AN INTRODUCTION TO
AEGIS ENGINEERING SYSTEMS

THE POSITIVE CHOICE

ABOUT AEGIS

AEGIS delivers engineering and independent certification services across the railway industry – in rolling stock, plant, infrastructure and operations.

Working with AEGIS gives direct access to highly experienced professionals providing engineering expertise, innovative solutions, rapid responses and value for money.

Our business success has been founded on technical expertise, with two key contributing factors: the ability to mobilise quickly, and the agility to be flexible in response to our clients' needs. Coupling this with a commitment to deliver excellent results – on time, every time – has brought us an expanding client base and consistent repeat business.

OUR SECTORS

We operate in the following industry sectors:

- Passenger Rolling Stock
- Infrastructure
- On Track Plant & Machines
- Freight
- Independent Assessment
- Certification

ENGINEERING

PROJECT ENGINEERING & MANAGEMENT

Engaging with AEGIS for engineering projects gives you the flexibility to manage your own project workload without the time and cost of employing additional full-time resource.

We undertake projects for UK passenger and freight operators as well as ROSCOs, component OEMs and overseas operators and suppliers across all disciplines including mechanical, electrical and software engineering and on new and legacy rolling stock.

These projects can be specific packages, or we can provide engineers to be part of your larger team.

Tasks typically include:

- Feasibility studies
- Reliability investigations
- Life extension studies
- Failure investigations
- Documentation production
- Calculations
- Component replacement / Obsolescence
- Vehicle modification design and documentation

SYSTEMS ENGINEERING

Systems Engineering is the glue that binds together and integrates the multiple engineering disciplines and solutions required to deliver a modern railway engineering project.

Complex projects require careful and logical approaches to ensure that the delivered system meets its objectives, with aspects including:

- Capture, definition and management of a clear set of system requirements
- Establishment of clear roles and responsibilities
- Management of interfaces (technical, organisational, project phases, etc.)
- Establishment of a requirements verification approach

AEGIS engineers follow the V lifecycle of EN 50126 or any bespoke project lifecycle structure agreed with the customer. Our engineers ensure that the developed system fulfils its defined requirements at each level of the cycle.

STRUCTURAL ENGINEERING

AEGIS delivers a wide range of structural assessments for railway applications such as:

- Rail vehicle bodyshell structures - in full or in part, including external doors, bodyside pillars, headstock, cantrail and solebar, bolster and vehicle underframe structures
- Traction system equipment - including structural failure analysis, system thermal expansion study and rotor assessments
- Body-mounted equipment - from small electrical components to internal furniture and underframe mounted equipment
- Bogie frame analysis and bogie mounted equipment

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KEY SERVICES

ENGINEERING

- Project Engineering
- Project Management
- Structural Engineering

ASSURANCE

- Standards Compliance
- Approvals & Authorisation Management
- Software Assessment

COMPATIBILITY

- Gauging Assessment
- EECS and EMC
- Vehicle Performance Analysis

RAMS

- Safety Management
- Common Safety Method (CSM-RA)
- RAM Management & Engineering

INDEPENDENT SERVICES

- Independent Safety Assessment (ISA)
- Assessment Body (AsBo)
- Independent Competent Person (ICP)
- Notified Body (NoBo)
- Designated Body (DeBo)
- Verification of Engineering Change (RIS-2700-RST)
- Plant Acceptance Body (PAB)

ASSURANCE

RAILWAY STANDARDS COMPLIANCE

AEGIS has a detailed understanding of railway standards and their application within the approvals process.

Whether it's a new build passenger train, new infrastructure product or on-track machines or an engineering change to existing stock or infrastructure, we can identify the applicable standards and specifications, determine the relevant clauses and produce, manage or provide the relevant compliance documentation to regulatory bodies.

APPROVALS AND AUTHORISATION MANAGEMENT

We offer specialist support in all aspects of technical approvals and authorisations, including:

- Defining and documenting Approvals Strategies
- Guidance on product approvals for new or novel equipment/ systems
- Guidance on gaining authorisation from the National Safety Authority
- Defining the applicable standards for your project/ engineering change
- Producing requirements capture documentation
- Providing training and technical guidance on the technical submissions required to demonstrate compliance
- Identification of the optimal validation testing approach

SOFTWARE ASSURANCE

AEGIS is an industry leader in Software Assessment and provides services against all software Standards, including EN 50128:2011, EN50657:2017 and ISO-EN61508-3.

We provide full training on software assurance standards (including the documentation that has to be produced), software requirements management and change management.

We help improve the quality of the software in order to increase the level of confidence that the software is free of vulnerabilities and that it is fit for its intended use.

Our service spans the entire software lifecycle, so it is essential that the process is in place from the start of development right the way through to the end of the software lifecycle. We offer invaluable support to everyone involved in developing software for a system or sub-system, whether safety related or not. The details and depth of the approach taken will depend on the safety criticality of the safety function and its application (up to SIL4).

Our software team is trained and experienced in performing all software assurance activities, optimising the processes by selecting the most appropriate techniques and methods, step by step.

Full services provided:

- Software Assessments
- Training
- Software process review and technical support against software standards
- Planning the development of the suite of software assurance documentation
- Requirements management and engineering (DOORS or other tools)
- Change management
- Test strategy
- Verification and validation

All services offered are delivered in accordance with the main software standards e.g. EN50128:2011, EN50657:2017, EN61508 part 3, ISO90000-3, IEEE Std1558, IEEE Std829, etc.

CYBERSECURITY

Cybersecurity has become an increasingly important subject in all "intelligent" and mission critical systems and the railway system is no exception. At AEGIS, we have the expertise to provide help and recommendations for applying Cybersecurity solutions within the railway sector.

We undertake assessment services as well as providing guidance on Cybersecurity documents, deliverables, and processes in accordance with existing standards (e.g. EN62443), guides and the new EN railway technical specification. Our cybersecurity experts are contributing members of the BSI/ CENELEC committee member of TC9X-WG26 "Cybersecurity for Railway application."

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COMPATIBILITY

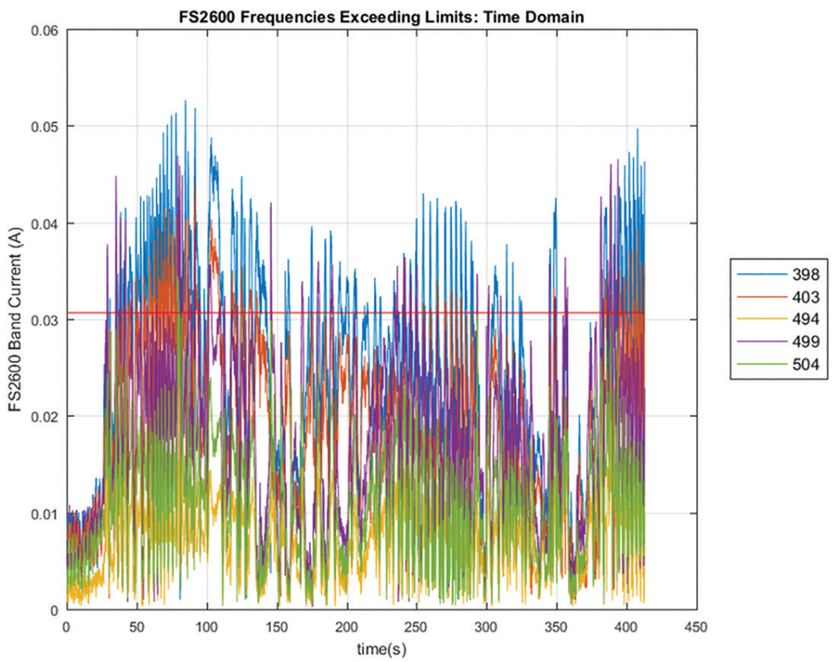
GAUGING ASSESSMENT & COMPATIBILITY

Gauging assessment is the exercise required to confirm that a train may operate over the railway without coming into physical contact with any part of the railway infrastructure, or with adjacent trains, when operating over the full range of speeds and loading conditions. Gauging assessments normally also consider platform stepping distances.

AEGIS can support gauging assessments for the following:

- Introduction of new rolling stock
- Transfer of existing stock to new routes
- Changes to existing rolling stock which may impact upon its dynamic behaviour (kinematic envelope) e.g. seating layout or other refurbishment
- Changes to the railway infrastructure

AEGIS has experience of carrying out gauging assessments for different vehicle types across a range of circumstances. With a broad knowledge of routes and vehicle types, we can propose the most practical strategy to demonstrate gauging compatibility. This could be by Absolute Gauging, Comparative Gauging or Hybrid Gauging (in which the two approaches are combined as appropriate).



ELECTROMAGNETIC COMPATIBILITY STUDIES

Electromagnetic Compatibility (EMC) describes the ability of electrical systems to operate without causing disturbance to or being disturbed by other systems. A failure of EMC can lead to system breakdowns, unreliability, and potential degradation of safety, affecting systems such as signalling, radio communications and rolling stock.

The electrically complex railway environment comprises various systems that have the ability to generate and/or be affected by electromagnetic disturbances.

The introduction or modification of any such systems on the railway will generally require an EMC study to ensure that reliability and safety are not compromised. AEGIS has:

- An industry leading EMC team with extensive knowledge and experience of the railway environment
- Experience of developing realistic and effective solutions for EMC problems
- Qualified Engineers with international experience
- Access to multidisciplinary teams with competence across the rail industry

We can provide the following EMC Services:

- EMC management plan preparation
- Derivation of EMC requirements
- EMC/Safety assurance strategies and plans
- Assessing system compatibility via analysis, calculation, modelling and testing
- Investigating system problems and the impact on railway and non-railway systems
- Assessing the impact of EMC requirements on equipment design and operation
- Specifying, managing and performing EMC testing and other validation activities
- Preparation of EMC documentation to satisfy regulatory requirements

VEHICLE PERFORMANCE ANALYSIS

Vehicle performance can be affected when changes are made to trains, the infrastructure or the way the trains are operated on the infrastructure. Examples are:

- Modifications to existing trains which may affect performance such as increased load capacity or re-configuration of a unit consist
- Introduction of trains to new routes
- Impact of change of line speed on station – station times
- Impact of line voltage changes on performance of electric stock

As well as understanding timetable impact, performance may need to be considered in terms of compatibility with signalling, particularly approach times/speeds to level crossings.

AEGIS can provide assessments of such factors and carry out bespoke calculations and analysis as necessary to support changes or inform feasibility decisions.

PHYSICAL COMPATIBILITY

AEGIS can provide services to demonstrate compatibility between infrastructure subsystems and rolling stock, for example hosting Compatibility review forums as required by RIS-8270-RST.

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RAMS

PRODUCT AND SYSTEM SAFETY CASES

AEGIS prepares and delivers complete product and system safety cases for new and refurbished transport systems and sub-systems, demonstrating risk is tolerable and ALARP.

Additionally, we are experts in gaining Safety Authorisation and Certification from the UK and European Regulatory Authorities.

SAFETY ENGINEERING ASSURANCE ASSESSMENT AND CERTIFICATION

We carry out safety engineering assurance assessment and certification of rolling stock and infrastructure, covering technical equipment plus operational and organisational aspects. This often involves creating or optimising safety processes and procedures, including development and implementation of risk mitigation and management strategies, to support our clients in controlling the risk to their operations.

SAFETY MANAGEMENT AND ENGINEERING SUPPORT

We provide safety management and engineering support throughout all phases of a project and safety life cycle, implementing industry standard safety principles (CSM, EN5012X / EN61508).

We apply an appropriate range of tools and methods for demonstrating Tolerable and ALARP risk on each project, including:

- Hazard Identification (HAZID)
- Hazard and Operability (HAZOP)
- Qualitative and Quantitative Risk Analysis (QRA)
- Interface Hazard Analysis (IHA)
- Operation and Support Hazard Analysis (OSHA)
- Hazard Log/Record creation and management
- Fault/Event tree analysis (FTA/ETA)
- Deriving safety targets, including Safety Integrity Levels (SIL) and Tolerable Hazard Rates (THR) for safety-related functions
- Human Factors
- Functional failure analysis
- Failure modes, effects and criticality analysis (FMECA)

COMMON SAFETY METHOD ON RISK EVALUATION AND ASSESSMENT

The Common Safety Method on Risk Evaluation and Assessment (CSM-RA) is a European Commission Regulation ((EU) 402/2013 and (EU) 2015/1136).

The Regulation introduces a common, risk-based framework to harmonise the assessment and acceptance of change on Europe's railways.

The full application of the Common Safety Method is offered by AEGIS:

- Producing Preliminary System Definitions to inform the decision as to whether a change is significant or not and therefore if it is required to go through the full CSM-RA process
- Producing System Definitions for a change that is determined to be 'Significant' to define the change to the railway and the system boundary
- Produce Engineering Safety Management Plans
- Hazard identification
- Hazard log management and close-out including using quantitative and qualitative risk analysis and derivation of safety requirements.

SYSTEM DEFINITION

AEGIS can produce project specific preliminary System Definitions which allow a significance assessment and decision to be made. The preliminary System Definition is written to provide sufficient detail of the project and of the changes to be introduced, and from this AEGIS can go on to document the CSM Significance Decision in accordance with the CSM-RA.

For changes that are established to be Significant, a detailed System Definition can then be produced, with the structure and content typically containing the following information:

- Introduction
- System Objective
- System Functions and Elements
- System Boundary
- Physical and Functional Interfaces
- System Environment
- Safety Measures and Safety Requirements
- Assumptions

The System Definition provides technical descriptions, including the scope and boundary, interface details and any other relevant information to support subsequent safety engineering activities and form the basis for the hazard identification process.

After developing the System Definition(s), AEGIS will liaise as necessary with project stakeholders for the approval and agreement of the documents.

ENGINEERING SAFETY MANAGEMENT PLANS

The next stage AEGIS perform is the preparation of the project specific Engineering Safety Management Plan, which will define a series of detailed safety activities that will provide the demonstration of acceptable risk reduced SFAIRP for the project in accordance with the CSM-RA Regulation and BS EN 50126.

The structure and content of the Engineering Safety Management Plan will reflect that required by BS EN 50126 and will typically contain the following information:

- Introduction
- Project Scope and Definition
- Safety Management System and Policy
- Safety Management Organisation
- Safety Engineering Process, Lifecycle and Activities
- Safety Documentation
- Safety Programme

Again, AEGIS will drive the process of gaining approval and agreement of the Engineering Safety Management Plan(s) from the project stakeholders.

HAZARD MANAGEMENT AND RISK ASSESSMENT

AEGIS have years of experience in performing Hazard Management and Risk Assessment in accordance with the CSM-RA, which will include the following activities:

- Preparation of a HAZID Briefing Note and facilitation of the Hazard Identification workshops (HAZIDs)
- Hazard Analysis and Risk Assessment – including the application of the CSM Risk Acceptance Principles
- Hazard Record and ongoing Hazard Management including identification of safety requirements and Safety Related Application Conditions.

AEGIS will then manage the process of obtaining the acceptance of the Hazard Record and Safety Requirements Specification from the approval bodies, including the Assessment Body.

RAM MANAGEMENT AND ENGINEERING

AEGIS has developed proven methodologies for the investigation of equipment and system reliability. We offer:

- Reliability Studies (MTBF predictions according to the desired standard e.g. Mil HDBK 217 F2) Parts count and parts stress analysis
- Availability Studies
- RAM Oriented Analyses:
  - Failure modes, effects and criticality analysis
  - Fault tree analysis (FTA)
  - Reliability block diagrams (RBD)
  - Common cause failure analysis
  - Markov Analysis
- Corrective Maintenance Analysis
- Preventive Maintenance Analysis
- Preventive Maintenance Interval reschedule analysis
- Maintenance task analysis
- Maintainability demonstration testing
- Reliability demonstration testing
- Reliability growth modelling
- Life Cycle Cost (LCC)

TRAINING

AEGIS can deliver customised training courses to meet customer specific needs. Below are some of the most recent training courses we have delivered:

- Common Safety Method (CSM-RA) Awareness
- RAMS Standardisation: CENELEC EN 50126, EN 50128 & EN 50129 series
- European Standards and legal Framework
- RAMS Techniques: FMECA and FTA Basic or Advanced
- European Standards: Safety Case structure and contents
- RAMS Tools (Reliability Workbench, BQR Suite)
- EMC Awareness
- ISO/IEC 17065 and ISO/IEC 17020 awareness
- Traction Systems
- Requirement Management
- OTM v Trains
- Introduction to Electrical Systems
- Introduction to Braking Systems
- Rail Plant Approvals
- Infrastructure Work Systems

INDEPENDENT SERVICES

AEGIS can deliver a combined role covering NoBo, DeBo, ISA and AsBo as required to support the efficient delivery of independent assurance requirements.

Benefits include simplification of interfaces and avoiding repetition / duplication of assessment.

NOTIFIED BODY AND DESIGNATED BODY

AEGIS is appointed by the DfT as a Notified Body (NoBo) and Designated Body (DeBo) against the rail interoperability Directive 2008/57/EC, and is able to undertake certification against all the structural and transverse Technical Specifications for Interoperability (TSIs), including:

- Rolling Stock (LOC & PAS)
- Control-Command and Signalling (CCS)
- Energy (ENE)
- Infrastructure (INF)
- Noise
- Persons with Reduced Mobility (PRM)
- Safety in Railway Tunnels (SRT).

As a Designated Body (DeBo) AEGIS will assess conformity against the Notified National Technical Rules (NNTRs). The majority of railway projects that require a demonstration of compliance with TSI will also require NNTR compliance.

We offer certification of new and modified vehicles and infrastructure, including interoperability constituents. Our team has considerable experience of different project types and in addition to the conformity assessment itself we can:

- Support the selection of applicable standards
- Support the selection of conformity assessment modules
- Construct the authorisation Technical File (this is the file submitted to the Office of Road and Rail for the sub-system to be authorised into service, it is in addition to the NoBo/DeBo technical file)

ASSESSMENT BODY

An Independent Assessment Body (AsBo) has become an industry requirement since the introduction of EU Regulation 402/2013, which was introduced to standardise the quality of risk assessments produced by railway companies when making changes to the mainline railway that could have a potential impact on operational safety.

Where a change is deemed "significant", it is a legislative requirement that a Risk Management Process (RMP) compliant with CSM-RA Regulation is implemented. As part of the CSM-RA, an independent Assessment Body (AsBo) must check that the RMP and its results comply with the Regulation.

CSM-RA is noted within the industry as a best practice risk management process. Increasingly, those projects deemed "not significant" or not falling within the formal scope of CSM-RA are choosing the adopt CSM-RA and selectively appointing an AsBo to verify the implementation of the process.

The change can be to any railway technical system such as; Rolling Stock, Signalling (Control and Command), Energy, Infrastructure as well as operational and organisational changes.

INDEPENDENT SAFETY ASSESSMENT

Independent safety assessment (ISA) is the formation of a judgement, separate and independent from any system design, development or operational personnel, that the safety requirements for the system are appropriate and adequate for the planned application and that the system satisfies those safety requirements.

In carrying out independent safety assessment, the AEGIS Independent Safety Assessment team will:

- Define the scope and context of the assessment
- Select and plan a cost-effective assessment strategy combining audit, desktop assessments, site visits and additional analyses
- Gather all relevant evidence of safety
- Provide a judgement
- Support the project through phased approval stages

An ISA is often mandated for major safety critical railway projects and for many it provides confidence that safety claims are justified and that any weaknesses that are identified have been mitigated appropriately.

Reasons for engaging an ISA include:

- To demonstrate compliance with the CENELEC EN50126, 8 or 9 or ISO IEC61508 standards
- An Infrastructure Manager or ROSCO can be assured that a contractor's product is safe

- To demonstrate to a regulator or customer that the product is safe

We have been providing ISA services to the rail industry for over 20 years, and our assessors:

- Have a detailed understanding and experience of preparing safety justifications from the client perspective
- Will work with the client to ensure the ultimate shared goal of a safe railway, whilst respecting the independence requirements of their accreditation

INDEPENDENT COMPETENT PERSON

Under the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), non-mainline transport operators need procedures to cover safety verification of new or altered rolling stock or infrastructure.

Within the safety verification process, we have experience of acting as the Independent Competent Person (ICP) to assess the compliance of engineering changes made to railway systems.

The AEGIS ICP can:

- Support the duty holder in identifying applicable industry and European standards against which to assess the engineering change
- Undertake conformance assessment of the engineering change
- Issue an ICP certificate or letter of attestation stating compliance with the agreed standards
- Attend approval/safety committees to provide an independent expert opinion on engineering conformance

LEVEL CROSSING RISK ASSESSMENTS

AEGIS has a dedicated team of engineers skilled at producing suitable and sufficient level crossing risk assessments as mandated by Network Rail and the ORR. We have an in-depth understanding of level crossing types, their operation and use, and the associated hazards and risks.

The service we offer includes a survey and a systematic review of the crossing, including the use of data output from the ALCRM risk model. We also provide the traffic census data as necessary. We have established an efficient project methodology which includes a stakeholder workshop in which data is reviewed and options are considered.

To date, we have provided suitable and sufficient risk assessments for more than 125 crossings, and our reports have received praise from clients and the ORR.

VERIFICATION OF ENGINEERING CHANGE TO RAIL VEHICLES

Our BS EN ISO/IEC 17065:2012 accreditation covers undertaking independent verification activities of engineering change to rail vehicles under RIS-2700-RST (Rail Industry Standard for Verification of Conformity of Engineering Change to Rail Vehicles). This procedure replaces the superseded Vehicle Acceptance Body (VAB) role and involves the verification of the design and construction (including maintenance arrangements) of a change against requirements within Railway Group Standards, resulting in a formal Attestation Statement.

Where clients wish to make changes to existing rail vehicles AEGIS can apply the RIS-2700-RST conformity assessment process to assure stakeholders of the compliance of that change to applicable Railway Group Standards.

WHAT DOES AEGIS DO WELL?

Here is what our customers have to say.

Has a wide range of skills and experience on hand

Subject matter experts who can be left to work under their own initiative

Excellent quality of work, and good at explaining different approaches to tasks

Responsive to enquiries and supportive of new ideas

I have a great deal of respect for AEGIS

Working with customers in a friendly and helpful manner to achieve the desired sign off date

Consistent on time delivery

Capable team of people

A WIDE CUSTOMER BASE

Balfour Beatty Rail

ALSTOM

SIEMENS

NetworkRail

angel Trains

RHOMBERG SERSA RAIL GROUP

HITACHI Inspire the Next

S&C North Alliance TRANSFORMING TRACKWORKS

CAF

BOMBARDIER

STADLER

FITZGERALD PLANT SERVICES LTD

THE POSITIVE CHOICE

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