags. A typical vacuum bag arrangement is shown in figure 1. It is important when using high vacuums and using the slower hardeners that vacuum is not applied until at least 50% into the mixed system working time, as applying the vacuum earlier may result in excessive resin flow and resin starved laminates. For advice on effective vacuum bag consolidation, please contact Gurit Technical Support.

CURING SCHEDULE

AMBIENT TEMPERATURE CURE

The system has been developed to provide good mechanical properties after an ambient only cure. The minimum recommended cure temperature is 18°C. Excellent mechanical/thermal properties can be achieved after a slightly elevated temperature post-cure. An initial cure of at least 48 hours (with slow hardener) or 16 hours (with fast hardener) at 18°C is recommended before demoulding.

When using the Slow, Extra Slow or High Tg Hardeners exclusively, an elevated temperature postcure is strongly recommended.

ELEVATED TEMPERATURE CURE

Post curing the laminate will greatly increase mechanical/thermal properties. The system will achieve similar properties with a cure of 5 hours at 70 - 80°C or 16 hours at 50°C. The latter temperature is easily achievable with low cost heating and insulation techniques.

The post cure need not be carried out immediately after laminating. It is possible to assemble several composite components and post-cure the entire assembly together. It is recommended, however, that elevated temperature curing should be completed before any further painting / finishing operations. Furthermore, care should be taken to adequately support the laminate if it is to be post cured after demoulding, and the laminate must be allowed to cool before the support is removed.

When postcuring it is recommended to use a ramp rate of 10°C/hour when heating from ambient to the postcure temperature, to ensure that the thermal performance of the laminate stays ahead of the oven temperature. Higher ramp rates may result in the resin softening and distortion of the part.

HEALTH AND SAFETY

The following points must be considered:

1. Skin contact must be avoided by wearing protective gloves. Gurit recommends the use of disposable nitrile gloves for most applications. The use of barrier creams is not recommended, but to preserve skin condition a moisturising cream should be used after washing.
2. Overalls or other protective clothing should be worn when mixing, laminating or sanding. Contaminated work clothes should be thoroughly cleaned before re-use.
3. Eye protection should be worn if there is a risk of resin, hardener, solvent or dust entering the eyes. If this occurs flush the eye with water for 15 minutes, holding the eyelid open, and seek medical attention.
4. Ensure adequate ventilation in work areas. Respiratory protection should be worn if there is insufficient ventilation. Solvent vapours should not be inhaled as they can cause dizziness, headaches, loss of consciousness and can have long term health effects.
5. If the skin becomes contaminated, then the area must be immediately cleansed. The use of resin-removing cleansers is recommended. To finish, wash with soap and warm water. The use of solvents on the skin to remove resins etc must be avoided.
Washing should be part of routine practice:
 - before eating or drinking
 - before smoking
 - before using the lavatory
 - after finishing work
6. The inhalation of sanding dust should be avoided and if it settles on the skin then it should be washed off. After more extensive sanding operations a shower/bath and hair wash is advised.

APPLICABLE RISK & SAFETY PHRASES

Gurit produces a separate full Safety Data Sheet for all hazardous products. Please ensure that you have the correct SDS to hand for the materials you are using before commencing work.

AMPREG™ 21FR RESIN & AMPREG™ 3X FAST HARDENER

This 1 page product summary is intended for use in conjunction with further advice provided under the Instructions for Use section. All data has been generated from typical production material and does not constitute a product specification.

MIXING AND HANDLING

PROPERTY	UNITS	AMPREG™ 21FR RESIN	FAST HARDENER	MIXED SYSTEM	TEST METHOD
Colour	-	White	Dark Orange	Pale Yellow	-
Mix ratio by weight	Parts by weight	100	17	-	-
Mix ratio by volume	Parts by volume	100	TBC	-	-
Density at 21 °C	g/cm ³	1.34	0.90 – 1.10	1.29	ISO 1183-1B

COMPONENT & MIXED SYSTEM PROPERTIES*

PROPERTY	UNITS	15°C	20°C	25°C	30°C	40°C	TEST METHOD
Ampreg™ 21FR Resin Viscosity	cP	23,300	11,600	5,500	3,800	20,000	-
Ampreg™ 3X Fast Hardener Viscosity	cP	900 - 1000	500 - 600	300 - 500	150 - 250	90 - 130	-
Initial Mixed System Viscosity	cP	-	-	TBC	-	-	-
Pot-life (150 g, mixed in water)	hrs:min	-	-	00:30	-	-	Tecam Gel Time

CURED RESIN & LAMINATE MECHANICAL AND THERMAL PROPERTIES

PROPERTIES	SYMBOL	UNITS	16 HOURS AT 50°C**	TEST STANDARD
Tensile Strength	σ_T	MPa	39.7	ISO 527-2
Tensile Modulus	E_T	GPa	4.77	ISO 527-2
Tensile Strain	ϵ_T	%	0.97	ISO 527-2
ILSS***	X_{ILSS}	MPa	28.0	ISO 14130

CURED FST PERFORMANCE

PROPERTY	REPORT	UNITS	16 HOURS AT 50°C**	SAMPLE DESCRIPTION	TEST STANDARD
Extinguish Time	Indicative result	s	Coupon 1 = 53 Coupon 2 = 33	A21FR / A3X Fast / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)
Burn Length	Indicative result	mm	Coupon 1 = 33 Coupon 2 = 32	A21FR / A3X Fast / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)

*working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampreg™ systems. It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.

**initial cure of 24 hours at 21°C

***laminare construction: 8 plies of WRE581T, 50% resin content by weight

AMPREG™ 21FR RESIN & AMPREG™ 3X STANDARD HARDENER

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MIXING AND HANDLING

PROPERTY	UNITS	AMPREG™ 21FR RESIN	STANDARD HARDENER	MIXED SYSTEM	TEST METHOD
Colour	-	White	Very Dark Orange	Cream	-
Mix ratio by weight	Parts by weight	100	17	-	-
Mix ratio by volume	Parts by volume	100	TBC	-	-
Density at 21 °C	g/cm ³	1.34	0.95 – 1.10	1.29	ISO 1183-1B

COMPONENT & MIXED SYSTEM PROPERTIES*

PROPERTY	UNITS	15°C	20°C	25°C	30°C	40°C	TEST METHOD
Ampeg™ 21FR Resin Viscosity	cP	23,300	11,600	5,500	3,800	20,000	-
Ampeg™ 3X Standard Hardener Viscosity	cP	200 - 300	150 - 200	100 – 150	50 – 100	30 - 60	-
Initial Mixed System Viscosity	cP	-	-	TBC	-	-	-
Pot-life (150 g, mixed in water)	hrs:min	-	-	01:16	-	-	Tecam Gel Time

CURED RESIN & LAMINATE MECHANICAL AND THERMAL PROPERTIES

PROPERTIES	SYMBOL	UNITS	16 HOURS AT 50°C**	TEST STANDARD
Tensile Strength	σ_T	MPa	49.2	ISO 527-2
Tensile Modulus	E_T	GPa	4.69	ISO 527-2
Tensile Strain	ϵ_T	%	1.40	ISO 527-2
ILSS***	X_{ILSS}	MPa	26.9	ISO 14130

CURED FST PERFORMANCE

PROPERTY	REPORT	UNITS	16 HOURS AT 50°C**	SAMPLE DESCRIPTION	TEST STANDARD
Extinguish Time	Indicative result	s	Coupon 1 = 5 Coupon 2 = 5	A21FR / A3X Standard / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)
Burn Length	Indicative result	mm	Coupon 1 = 29 Coupon 2 = 53	A21FR / A3X Standard / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)

*working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampeg™ systems. It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.

**initial cure of 24 hours at 21°C

***laminare construction: 8 plies of WRE581T, 50% resin content by weight

AMPREG™ 21FR RESIN & AMPREG™ 3X SLOW HARDENER

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MIXING AND HANDLING

PROPERTY	UNITS	AMPREG™ 21FR RESIN	SLOW HARDENER	MIXED SYSTEM	TEST METHOD
Colour	-	White	Burnt Orange	Pale Yellow	-
Mix ratio by weight	Parts by weight	100	17	-	-
Mix ratio by volume	Parts by volume	100	TBC	-	-
Density at 21 °C	g/cm ³	1.34	0.90 – 1.10	1.29	ISO 1183-1B

COMPONENT & MIXED SYSTEM PROPERTIES*

PROPERTY	UNITS	15°C	20°C	25°C	30°C	40°C	TEST METHOD
Ampreg™ 21FR Resin Viscosity	cP	23,300	11,600	5,500	3,800	20,000	-
Ampreg™ 3X Slow Hardener Viscosity	cP	34 - 42	24 - 34	20 - 30	14 - 20	8 - 16	-
Initial Mixed System Viscosity	cP	-	-	TBC	-	-	-
Pot-life (150 g, mixed in water)	hrs:min	-	-	02:48	-	-	Tecam Gel Time

CURED RESIN & LAMINATE MECHANICAL AND THERMAL PROPERTIES

PROPERTIES	SYMBOL	UNITS	16 HOURS AT 50°C**	TEST STANDARD
Tensile Strength	σ_T	MPa	43.0	ISO 527-2
Tensile Modulus	E_T	GPa	4.66	ISO 527-2
Tensile Strain	ϵ_T	%	1.10	ISO 527-2
ILSS***	X_{ILSS}	MPa	30.2	ISO 14130

CURED FST PERFORMANCE

PROPERTY	REPORT	UNITS	16 HOURS AT 50°C**	SAMPLE DESCRIPTION	TEST STANDARD
Extinguish Time	Indicative result	s	Coupon 1 = 40 Coupon 2 = 14	A21FR / A3X Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)
Burn Length	Indicative result	mm	Coupon 1 = 37 Coupon 2 = 31	A21FR / A3X Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)

*working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampreg™ systems. It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.

**initial cure of 24 hours at 21°C

***laminare construction: 8 plies of WRE581T, 50% resin content by weight

AMPREG™ 21FR RESIN & AMPREG™ 3X EXTRA-SLOW HARDENER

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MIXING AND HANDLING

PROPERTY	UNITS	AMPREG™ 21FR RESIN	EXTRA-SLOW HARDENER	MIXED SYSTEM	TEST METHOD
Colour	-	White	Colourless / Very Pale Yellow	Cream	-
Mix ratio by weight	Parts by weight	100	17	-	-
Mix ratio by volume	Parts by volume	100	TBC	-	-
Density at 21 °C	g/cm ³	1.34	0.85 – 1.05	1.28	ISO 1183-1B

COMPONENT & MIXED SYSTEM PROPERTIES*

PROPERTY	UNITS	15°C	20°C	25°C	30°C	40°C	TEST METHOD
Ampreg™ 21FR Resin Viscosity	cP	23,300	11,600	5,500	3,800	20,000	-
Ampreg™ 3X Extra-Slow Hardener Viscosity	cP	18 - 28	15 - 20	5 - 15	5 – 10	4 - 8	-
Initial Mixed System Viscosity	cP	-	-	TBC	-	-	-
Pot-life (150 g, mixed in water)	hrs:min	-	-	06:15	-	-	Tecam Gel Time

CURED RESIN & LAMINATE MECHANICAL AND THERMAL PROPERTIES

PROPERTIES	SYMBOL	UNITS	16 HOURS AT 50°C**	TEST STANDARD
Tensile Strength	σ_T	MPa	45.7	ISO 527-2
Tensile Modulus	E_T	GPa	4.55	ISO 527-2
Tensile Strain	ϵ_T	%	1.21	ISO 527-2
ILSS***	X_{ILSS}	MPa	29.6	ISO 14130

CURED FST PERFORMANCE

PROPERTY	REPORT	UNITS	16 HOURS AT 50°C**	SAMPLE DESCRIPTION	TEST STANDARD
Extinguish Time	Indicative result	s	Coupon 1 = 13 Coupon 2 = 30	A21FR / A3X Extra-Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)
Burn Length	Indicative result	mm	Coupon 1 = 44 Coupon 2 = 45	A21FR / A3X Extra-Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)

*working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampreg™ systems. It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.

**initial cure of 24 hours at 21°C

***laminare construction: 8 plies of WRE581T, 40% resin content by weight

AMPREG™ 21FR RESIN & AMPREG™ 3X ULTRA-SLOW HARDENER

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MIXING AND HANDLING

PROPERTY	UNITS	AMPREG™ 21FR RESIN	ULTRA-SLOW HARDENER	MIXED SYSTEM	TEST METHOD
Colour	-	White	Blue	Pale Blue	-
Mix ratio by weight	Parts by weight	100	18	-	-
Mix ratio by volume	Parts by volume	100	26	-	-
Density at 21 °C	g/cm ³	1.34	0.94	1.26	ISO 1183-1B

COMPONENT & MIXED SYSTEM PROPERTIES*

PROPERTY	UNITS	15°C	20°C	25°C	30°C	40°C	TEST METHOD
Ampreg™ 21FR Resin Viscosity	cP	23,300	11,600	5,500	3,800	20,000	-
Ampreg™ 3X Ultra-Slow Hardener Viscosity	cP	34	22	14	9	-	-
Initial Mixed System Viscosity	cP	-	-	7.0	5.3	2.5	-
Pot-life (150 g, mixed in water)	hrs:min	-	-	06:55	-	-	Tecam Gel Time
Earliest Time To Apply Vacuum	hrs:min	-	-	07:40	-	-	Internal Gurit Method
Latest Time To Apply Vacuum	hrs:min	-	-	10:00	-	-	Internal Gurit Method
Earliest Demould Time	hrs:min	It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.					Internal Gurit Method

CURED RESIN & LAMINATE MECHANICAL AND THERMAL PROPERTIES

PROPERTIES	SYMBOL	UNITS	4 HOURS AT 70°C**	TEST STANDARD
Glass Transition Temperature	T _{g2}	°C	75.5	ISO 11357 (DSC)
Glass Transition Temperature	T _{g1}	°C	75.6	ISO 6721 (DMA)
Ultimate Glass Transition Temp	UT _{g1}	°C	101.1	ISO 6721 (DMA)
Cured Density	ρ _{CURED}	g/cm ³	1.28	ISO 1183-1A
Tensile Strength	σ _T	MPa	47.2	ISO 527-2
Tensile Modulus	E _T	GPa	4.57	ISO 527-2
Tensile Strain	ε _T	%	1.38	ISO 527-2
ILSS***	X _{ILSS}	MPa	24.5	ISO 14130

CURED FST PERFORMANCE

PROPERTY	REPORT	UNITS	16 HOURS AT 50°C**	SAMPLE DESCRIPTION	TEST STANDARD
Extinguish Time	Indicative result	s	Coupon 1 = 10 Coupon 2 = 9	A21FR / A3X Ultra-Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)
Burn Length	Indicative result	mm	Coupon 1 = 26 Coupon 2 = 24	A21FR / A3X Ultra-Slow / 8 x WRE581T / 40% RC	FAR Part 25 (60s flame applied)

*working time properties are highly subjective to ambient conditions and should be used as an approximate guideline for all Ampreg™ systems. It is recommended to postcure laminates for 16 hours at 40°C, when manufactured using Extra Slow or Ultra Slow Hardeners.

**initial cure of 24 hours at 21°C

***laminare construction: 8 plies of WRE581T, 40% resin content by weight

NOTICE

All advice, instruction or recommendation is given in good faith but the selling Gurit entity (the Company) only warrants that advice in writing is given with reasonable skill and care. No further duty or responsibility is accepted by the Company. All advice is given subject to the terms and conditions of sale (the Conditions) which are available on request from the Company or may be viewed at Gurit's Website: www.gurit.com/terms-and-conditions.aspx

The Company strongly recommends that Customers make test panels in the final process conditions and conduct appropriate testing of any goods or materials supplied by the Company prior to final use to ensure that they are suitable for the Customer's planned application. Such testing should include testing under conditions as close as possible to those to which the final component may be subjected. The Company specifically excludes any warranty of fitness for purpose of the goods other than as set out in writing by the Company. Due to the varied nature of end-use applications, the Company does, in particular, not warrant that the test panels in the final process conditions and/or the final component pass any fire standards.

The Company reserves the right to change specifications and prices without notice and Customers should satisfy themselves that information relied on by the Customer is that which is currently published by the Company on its website. Any queries may be addressed to the Technical Services Department.

Gurit is continuously reviewing and updating literature. Please ensure that you have the current version by contacting your sales contact and quoting the revision number in the bottom left-hand corner of this page.

TECHNICAL CONTACT INFORMATION

For all other enquiries such as technical queries:

Telephone + 44 1983 828000 (08:30 – 17:00 GMT)
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24-HOUR CHEMICAL EMERGENCY NUMBER

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