Vortok Balise Mounting Arm

The Rapid Balise Installation System

Mounting Balise in Seconds
Product Description

The Vortok Balise mounting system can be installed onto any combination of rail fastening and sleeper type. The system removes the requirement for drilling into concrete sleepers, or digging out ballast for the steel band type of fixing, by making use of the existing rail fastenings making the installation process very fast and simple whilst using a minimal number of standard rail tools.

Manufactured from very strong, yet lightweight, GRP material the mounts are resistant to changes in climatic conditions and have a very long life in track. They will not corrode, nor are they affected by chemical spillages or corrosive environments found near mining areas for example.

The system is completely insulated and will not interfere with track circuits and by design it is able to withstand the vibration forces generated from passing of high speed trains.

The Vortok mounting system is suitable for all the various Balise types with over 170,000 installed all over the world supporting ABB, Alstom, Ansaldo, Bombardier, Siemens and Thales Balise variants as well as other inductive aerial systems, sensors and safety devices.

- Any sleeper type
- Any Balise type
- Any rail fixation system
- No need to drill sleepers
- No digging of ballast
- Not prone to ballast erosion
- Fix Balise in minutes at a fraction of the traditional installation costs!
- Tamper friendly, keeping Balise within sleeper profile

Product History

The Vortok Balise mounting arm was originally developed by Vortok for the nationwide installation of the Train Protection and Warning System (TPWS) developed for the United Kingdom network by Thales.

When the TPWS aerial panels were being installed, particularly upon concrete sleepers, it was taking up to 2 hours per location. Vortok developed the Balise mounting arm for Thales to vastly speed up installation time removing both the need for special fastenings and any requirement to drill into concrete sleepers. The initial roll out of this system in the UK called for the installation of 53,000 panels, this was accomplished using the Balise mount system on all sleeper and fastening types throughout the UK.

Vortok have since developed a number of arms suitable for the mounting of all Balise types and many other device types to any combination of sleeper and fastening type found worldwide.
TPWS Mounts with Aerial Panel

Since 2001 over 130,000 of the original mounts have been put in track in the UK, Ireland and Australia with a zero failure rate to date. A letter of reference from Thales is included in the appendix.

Subsequent to the TPWS project the Vortok system has been adapted for other uses including the mounting in track of Balise to control tilting trains, carry cables across track, support devices such as Gatekeeper and of course Balise for ETCS/ERTMS.

Non ETCS Projects

Gatekeeper Track Switch System

Pictured left is Gatekeeper, a permanently installed track circuit switch for possession management. Utilising the Vortok Balise beam this device can be fitted to track within minutes.

Gatekeeper units are installed permanently in track, when the possession of the track ends the stop sign is removed allowing the movement of traffic.

Gatekeeper is permitted for use upon high speed lines and is typically used in areas of track.

Shown below is the Gatekeeper device in running track without the signboard used in possession. Gatekeeper is vibration tested to EN 50125-3 the device and beam weighing
Pictured above are two different styles of conduit beam used to hold and secure cables crossing sleepers. Once again the Balise Mount system is used to attach to the existing fastening system and enables very fast installation.

**Pendolino tilting train Balise (Alstom)**

Virgin Trains Pendolino as used on the West Coast Main Line in the UK.

Alstom Balise used to control the trains tilt on its mounting beam.

Each curve in rack is different in nature, the degree of cant/super elevation for example. To ensure a smooth ride it is necessary for the train to know this prior to entering and exiting each curve so that the correct level of tilt for the conditions and speed is set.

A combination of the size of this Balise, the track geometry where they are placed and height requirements led to the design of this adjustable variant of the Vortok system.
Balise mounts for ERTCS / ERTMS Project

As the progress toward the interoperability of the signalling systems across Europe gathers pace so has the development of new mounting arms suitable for each network operators different sleeper and fastening combinations.

In addition to the different requirements of each railway network the UNISIG regulations themselves include criteria that directly affect the design of the mounting beam. The Vortok system ensures full compliance with these regulations.

- Minimum clearances from the top of the rail.
- Rail wear allowances.
- Maximum surface area of metalwork required to mount the Balise.
- Free metal area requirement.
- Vibration resistant, even upon the highest speed lines.
- Environmental compliance.
- Conformance with insulation requirements.
- Compliant to EN Standards.

Adapting to Local Conditions and Variations

Aside from catering for the large array of fixation systems such as Pandrol e-clip, Fastclip, Vossloh, Nabra, Angluer, along with differing sleeper profiles, the Vortok system can also accommodate the seemingly endless varieties of a particular type of system. Taking the Pandrol e-clip as an example Vortok has designed a beam that is suitable for the dozens of e-clip varieties found across the UK network.
Adapting to Local Conditions and Variations

During the initial trials in Belgium for the national roll out of ETCS an e-clip housing of a design previously unknown to Vortok was uncovered. For this type of Pandrol e-clip a new design of yoke was required to that used in the UK and the following design was approved by both Infrabel and Siemens.

This beam design passed all the required testing procedures, including the vibration tests for high speed lines and can be used on the M41 sleeper type. Further investigation into the combination of sleeper variations found yet more variants resulting in further design challenges.

The customers ideal scenario was to have one beam that would suit all the sleeper and e-clip combinations in their network. With close to 10 sleeper types and numerous small but important variations to the e-clip housing this beam, and specifically the yoke design, has proven to be our
Adapting to Local Conditions and Variations

Vortok has now developed Balise arms suitable for use on a wide variety of sleeper and fixation combinations, all meeting the UNISIG criteria. All our designs remain true to the original design concept of providing a secure method of fixing Balise in track in a matter of minutes rather than hours.

Two Balise mount variants were needed to cover all requirements in the Swiss network - pictures courtesy of SBB

Cost of Installation and Ownership.

Vortok has now developed Balise arms suitable for use on the vast majority of sleeper and fixation combinations to be found in track, all meeting the UNISIG criteria. Our designs remain true to the original concept of providing a secure method of fixing Balise in track in a matter of minutes rather than hours.

The following table assumes a typical installation of two Balise per location;

<table>
<thead>
<tr>
<th>Mounting Method</th>
<th>Installation Time</th>
<th>Removal Time</th>
<th>Possession Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vortok Balise Arm</td>
<td>5 Minutes</td>
<td>5 minutes</td>
<td>No - Can be placed in track between traffic!</td>
</tr>
<tr>
<td>Drilling Concrete</td>
<td>2 Hours</td>
<td>5 minutes</td>
<td>Yes - 2 Hours</td>
</tr>
<tr>
<td>Steel Band System (When ballast not frozen)</td>
<td>1½ - 2 Hours</td>
<td>1 - 1½ Hours</td>
<td>Yes - Yes 1½ - 2 Hours</td>
</tr>
</tbody>
</table>

A great advantage of the Vortok system is the zero requirement for possession. Additionally the labour cost incurred in using the Vortok system is reported as being no more than a fifth of that incurred when drilling sleepers or digging ballast. SBB in Switzerland report a cost of CHF 200 using Vortok beams compared to CHF 1,000 when drilling at each location.
**Typical Balise Mounting Arm Specifications.**

Main mounting arm beam: manufactured in GRP Modar. (Data sheet in appendix)

We use the 865 grade of Modar for the combination of both strength and fire resistant properties, it is safe to use in underground applications and acts as an insulator so will not interfere with track circuits for example.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall thickness:</td>
<td>5mm</td>
</tr>
<tr>
<td>Profile:</td>
<td>80mm by 20mm (Typical)</td>
</tr>
<tr>
<td>Weight without Balise:</td>
<td>3.11kg (Typical)</td>
</tr>
<tr>
<td>Yokes and mounting points:</td>
<td>2 or 3mm Stainless Steel</td>
</tr>
<tr>
<td></td>
<td>12mm diameter stainless steel bolts</td>
</tr>
<tr>
<td></td>
<td>Nord-Lock bolt securing system.</td>
</tr>
<tr>
<td>Torque:</td>
<td>To 38Nm (Maximum allowable for Eurobalise)</td>
</tr>
<tr>
<td>Time to Fit Beam:</td>
<td>Maximum of 2 minutes to remove fastenings, place beam in position and refasten. Same to remove.</td>
</tr>
<tr>
<td>Time to fit Balise to beam:</td>
<td>2 minutes maximum.</td>
</tr>
<tr>
<td>Maintenance schedule:</td>
<td>Only a visual inspection is required at the same time as normal</td>
</tr>
</tbody>
</table>

*Vossloh type fastening and yoke*
Appendix

Product Images

Approvals

Modar Data Sheet

Design Requirements

Grey Balise as used in Belgium mounted on concrete sleeper with Pandrol e-clip fixations.
ABB Balise on Mounting Arm Sweden.

Double Thales TWPS Ariel Panels mounted on three of over 130,000 Balise mounting arms on the UK network.
Balise Mount for Nabla Fastenings

Nabla variant as used on Channel Tunnel rail rail link.

Standard Vossloh beam under test in Switzerland.

Vossloh variant to lower the Balise in track.
Double mounting arm for large Ansaldo Balise on Fastclip fastening.

Deflection and destruction test upon Vossloh sleeper - Beam proved strong enough to lift the sleeper. (Test report

The Vortok beam undergoing vibration and load deflection testing.
Mr. Peter Shrubsole
Vortok International
6-8 Haxter Close
Bellerive Industrial Estate
Roborough
Plymouth. PL6 7DD

Our ref: Vortok/swh/062012
Your ref:

20 December 2006

To whom it may concern.

Thales hereby confirm that to date, we have utilised more than 50,000 Vortok Balise mounting arms as part of our TPWS installations throughout the United Kingdom, Northern Ireland and Australia.

The performance of Vortok and its products has remained entirely satisfactory throughout our five year working relationship and Vortok continues to be our preferred supplier.

Yours faithfully,

Stephen Hare
Programme Manager
For and on behalf of Thales Land & Joint Systems U.K.
Typtest Zertifikat
Type Test Certificate

Produkt Bezeichnung: Siemens Eurobalise S21 GFK-Balisenträger
Product Designation: Siemens Eurobalise S21 GRP-mounting arm

Hersteller: Siemens Aktiengesellschaft
Manufacturer: Transportation Systems Division TS RA

Adresse: Ackerstraße 22
Address: 38126 Braunschweig
Germany

Der Typtest beinhaltet:
The type test comprises:

- Mechanische Prüfung
  Mechanical test
- Anhang zum Typtest Zertifikat
  Annex to Type Test Certificate

Dieses ist ein Nachweis dafür, dass das oben benannte Produkt die Typtests bestanden hat.
This is to state that the product named above has successfully passed the type test.

Siemens Aktiengesellschaft

Braunschweig, 06.07.2007

Name, Funktion
Name, Function
Herr Liebscher, TS RA PC PM, Product Management

Name, Funktion
Name, Function
Herr Haensch, TS RA PC QP, Quality Management

Typtest Zertifikat
Type Test Certificate

50 1096 OIL ORG 07.97

Document No.: A6Z00001299926 A25326-A40-D34-1-J6
1 von 3

Copyright (C) Siemens AG 2007 All Rights Reserved
Mechanische Prüfung
Mechanical Test

Produkt Bezeichnung: Siemens Eurobalise S21 GFK-Balisenträger
Product Designation: Siemens Eurobalise S21 GRP-mounting arm

Das oben benannte Produkt hält folgende Normen ein:
The product named above complies with the following standards:

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<th>Art der Prüfung</th>
<th>Auswertung</th>
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<tbody>
<tr>
<td><strong>Betriebsprüfung</strong></td>
<td><strong>Einhaltung der Norm DIN EN 60068-2-64</strong></td>
</tr>
</tbody>
</table>
| Schwingen, rauchförmig | vertical:
| 5 Hz 2 (m/s²)²/Hz, 850 Hz 39,9 (m/s²)²/Hz, 2000 Hz 5,99 (m/s²)²/Hz, Effektivwert 176 (m/s²)rms |
| transversal (quer zu Fahrtrichtung): 5 Hz 0,2 (m/s²)²/Hz, 200 Hz 1,6 (m/s²)²/Hz, 450 Hz 4,39 (m/s²)²/Hz, 2000 Hz 2 (m/s²)²/Hz, Effektivwert 74 (m/s²)rms |
| longitudinal (in Fahrtrichtung): 5 Hz 0,399 (m/s²)²/Hz, 100 Hz 0,0798 (m/s²)²/Hz, 700 Hz 12 (m/s²)²/Hz, 2000 Hz 7,98 (m/s²)²/Hz, Effektivwert 118 (m/s²)rms |
| **Prüfdauer**: 100 Minuten je Achse |
| **Functional test** | **Standard DIN EN 60068-2-64** |
| for facilities on track | vertical:
| Vibration, broad-band random | 5 Hz 2 (m/s²)²/Hz, 850 Hz 39,9 (m/s²)²/Hz, 2000 Hz 5,99 (m/s²)²/Hz, Effektivwert 176 (m/s²)rms |
| transversal (cross to drive direction): 5 Hz 0,2 (m/s²)²/Hz, 200 Hz 1,6 (m/s²)²/Hz, 450 Hz 4,39 (m/s²)²/Hz, 2000 Hz 2 (m/s²)²/Hz, Effektivwert 74 (m/s²)rms |
| longitudinal (in drive direction): 5 Hz 0,399 (m/s²)²/Hz, 100 Hz 0,0798 (m/s²)²/Hz, 700 Hz 12 (m/s²)²/Hz, 2000 Hz 7,98 (m/s²)²/Hz, Effektivwert 118 (m/s²)rms |
| 100 minutes per axes |
| **Betriebsprüfung** | **Einhaltung der Norm DIN EN 60068-2-29** |
| Dauerschoken, halbsinusförmig | Schocks 103g, 2 ms 100 Schocks in vertikaler Achse |
| **Functional test shock** | **Standard DIN EN 60068-2-29** |
| half sinuously | Shocks 100g, 2 ms 100 Shocks in vertical axes |

Typtest Zertifikat
Type Test Certificate

50 1096 OIL ORG 07.97

Document No.: A6Z0000129926 A25326-A40-D34-1-J6

Copyright (C) Siemens AG 2007 All Rights Reserved
Der Typtest wird nachgewiesen für folgende Komponenten:

*The Type Test is assured for the following components:*

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<td>Balisenträger für M41 ohne Codierung</td>
<td>Mounting arm for M41 without code</td>
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<tr>
<td>C25326-A40-D33</td>
<td>Balisenträger für Angeler ohne Codierung</td>
<td>Mounting arm for Angeler without code</td>
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</tr>
<tr>
<td>C25326-A40-D34</td>
<td>Balisenträger für Holzschwellen ohne Codierung</td>
<td>Mounting arm for wood sleepers without code</td>
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<td>C25326-A40-D37</td>
<td>Balisenträger für Holzschwellen mit Codierung</td>
<td>Mounting arm for wood sleepers with code</td>
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Finnish Railway Approval Certificate

RATAHALINTOKESKUS
BANFÖRVALTNINGSCENTRALEN

PÄÄTÖS
27.9.2007
1924/630/2007

Konepaja Mankinen Ky
Pl 3
11711 Riihimäki

TYYPPIHYVÄKSYNTÄ: VOR TOK BALI ISIN KIINNITYSVARSI P A N D R O L E - JOUSELLE
JA VOSSLOH-KIINNITYKSELLE

Hakemus


Kiinnitysvarsia on ollut koekäyttössä noin 1,5 vuoden ajan rataan asennettuna välillä Jyväskylä – Äänekoski (Suolahden kohdalla). Kunnossapidolla ei ole ollut huomauttamista kiinnitysvarsista. Koekäyttöölvän diarinumero on 3093/742/05.

Hakija on liittänyt hakemukseensa kiinnitysvarten asennus- ja tarkastusohjeen, valmistajan (Delachaux Group) spesifikaatioita ja Network Rail:n ”Certificate of Acceptance”-todistuksen.

Päätös

Ratahallintokeskus myöntää hakemuksen mukaisesti Konepaja Mankinen Ky:lle tyyppihyväksynnän Vortok-merkissä ballisin kiinnitysvaren käytölle Pandrol e-jousen ja Vossloh-kiinnityksen yhteydessä.

Koekäyttööllä olleet kiinnitysvarrat on poistettava radalta.

Tästä päätöksestä peritään maksu 73 € (LVM asetus 754/30.8.2006).

Markku Nummelin
Tekninen johtaja

Jari Viitanen
Yliarkistoaja

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kipamori@nki.fi
etuni.sukunimi@nki.fi

Koskusvi Namäste
www.nki.fi
IMPORTANT INFORMATION FOR USERS

Product Acceptance Advice Note
This advice note provides appropriate background information and any specific action that may be required in accordance with the attached certificate. It will enable you to meet your obligations in meeting the requirements of the Company procedure RT/LS/P029.

<table>
<thead>
<tr>
<th>Certificate Ref.</th>
<th>Issue</th>
<th>Product</th>
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<tbody>
<tr>
<td>PA05/01222</td>
<td>5</td>
<td>Tilt Authorisation &amp; Speed Supervision (TASS) Eurobale and Fixings</td>
</tr>
</tbody>
</table>

Manufacturer
ALSTOM Transport Information Solutions
33 rue des Bateliers, Boîte postale 166, 93404 Saint-Ouen, Cedex, France

Background
The issue 4 certificate of acceptance contained the following clause:
- The Balises may be operated in ‘telepowered mode’ for the purposes of testing and authorisation is not provided to control the speed supervision and tilt authorisation of the Class 221 or 390 in passenger operation.

The issue 5 certificate of acceptance changes the condition of acceptance to the following:
- The Balises may be operated in ‘telepowered mode’ to enable speed supervision and tilt authorisation on the Class 221 and 390 trains whilst in passenger or non-passenger operation.
- Alteration of the Conditions generally to reflect the development of the TASS system and publication of Network Rail Company Standards for TASS, particularly RT/E/S02024 “Requirements for TASS Infrastructure – Installation, Test and Maintenance”.

For further information regarding the change please contact Mr Dermot Courtney, Route Acceptance Specialist, on 0207 557 9190 (internal 085 79190) or alternatively you may send an email to mailto:dermot.courtney@networkrail.co.uk.

Network Rail action
Deficiencies in performance affecting the accepted functionality of the product or its safety integrity identified by users of the product shall be reported in writing to Network Rail, HQ Acceptance Services.

Richard Lockett
Product Acceptance Specialist
Certificate of Acceptance

Certificate No: PA05/01222
Effective date: 23/09/2004

Product: Tilt Authorisation & Speed Supervision (TASS) Eurobalise and Fixings

Manufacturer: ALSTOM Transport Information Solutions
33 rue des Batelliers
Boîte postale 166
93404 Saint-Ouen
Cedex
France

The product above is accepted for use on the Network Rail infrastructure within the defined scope of acceptance and any specific conditions in the certificate.

Scope of Acceptance
Eurobalise and associated Vortok fixings for installation on any part of the Network Rail controlled infrastructure operated in telepowered mode.

Specific Conditions:
See following pages for more detailed specific conditions of use and the product configuration.

Authorised by:

Neil Bannett BSc, MBA, CEng, MIEE, MBCS, MAPM, MCM
Chairman, Infrastructure Systems Review Panel
Certificate of Acceptance

Certificate No: PA05/01222  Effective date: 23/09/2004  Issue: 5  Date: 22/09/2004

Product: Tilt Authorisation & Speed Supervision (TASS) Eurobalise and Fixings

Manufacturer: ALSTOM Transport Information Solutions
33 rue des Batellers
Bolte postale 166
93404 Saint-Ouen
Cedex
France

The product above is accepted for use on the Network Rail infrastructure within the defined scope of acceptance and any specific conditions in the certificate.

Scope of Acceptance
Eurobalise and associated Vortok fixings for installation on any part of the Network Rail controlled infrastructure operated in telepowered mode.

Specific Conditions:
See following pages for more detailed specific conditions of use and the product configuration.

Authorised by:

[Signature]

Neil Barnett BSc, MBA, CEng, MIEE, MBCS, MAPM, MCM
Chairman, Infrastructure Systems Review Panel
# Certificate of Acceptance

## PRODUCT CONFIGURATION

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<th>Part No.</th>
<th>Description</th>
<th>PADS No.</th>
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<td>TASS Track Equipment</td>
<td>089/048993</td>
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<tr>
<td>Product I.D 2174</td>
<td>Balise</td>
<td>089/048994</td>
</tr>
<tr>
<td>BM/001</td>
<td>Pandrol</td>
<td>089/048995</td>
</tr>
<tr>
<td>BM/026T</td>
<td>Timber</td>
<td>089/048996</td>
</tr>
<tr>
<td>BM/015</td>
<td>Fastclip</td>
<td>089/048997</td>
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<td>BM/026C</td>
<td>Concrete</td>
<td>089/048998</td>
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<tr>
<td>BM/031</td>
<td>Fastclip 600</td>
<td>089/048999</td>
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</table>

### Balise Beam Fixing Details by Sleeper Type:

<table>
<thead>
<tr>
<th>Sleeper Type</th>
<th>Beam Securing Arrangement</th>
<th>Vortok Drawing ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Sleepers with rail secured Pandrol Clips (of e-clip design including all models from F23 to the F40 style and their 3rd rail variants) Steel sleepers Corus 400 series, T&amp;T HH10 MK1, HH10, Mk2, HH12 MK2.</td>
<td>Each beam is secured to the rail fixing using two specially designed Pandrol Clip type e-2001 designed for use with beam Yoke.</td>
<td>MC/BM/100/001 Issue 1, 15th January 2001.</td>
</tr>
<tr>
<td>Sleepers with rail secured by 'Fastclip' fastenings (including the F41 and G44 type) Steel Sleepers Corus 500 series, T&amp;T HH10 MK1, HH10, Mk2, HH12 MK2.</td>
<td>Each beam is secured using two Fastclip fastenings, one per yoke end.</td>
<td>MC/BM/100/026 Issue 1, 7th February 2001.</td>
</tr>
<tr>
<td>Timber Sleepers (irrespective of fastening type)</td>
<td>Each beam is held down to the timber Sleeper by six stainless steel coach screws supplied with the installation kit</td>
<td>MC/BM/100/015 Issue 1, 7th February 2001.</td>
</tr>
<tr>
<td>Concrete Sleepers without appropriate Pandrol or Fastclip fastenings</td>
<td>Each beam is secured with two stainless steel Hilti studs.</td>
<td>MC/BM/100/015 Issue 1, 7th February 2001.</td>
</tr>
<tr>
<td>Corus 600 series steel sleepers</td>
<td>Each beam is secured using two Fastclips fastening, one per yoke end.</td>
<td>MC/BM/100/031 Issue 1, 11th November 2002.</td>
</tr>
</tbody>
</table>
# Certificate of Acceptance

Certificate No: PA05/01222  
Effective date: 23/09/2004  
Issue: 5  
Date: 22/09/2004  
Page 4 of 5

## ASSESSED DOCUMENTATION

<table>
<thead>
<tr>
<th>Reference</th>
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<tr>
<td>C80056-RPT-MHA-0411 Issue 02</td>
<td>TASS Balise Fixings Safety Case</td>
<td>02/09/2001</td>
</tr>
<tr>
<td>ESRP/01/19</td>
<td>ESRP Project Record Sheet – Balise Fixing Safety Case</td>
<td>18/09/2001</td>
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<tr>
<td>C80056-SPEC-SYS-00023, Issue 01</td>
<td>Trackside Installation and Commissioning Manual for the Tit Authorisation and Speed Supervision (TASS) System.</td>
<td>18/05/2001</td>
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<tr>
<td>PA05/446, Issue 6</td>
<td>Railtrack Certificate of Acceptance. Train Protection and Warning System.</td>
<td>06/12/2000</td>
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<td>8002/1/CR</td>
<td>Radiation Hazard and EMC of TASS antennas based on computer modelled fields.</td>
<td>12/12/2001</td>
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<td>LNE SRG Minutes C80056-RPT-MHA-0418 Issue 2</td>
<td>Extracts from RTLNE SRG in York on 20th November 2001</td>
<td>20/11/2001</td>
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<tr>
<td>C80056-RPT-SPEC-00157 Iss 1</td>
<td>Addendum to TASS Balise Fixings Safety Case</td>
<td>18/07/2002</td>
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<td>----</td>
<td>Corus 600 Steel Sleeper TASS Fixing Bracket Variant: Product Acceptance Justification Report</td>
<td>28/11/2002</td>
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<td>070_012</td>
<td>TASS Trainbourne Tools EC Type Examination Certificate</td>
<td>4/06/2004</td>
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<tr>
<td>RT/E/S/02024</td>
<td>Requirements for TASS Infrastructure – Installation, Test and Maintenance</td>
<td>December 2003</td>
</tr>
<tr>
<td>CCRM/NR/RP/0000010 8 iss 1</td>
<td>Electromagnetic compatibility on non-upgrade routes</td>
<td>23/01/04</td>
</tr>
</tbody>
</table>

## CERTIFICATE HISTORY

This certificate supersedes PA05/01222 issue 4.
Certificate of Acceptance

Certificate No: PA05/01222
Effective date: 23/09/2004
Issue: 5
Date: 22/09/2004
Page 5 of 5

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PRODUCT CODE PUL.865.708
80 X 20 X 5 BOX SECTION

MODAR 865 RESIN FEATURES

- Low viscosity enables high filler loadings.
- Good mechanical properties as glass is wet out well and resin toughness utilises the reinforcement potential.
- Highly reactive ensuring high line speeds and reduced shrinkage cracks on thicker sections.
- Ideally suited to be used in combination with aluminium trihydrate to achieve high levels of performance in exposure to fire.

LIQUID PROPERTIES @ 25°C

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (mPa.s)</td>
<td>130</td>
</tr>
<tr>
<td>Gel time (seconds)</td>
<td>60</td>
</tr>
<tr>
<td>Gel Peak Time (seconds)</td>
<td>70</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.07</td>
</tr>
<tr>
<td>Solid Contents (%)</td>
<td>50</td>
</tr>
<tr>
<td>Flash Point (°C)</td>
<td>10</td>
</tr>
<tr>
<td>Boiling Point (°C)</td>
<td>110</td>
</tr>
</tbody>
</table>

Gel peak time method: @20°C, 1.5% pure BPO+0.5% DMPT. Viscosity=Brookfield LV 60rpm, No.1 spindle, @ 25°C

<table>
<thead>
<tr>
<th>Component</th>
<th>Parts per hundred (by weight) on resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>% BPO (Benzoyl peroxide) (40%)</td>
<td>3.75 3.5 3.0 3.0</td>
</tr>
<tr>
<td>% DMA (Dimethyl Aniline)</td>
<td>0.5 0.3 0.2 -</td>
</tr>
<tr>
<td>% DEA (Diethyl Aniline)</td>
<td>- - - 0.5</td>
</tr>
<tr>
<td>Gel Time (Minute)</td>
<td>4 6.5 12.5 11</td>
</tr>
<tr>
<td>Gel to Peak (Minute)</td>
<td>3 5 7 8</td>
</tr>
</tbody>
</table>
PRODUCT CODE P0061
80 X 20 X 5 BOX SECTION

TYPICAL PROPERTIES UNREINFORCED CAST 865 RESIN
(Thickness = 0.125”, 3.2mm)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength (Mpa)</td>
<td>215.0</td>
</tr>
<tr>
<td>Flexural Modulus (Gpa)</td>
<td>3.38</td>
</tr>
<tr>
<td>Tensile Strength (Mpa)</td>
<td>79.3</td>
</tr>
<tr>
<td>Tensile Modulus (Gpa)</td>
<td>2.69</td>
</tr>
<tr>
<td>Tensile Elongation (%)</td>
<td>6.1</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>40</td>
</tr>
<tr>
<td>Compressive Yield Strength (Mpa)</td>
<td>113.6</td>
</tr>
<tr>
<td>Heat Deflection Temperature (°C)</td>
<td>107</td>
</tr>
<tr>
<td>Charpy Impact (KJ/M²)</td>
<td>22</td>
</tr>
<tr>
<td>Water Absorption (%) (24 hrs @ 23°C)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

TYPICAL PROPERTIES OF GLASS/MAT 865 LAMINATE
Tyglass Y0073 0/90° woven mat

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flexural Properties:</strong> Glass Content 47% w/w Flexural Strength (Mpa)</td>
<td>583.0</td>
</tr>
<tr>
<td>Flexural Modulus (Gpa)</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Interlaminar Shear Properties:</strong> Glass Content 71% Interlaminar Shear Strength (Mpa)</td>
<td>44.0</td>
</tr>
<tr>
<td><strong>Tensile Properties:</strong> Glass Content 66.4% Tensile Strength (Mpa)</td>
<td>364.8</td>
</tr>
<tr>
<td>Tensile Modulus (Gpa)</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>3.7</td>
</tr>
</tbody>
</table>
PRODUCT CODE P0061
80 X 20 X 5 BOX SECTION

MODAR + ALUMINA TRIHYDRATE FIRE RETARDANT PROFILE

The addition of the non-toxic Aluminium Trihydrate (ATH) powder as a fire retardant additive produces products capable of meeting the most stringent fire standards with the benefit of low smoke and low toxic gas emissions.

By the addition of dispersion and wetting agents Modar accepts ATH incorporation up to very high levels.

The fire performances of profiles are directly proportional to the ATH loading and

- Glass content (Volume fraction)
- Glass distribution
- Thickness

Thus individual products have their own capabilities, the table below gives guidance to the minimum levels of ATH to meet the listed fire standards.

The table is based on results obtained with Modar 826 and 835S using 4mm thick products with 40% volume of glass in a 450gsm mat/roving/450gsm mat construction.

<table>
<thead>
<tr>
<th>Fire Standard</th>
<th>Minimum ATH (PPHR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 476 parts 6&amp; 7</td>
<td></td>
</tr>
<tr>
<td>Class 1</td>
<td>90</td>
</tr>
<tr>
<td>Class</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>170</td>
</tr>
<tr>
<td>French NFP 92-501</td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td>150</td>
</tr>
<tr>
<td>German DIN 4102</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>150</td>
</tr>
<tr>
<td>German DIN 5510</td>
<td></td>
</tr>
<tr>
<td>S4/SR2/ST2</td>
<td>100</td>
</tr>
<tr>
<td>UL94-V0</td>
<td>90</td>
</tr>
</tbody>
</table>

(PPHR = Parts per hundred of resin)
**PRODUCT CODE P0061**

80 X 20 X 5 BOX SECTION

Strength Comparison Between V0 and V1 Standard Polyester

<table>
<thead>
<tr>
<th>VALUE</th>
<th>V0 MODAR 865</th>
<th>METHOD</th>
<th>NFR NORS 6394</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength (Mpa)</td>
<td>215</td>
<td>ASTM D-570</td>
<td>110</td>
<td>ISO 178</td>
</tr>
<tr>
<td>Flexural Modulus (Gpa)</td>
<td>3.38</td>
<td>ASTM D-570</td>
<td>3.6</td>
<td>ISO 178</td>
</tr>
<tr>
<td>Tensile Strength (Mpa)</td>
<td>79.3</td>
<td>ASTM D-638</td>
<td>80</td>
<td>ISO 527</td>
</tr>
<tr>
<td>Tensile Modulus (Gpa)</td>
<td>2.69</td>
<td>ASTM D-638</td>
<td>3.7</td>
<td>ISO 527</td>
</tr>
<tr>
<td>Tensile elongation (%)</td>
<td>6.1</td>
<td>ASTM D-638</td>
<td>5</td>
<td>ISO 527</td>
</tr>
<tr>
<td>Heat deflection Temp °C</td>
<td>107</td>
<td>ASTM D-648</td>
<td>110</td>
<td>ISO 75-2 A</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>40</td>
<td>ASTM D-2583</td>
<td>45</td>
<td>Barcol 934-1</td>
</tr>
</tbody>
</table>

Properties are from resin suppliers Technical Data sheets. All data is for un-reinforced cast resin.

M. Welham 13.06.08
Design Requirements

To enable us to propose a suitable design we will need the following information. In some cases where the fixation type is unusual we may require more information, however the following will enable us to make an initial assessment and in most cases provide a finished design.

<table>
<thead>
<tr>
<th>Fixation Types?</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Screw type, such as Vossloh, please indicate pitch between the centre point of the screws</td>
</tr>
<tr>
<td>Rail Profiles used on network.</td>
</tr>
<tr>
<td>Maximum rail wear for each type</td>
</tr>
<tr>
<td>Balise type</td>
</tr>
<tr>
<td>Do you have any metal sleepers on the network.</td>
</tr>
<tr>
<td>If yes to the above please state the rail profiles used on this</td>
</tr>
</tbody>
</table>

Other information check list

- Sleeper profile drawings. Please provide drawings for all different types of sleeper associated with each fixation type
- If requested please provide availability of sleeper samples, dimensions and weight for Vortok to collect at our cost.
- Rail profile details, including the maximum wear tolerance.