Forth Road Bridge

Suspended Span Gantry Access ImprovementsHanger Replacement with main cable temporary access

Design Approval In Principle

Replacement of Elevating Working Platforms

Rev	Status	Date	By	Check	Approve
0	Draft	12/0314/06/2010	FD	CT	
1	Draft	07/04/2010	FD	RMC	
2	Draft	15/04/2010	GN/FD	CT	

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	Name of Project	Forth Road Bridge Suspended Span Gantry Access Improvements Replacement of the elevating working platforms
	Name of Bridge or Structure	Forth Road Bridge
	Structure Ref. No.	N/A
1.0	**HIGHWAY DETAILS**	
1.1	***Type of Highway***	Dual two lane All Purpose
1.2	***Permitted traffic speed***	50mph
2.0	**SITE DETAILS**	
2.1	***Obstacle crossed***	Firth of Forth
3.0	**PROPOSED STRUCTURE**	
3.1	***Purpose***	The replacement of the elevating working platforms on the under deck access Ggantries, located on the suspended spans of The Forth Road Bridge is necessary as the platforms have come to the end of their safe useable life and need to be replaced to ensure safety standards are met for all users of the gantry.The existing hanger ropes transfer the load from the bridge deck to the main cable are at risk of individual failure due to cars hitting them. In order to mitigate against a failure it is necessary that a system is in place to replace individual cables.
3.2	***Description***	The temporary platforms will consist of two proprietary "STF" (Steel Truss Frame) type suspended personnel access platforms suspended from purpose made saddles mounted on the main suspension cable. The system will consist of two platforms; one platform on each side of the main cable. The platform above the footway/cycle track will be able to descend to

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		deck level using proprietary winches and safety devises and this will form the primary access route. Provision for containment netting and sheeting of the Temporary Suspended Platform (TSP) will be incorporated.
3.3	***Structure Type***	All permanent and temporary works, including all associated works, to: 1. Remove the existing (4 No.) elevating work platforms from the suspended span access gantries of the Forth Road Bridge, 2. Provision, installation, testing and commissioning of new (4 No.) elevating work platforms to be mounted on the suspended span access gantries of the Forth Road Bridge. Platforms will consist of :- • STF type proprietary access platforms which are steel trussed structures. (see drawing ALPSFRB-GA20) • Purpose made saddles. (see drawing ALPSFRB-GA21)The gantries to which the new elevating work platforms will be fixed are existing structures – while the new elevating work platform replace existing units, the loadings which the new equipment will transmit to the gantry may be different to the loadings imposed by the original equipment. An assessment of the effect of the loadings arising from the new elevating work platforms and acting on the existing gantry structure shall be undertaken. This assessment shall also review/determine the loads which are transmitted between the gantry and the bridge structure, via the gantry runway beams.
3.4	***Structure Arrangement***	**Vertical loads** Vertical loads from the access platform self weight and live load will be transmitted from the platform vertical hauling system up to purpose designed anchor points on the suspension cable mounted saddles. The saddles will transfer this vertical load to the 600mm diameter suspension cables via a radiused saddle fabrication. When one platform is lowered, tension will always be kept on the ropes up to the saddles, by not fully

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landing the lowered platform on to the deck. A system of restraints will prevent rotation of the saddles due to unequal loading of the platforms while working.

Restraint loads along the cable

The inclination of the restraint load is approximately 19.5°. The longitudinal forces will be resisted by the clamping action of the purpose made saddles. Note: rubber protection will be in place between the clamp and the main cable.

Transverse loads

Transverse loads are generated by wind and notional live load inertia reactions. These loads may result in a tendency for the saddle to rotate. This rotation will be prevented by a system of restraints. The lateral loads applied to this support system are small because of the operational wind limits which apply to the platform. In storm conditions the platform is tied to the main cable with nylon webbing slings and these transmit the entire transverse load.
To compensate for transverse loads (with uneven loads on the saddle clamp) the TSP's safety wires will be attached to clamps placed around the top cord of the bridge and all slack taken out.

There are 4 different structures, with different organisations involved in the design or checking of each, to be referred to as follows:

Structure Ref	Description
A	Elevating work platforms
B	Adapter frame
C	Gantry structures
D	Bridge structure and runway beams

3.5 ***Materials and Finishes***

The platform structure will be steel. The platform floor will have a GRP nonslip surface to provide safe access. All tools, equipment and material on the platform will be attached to a suitable point at all times to prevent them from falling. In addition, debris netting and containment will be provided. Support and restraint point contacts on the main cable will be suitably protected using neoprene sheet. (Rubber lined clamp) see drawing GA21.

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3.6 3.7	***Risks and Hazards Considered***	See attached risk assessment and failure mode analysis

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	List of Key Stakeholders	
	Client Contact: Chris Tracey Forth Road Bridge Forth Estuary Transport Authority Administration Block South Queensferry West Lothian EH30 9SF **CDM Co-ordinator** Contact: Mr J McDaid Charles Scott and Partner 9 Park Quadrant Glasgow G3 6BS Tel: 0141 331 2454 **Design Checker** Charles Scott and Partners Mr G Neilson 9 Park Quadrant Glasgow G3 6BS Tel: 0141 280 3333 **Contractors Design Checker** Fairhurst W A Fairhurst & Partners 225 Bath Street, Glasgow G2 4GZ	**Designer** FABER MAUNSELL AECOM 5th Floor 2 City Walk LEEDS LS11 9AR **Contractor** Contact: Mr K Perryman Maintenance Department Forth Estuary Transport Authority Administration Block South Queensferry West Lothian EH30 9SF Tel: 0845 120 7090 **Subcontractor:** ALPS PO Box 896 Tel: 0114 236 2360 Sheffield S17 4YN **Contractors Designer** T.B.C. In the case of structure A, the design is covered by BS EN 280. Structure B refers to the frame to connect the elevating work platform to the gantry. Although it becomes part of the gantry structure it is referred to separately as it is a new design. Structure C refers to the gantry which is an existing design – no new design is involved, but a design check is required. Structure D refers to the bridge and runway beams which are existing designs – no new design is involved, but a design check is required.
3.8	***Risks and hazards considered*** ***Structure Type***	Each Elevating Work Platform will consist of a work platform, an extending structure and an adapter frame which connects the extending structure to the gantry structure.

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		The elevating work platforms shall comply with BS EN 280, which is a harmonized standard, ensuring compliance with the Machinery Directive, which has been transposed into UK legislation as The Supply Of Machinery (Safety) Regulations 2008. The adapter frame is a new structure to be designed by the Contractor although it effectively becomes part of the gantry. It is designed to similar criteria to the gantry, as indicated below. **Contractor shall attach and make reference to data sheets.**
3.9	***DESIGN CRITERIA*** ***Risks and hazards considered***	See Contractor's risk assessment and Elevating Work Platform supplier's risk assessment. Refer also to section 4 of B S EN 280. Refer also to the general risk assessment in Gantry Operating Manual (Vol 1 ed 2 1999). Refer to Appendix E for Safety Consultation Group information on safe operation of the gantries. ****Major risks shall be identified /confirmed by the Contractor and an appropriately detailed designer's risk assessment attached.**
4.0	LOADING**DESIGN CRITERIA**	
4.1	***Dead Loading****Loading*	Refer to Appendix C for gantry loading. The loading criteria for the elevating work platforms are specified in BS EN 280 and as indicated below.
4.2	Live LoadingDead Loading	Dead load comprises the weights of all the temporary structure, flooring, handrails, sheeting etc. The total dead is ~1116Kg Using 4 x 1000Kg hoists the dead load + live load imposed on the main cable will not be greater than this load.Ref BS EN 280

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		See Appendix C gantry dead loading
4.3	Wind LoadLive Loading	The platforms maximum WLL is 884Kg UDL. Consideration will be given to unsymmetrical or localised loading. Only the required loading for the application will be used for the SWL of the platform. See load list with weights attached GRP floor has been proof tested. See attachedRef BS EN 280 See Appendix C gantry live loading
4.4	Snow & Ice LoadsWind Load	The platforms will be designed for wind load in accordance with BD37 using a 50 year return period. The design will consider wind loads when the containment netting is in place and if stowed. The operational wind speed for the platforms will be restricted to 14m/s. Forecasted weather conditions will be monitoredOut-of-service condition for elevating work platform and adapter frame: based on a wind speed of 50 m/s. See Appendix C for gantry wind loading.
	List of relevant documents from TASSnow & Ice Loads	Not considered. The platforms will be removed prior to any significant risk of snow and ice formation.Not considered – the gantry flooring is open mesh and as the gantries are located directly underneath the bridge carriageways, the risk of significant snow/ice loading is considered insignificant.
	List relevant Safety Consultation DocumentList of relevant documents from TAS	Refer to Appendix A.
	Proposed departures from Standards given in 4.2List relevant Safety Consultation Document	Safety Consultation Document – see Appendix E
	Proposed methods for dealing with aspects not covered by	The adapter frame shall be designed to BS 5400-3:2000 with partial load factor of 2 for gravity based loads and a partial load factor of 1.4 for wind.

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	Standards in 4.2Proposed departures from Standards given in 4.2	**To be confirmed (or expanded) by the Contractor
	STRUCTURAL ANALYSIS *Proposed methods for dealing with aspects not covered by Standards in 4.2*	**Details shall be provided by the Contractor, if required
	Methods of analysis proposed for structureSTRUCTURAL ANALYSIS	There are 4 different structures identified in section 3.1 above, the analyses of which are carried out by different organisations, which may use different techniques and software in the course of the analysis of each structure.
	Description and diagram of idealised structure to be used for analysisMethods of analysis proposed for structure	Refer to Appendix D **Details shall be confirmed (or expanded) by the Contractor
	Assumptions intended for calculation of structural element stiffnessDescription and diagram of idealised structure to be used for analysis	Refer to Appendix D **to be confirmed (or expanded) by the Contractor
	CHECKING *Assumptions intended for calculation of structural element stiffness*	Refer to Appendix D **Details shall be confirmed (or expanded) by the Contractor
	Design Check *Proposed Category*	4 separate structures are identified in section 3.1, referenced as A, B, C and D

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	Proposed Independent checker				
	CHECKING				
	Check on Contractor Designers Design	**Structure 1**	**Structure 3**	**Structure 3**	**Structure 3**
			Eadon	GN3D	Forth
	Erection Proposals or Temporary Works	**Structure**	**Structure**	**Structure**	**Structure**
	Reasons for recommending an independent check	DB2/05 cl 3.4.4 prescribes Category 3 checks for bridge access gantries. In the case on Structure Ref A, the elevating work platform, the design is carried out to BS EN 280, which is a harmonised standard and is considered to satisfy the essential health and safety requirements of the Machinery Directive. BS EN 280 specifies verification procedures which include a design check. The machinery shall bear CE marking and shall be accompanied by an EC declaration of conformity. This shall be provided by the supplier in lieu of a design certificate.			
	Pier Review of Process	This will be carried out before…… and will be completed by……			
	Construction Compliance CertificateErection Proposals or Temporary Works	This will be carried out before…… and will be completed by……			
	DRAWINGS AND DOCUMENTS DRAWINGS AND	This is to be issued following the agreement, understanding and signatures of the client certifier, CDM co-ordinator and designer.			

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	DOCUMENTS			
	Certificates Issued Description:	Signed By	Date	Overseeing Authority
	Erection Proposals or Temporary Works	Erection methods and temporary works which involve equipment or temporary structures to be fixed to the bridge structure shall be subject to a Category 3 check. The checker shall be Eadon Consulting Limited.		
	List of drawingsDRAWINGS AND DOCUMENTS			
	List of documents relating to inspection, maintenance and safe operationList of drawings	Refer Appendix B		
	List of documents	Safety Consultation Document		

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	~~*relating to inspection, maintenance and safe operation*~~	Refer to Appendix E Suspended Span Access Gantries Operating and Maintenance Manuals (2nd ed 1999) Elevating Work Platform Operating and Maintenance Manuals: Documents in course of preparation

	THE ABOVE IS SUBMITTED FOR ACCEPTANCE Signed: …… Name: Engineering Qualifications: Organisation: Date: ……
	THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW Signed: …… Name: Barry Colford Chief Engineer and Bridge Master Engineering Qualifications: B.Sc. (Hons) C. Eng., M.I.C.E TAA: Forth Estuary Transport Authority Date: ……

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Appendix A

Schedule of Design Documents Relating
to Highway Bridges and Structures relevant to the
Replacement of the Elevated Working PlatformsHanger Ropes

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1. Schedule of Design Documents Relating to Highway Bridges and Structures

British Standards

BS 5268; Part 2; (1996) Structural Use of Timber
BS 5268; Part 2; (1996) Structural Use of Timber
BS 5400 Steel concrete and composite bridges
Part 1; (1988) General Statement (see BD 15 (DMRB 1.3.2))
Part 2; (1978) Specification for loads (as implemented by BD 37 (DMRB 1.3))
Part 3; (2000) CP for design of steel bridges (see BD 13 (DMRB 1.3))
Part 10; (1980) CP for fatigue (see BD 9 (DMRB 1.3))
BS 8118; (1991) The structural use of aluminium
BS 5400 Steel concrete and composite bridges
Part 1; (1988) General Statement (see BD 15 (DMRB 1.3.2))
Part 2; (1978) Specification for loads (as implemented by BD 37 (DMRB 1.3))
Part 3; (2000) CP for design of steel bridges (see BD 13 (DMRB 1.3))
Part 10; (1980) CP for fatigue (see BD 9 (DMRB 1.3))
BS 8118; (1991) The structural use of aluminium

Miscellaneous
Traffic Management Act 2008

The Manual of Contract Documents for Highway Works (MCDHW)
Volume 1: Specification for Highway Works
Volume 2: Notes for Guidance on the Specification for Highway Works
The Manual of Contract Documents for Highway Works (MCDHW)
Volume 1: Specification for Highway Works
Volume 2: Notes for Guidance on the Specification for Highway Works

The Design Manual for Roads and Bridges (DMRB)

Bridges and Structures, Advice Notes (BA Series)
BA 9/81 The Use of BS 5400: Part 10: 1980. Code of Practice for Fatigue

Bridges and Structures, Standards (BD Series)
BD 2/05 Technical Approval of Highway Structures
BD 9/81 Implementation of BS 5400: Part 10: 1980. Code of Practice for Fatigue
BD 13/04 Design of Steel Bridges. Use of BS 5400-3: 2000
BD 15/92 General Principles for the Design and Construction of Bridges. Use of BS 5400: Part 1: 1988

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BD 35/05 Quality Assurance Scheme for Paints and Similar Protective Coatings

BD 37/01 Loads for Highway Bridges

Bridges and Structures, Advice Notes (BA Series)

BA 9/81 The Use of BS 5400: Part 10: 1980. Code of Practice for Fatigue

Bridges and Structures, Standards (BD Series)

BD 2/05 Technical Approval of Highway Structures

BD 9/81 Implementation of BS 5400: Part 10: 1980. Code of Practice for Fatigue

BD 13/04 Design of Steel Bridges. Use of BS 5400-3: 2000

BD 15/92 General Principles for the Design and Construction of Bridges. Use of BS 5400: Part 1: 1988

BD 37/01 Loads for Highway Bridges

2. Schedule of Documents Relating to Design of Temporary Works

British Standards

BS EN 39, (2001) - Loose Steel Tubes for Tube and Coupler Scaffolds – Technical Delivery Conditions

BS 1139, Part 1: Section 1.2 (1990) - Metal Scaffolding. Tubes. Specification for Aluminium Tube

BS 1139, Part 2: Section 2.1 (1991) - Metal Scaffolding. Couplers. Specification for Steel Couplers, Loose Spigots and Baseplates for use in Working Scaffolds

BS EN 74 Falsework Made of Steel Tubes

BS 1139 Part 2: Section 2.2 (1991) - Metal Scaffolding. Couplers. Specification for Steel and Aluminium Couplers, Fittings and Accessories for use in Tubular Scaffolding

BS 1139, Part 3 - Metal Scaffolding. Specification for Prefabricated Mobile Access and Working Towers

BS 1139, Part 4 (1982) - Metal Scaffolding. Specification for Prefabricated Steel Splitheads and Trestles

BS EN 12811-1 (2003) - Temporary Works Equipment, Scaffolds, Performance Requirements and General Design

BS 5974 (1990) - Code of Practice for Temporarily Installed Suspended Scaffolds and Access Equipment

BS 5975 (1996) - Code of Practice for Falsework

BS EN 12812 (2004) - Falsework, Performance Requirements and General Design

BS 7121 Part 1 (1989) - Code of Practice for the Safe use of Cranes

BS 6037 Part 1 (2003) - Code of practice for the planning, design, installation and use of permanently installed access equipment - Suspended access equipment

BS EN 1808 (1999) - Safety requirements on suspended access equipment - design calculations, stability criteria, construction – tests

BS5950 – Structural Use of Steelwork in Building***British Standards***

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BS EN 39, (2001) - Loose Steel Tubes for Tube and Coupler Scaffolds – Technical Delivery Conditions

BS 1139, Part 1: Section 1.2 (1990) - Metal Scaffolding. Tubes. Specification for Aluminium Tube

BS 1139, Part 2: Section 2.1 (1991) - Metal Scaffolding. Couplers. Specification for Steel Couplers, Loose Spigots and Baseplates for use in Working Scaffolds

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BS 5975 (1996) - Code of Practice for Falsework

BS EN 12812 (2004) – Falsework, Performance Requirements and General Design

BS 7121 Part 1 (1989) - Code of Practice for the Safe use of Cranes

BS 6037 Part 1 (2003) - Code of practice for the planning, design, installation and use of permanently installed access equipment - Suspended access equipment

BS EN 1808 (1999) - Safety requirements on suspended access equipment - design calculations, stability criteria, construction – tests

BS5950 – Structural Use of Steelwork in Building.

BS 7121 Part 1 (1989) - Code of Practice for the Safe use of Cranes

BS 7985:2002 Code of Practice for the use of rope access methods for industrial purposes

BS 6570 Code of practice for the selection, care and maintenance of steel wire ropes

Lifting Operations And Lifting Equipment Regulations (LOLER)

BS EN 280 (2001): Mobile elevating work platforms. Design calculations. Stability criteria. Construction. Safety. Examinations and tests

Miscellaneous

Code of Practice for the Safe Use of Lifting Equipment. Lifting Equipment Engineers Association

3. Other Standards

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SSPC: Society for Protective Coatings Guide 6 – Guide for Containing Debris Generated during Paint Removal Operations: Class 2P.

The operation and maintenance of bridge access gantries and runways, Second Edition (Draft), Institution of Structural Engineers

Miscellaneous

Code of Practice for the Safe Use of Lifting Equipment. Lifting Equipment Engineers Association

3. Other Standards

SSPC: Society for Protective Coatings Guide 6 – Guide for Containing Debris Generated during Paint Removal Operations: Class 2P.

The operation and maintenance of bridge access gantries and runways, Second Edition, October 2007, Institution of Structural Engineers

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Appendix B

List of Drawings

List of Drawings:

Drawing Number	Revision	Title
		GN3D Engineering Drawings
47484/W/924 1018_001	A-	NE Side Span PP 18 NE, 22,26,32,43 Stage 2 Hole Reaming Jig Typical cross section through main span gantry and bridge
1018_002	-	Replacement Elevating Work Platforms – Working Envelopes and Parking Envelopes
47484/W/925 1018_003	A-	Additional Works, Cabel Band Replacement NE Side Spam - PP 18 NE Stage 2 Main Span Gantry General Arrangement : sht 1
1018_004	-	Main Span Gantry General Arrangement : sht 2
47484/W/926 (i)	A	NE Side Spaj - PP 22NE Stage 2 Sheet 1
		Charles Scott and Platforms
47484/W/926 (ii) 3116/13	A-	Additional Works "Details" Stage 2 NE Side Span PP 18NE, 22NE, 26NE, 32NE, 42NE Gantry Mk 'A' Basic Structural Layout
3116/14	-	Gantry Mk 'B' Basic Structural Layout
47484/W/927 3116/15	A A	Additional Works, Cabel Band Replacement NE Side Span - PP 26 NE Stage 2 Layout of Hydraulic & Air Pipework on Gantry
3116/102	-	Strengthening Works to Existing Gantries
47484/W/928	A	Additional Works NE Side Span - PP 32 NE Stage 2
		C Spencer Limited Drawings
47484/W/929	A	Additional Works NE Side Span - PP 42 NE Stage 2
		Gardner Denver Drawings
		Eadon Consulting Limited Drawings

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List to be expanded as project progresses and information becomes available.

Appendix C

Details of Design Loading

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C1.Design Loading for Gantry Structure and Suspension Trolleys

C1.1.Design Criteria

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The design criteria adopted to be based on BS 2573, "Rules for the Design of Cranes". This is based on previous design reviews and is considered to be consistent with BS EN 1808, which is deemed to be the most relevant standard to suspended gantries.

BS 2573:Part 1:1983 Specification for Classification, Stress Calculations and Design Criteria for Structures

Class of Utilisation ————U6

State of Loading ————Q2

Duty Factor ————0.95

BS 2573:Part 2:1980 Specification for Classification, Stress Calculations and Design of Mechanisms

Class of Utilisation ————T6

State of Loading ————L3

Mechanism Duty Factor —0.7

C1.2.Load Cases

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For the purposes of the gantry structure and suspension trolleys, two load cases to be considered: In-service with wind and out of service wind. The loads acting to be based on:-

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- Dead loads, including the self weight of the gantry structure.
- Live loads, including the weight of personnel and equipment and also the overturning effect of the hydraulic work platforms when raised and extended.
- Wind loads, direct and indirect (i.e. overturning effects).
- Gravity load component, acting longitudinally, due to the gradient of the runway beams.
- Side load arising from variation in the distance between east and west runway beams, due to the effect of the suspension trolley springs.

The wind loads to be based on the following approximate equivalent wind speeds:-

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- In-service ————45 mph (20 m/s)
- Out of service ————112 mph (50m/s)

With design wind pressures as defined by BS 2573:Part1

C1.3.Dead Loads

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The dead load/self-weight components to be used in the design are indicated in the table below and they reflect the self-weight of the gantry as estimated during a previous design review as 23 tonne. This is slightly greater than the actual weight of the gantry, measured following completion of the modifications and strengthening in 1997 as 22 tonne, based on the weight of the original elevating work platforms.

The estimated weight of the original elevating work platform is : 1.75 tonne per unit.
The estimated weights of the new replacement elevating work platform, including adapter frame is : 1.2 tonne per unit.

Both these estimated weights to be confirmed by measurement.

For the purposes of design it is proposed that the previous dead load of 23 tonne be adopted until actual measured weights are confirmed. Provided there are no issues arising from the adoption of the previous dead load, then this value should remain for the purposes of design as it provides some margin for possible gantry refurbishment in the future.

The above gantry self weights exclude the weight of the drive/brake trolleys which are independently supported from the runway beam. The self-weight of each drive/brake trolley is approximately 0.6 tonne.

C1.4.Live Loads

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The 'normal operating' load of the gantry is based on 9 men at 90 kg and under normal use this load would be distributed over the gantry.

The 'safe working load' adopted in previous design review is based on 12 men at 90 kg. This has been the stated 'safe working load' of the gantry and the load used in load testing. Under normal circumstances the gantry loading shall not exceed the 'normal operating' load.

For the purposes of determining a reasonable 'worst case' design load for the suspension trolleys, an unfactored live load equivalent to 12 men at 90 kg shall be used, with 75% of this load taken to act acting on a single trolley.

In addition to the load due to personnel, the hydraulic work platforms cause moments to act on the gantry structure, which in turn result in vertical and horizontal load effects at the gantry's supports (i.e. trolleys).

For the purposes of obtaining a 'worst case' design, several different configurations of the elevating work platforms may have to be considered (see separate section).

A small transverse horizontal load component is also included, due to the behaviour of the gantry structure (see table below).

C1.5. Loads due to Elevating Work Platforms

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Design loads on which design of elevating work platforms is based, are prescribed in BS EN 280.

Unfactored load effects on the gantry are shown in the following table (Contractor to provide required information):

	Vertical load component	Horizontal load component (north/south)	Horizontal load component (east/west)	Torque about vertical axis	Moment in vertical plane (north/south)	Moment in vertical plane (north/south)
In-service (i)						
In-service (ii)						
In-service (iii)						
Out of service						

Horizontal load component to include effects of wind. In service wind loads for the elevating work platform in use shall comply with BS EN 280. Out of service wind load and gantry in-sevice wind loads at 35 mph and 45 mph for the elevating work platforms in the fully lowered, parked positions shall include the effects of weatherproof covers being fitted.

Above information to be provided by Contractor/Elevating Work Platform supplier

C1.6. Effect of Suspension Trolley Springs

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The suspension trolleys include hangers which act as pendulums, with a pivot top and bottom. These hanger arrangements include springs which are intended to limit the sideways movement of the gantry under a transverse wind. The transverse load component included in the design is equivalent to a 15 mm lateral deflection of each hanger with respect to the gantry, due to variations in the distance between the runway beams.

C2. Design Loading for Runway Beam and Bridge

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~~To be reviewed once loads on gantry established.~~

Appendix D

Details relating to Structural Analysis

This appendix provides details used in the analyses of the structures identified in the AIP, by the various parties involved.

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D1.Structural Analysis of Elevating Work Platforms

D1.1.Methods of Analysis

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Refer to B S EN 280 Cl. 5.2

D1.2.Description and Diagram of idealized structure used for analysis

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Information to be provided by Contractor / elevating work platform supplier

D2.Structural Analysis of Adapter Frame

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D2.1.Methods of Analysis

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D2.2.Description and Diagram of idealized structure used for analysis

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Information to be provided by Contractor

D3.Structural Analysis of Gantry

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D3.1.Methods of Analysis

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The gantry design shall be verified using a combination of "manual" calculations, based on established methods and in combination with Finite Element Analysis (FEA).

The 3D modelling and analysis of the gantries and their mechanical and structural components shall be carried out using Pro/ENGINEER Wildfire (Version 4.0 or 5.0) and the associated Mechanica package, which is a linear elastic finite element analysis tool (Pro/ENGINEER Wildfire is a general purpose Computer Aided Engineering system and is produced by PTC, Parametric Technology Corporation, based in Needham, Massachusetts, USA).

The use of non linear techniques, including large deflection analysis is not considered relevant in the design of the gantries.

D3.2.Description and Diagram of idealized structure used for analysis

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The gantry structures shall be modelled principally using beam elements.

Fig D.x contains illustrations of typical idealised structural models of the gantry.

Fig D.x

In the case of truss structures, chords shall be treated as continuous and the joints between chords and web members shall generally be treated as pin jointed nodes, unless the particular truss configuration involves low slenderness members in which case rigid frame analysis shall be undertaken to assess moment affects at such joints. In general, joints shall be designed so that member centre lines intersect. However, where such alignment is not possible, account shall be taken of any joint eccentricities which may arise.

D4.Structural Analysis of Runway Beam and Bridge

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D4.1.Methods of Analysis

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D4.2.Description and Diagram of idealized structure used for analysis

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Information to be provided by checker

Appendix EC
TECHNICAL APPROVAL PROCEDURESafety Consultation Document

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ANNEX A6
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1. Introduction/Description of works

1.1. Purpose of Suspended Span Gantry Improvements Safety Consultation GroupMoveable Bridge/Bridge Access Gantry Design and Safety Consultation Group

The Works are located on the Forth Road Bridge which links Fife and the City of Edinburgh.

The Works involve all works associated with the replacement of the elevated work platforms located on the Forth Road Bridge suspended span access gantries. There are four elevated work platforms in total, two located on each of the two access gantries, which are used to facilitate inspection and light maintenance of the suspended span deck steelwork.

The existing hydraulically powered elevated work platforms are proprietary units originally manufactured by Simon-Gala Limited, based on their RZB 15 'Topper' Model for trailers, modified to allow them to be mounted to the access gantry steelwork. These platforms have reached the end of their service life and need to be replaced.

The access gantries which accommodate the elevated work platforms are suspended below the deck truss and can be propelled longitudinally along the main span and side spans of the bridge. When the desired work location is reached and the gantries are stationary, the elevated work platforms can then be used to inspect or work on the steelwork in the locality of that particular area. When not in operation, the elevated work platforms are stowed at a low level on the gantries so they do not collide with the bridge deck steelwork when the access gantries are in motion.

It should be noted that one of the access gantries is permanently located below the main span and the other is currently located below the north side span.

The new elevated work platforms must have, as a minimum requirement, the same movement envelope as the existing platforms without compromising the structural integrity of both the access gantries and the bridge superstructure. As with the existing platforms, the new system should be able to be stowed at a low level to avoid collision with bridge deck steelwork when the access gantries are in motion.

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During the Works the Forth Road Bridge will remain open to vehicular and pedestrian traffic with only agreed closures within the constraints set out in the

Contract Documentation being permitted. Temporary Works and careful programming and planning will be required to provide protection for both bridge and river users to ensure the successful completion of the Works.The purpose of the suspended Span Gantry Improvements Safety Consultation Group is to identify the design safety requirements of the New Elevating Work Platforms is to identify the design safety requirements of the New Elevating Work Platforms and their operating and Management Requirements.

1.2. Terms of Reference

The Forth Estuary Transport AuthorityRoad Bridge as Employer has appointed C Spencer Limited as Principal Contractor, GN3D Engineering as Designer and Charles Scott & Partners as CDM Co-ordinator.

See contract

1.3. Systems overview (See Appendices)

Each gantry has a simple manual based control system. The gantry travel feature is powered from the bridge compressed air main; the compressed air drives a hydraulic pump which supplied hydraulically operated wire rope hoist mechanisms. The hoist mechanisms pull the gantry along fixed wire ropes. Control of the travel function is by simple manual hydraulic valve levers.

The elevating work platforms are powered by an electrical power supply, which shall take the form of a trailer mounted generator positioned on the cycleway/footpath, adjacent to the gantry's location . There are currently no system interlocks between the gantry travel function and the operation of the elevating work platforms. Provision is included in the elevating work platforms for a switch on each unit to provide an electrical signal indicating that the elevating work platform is parked in the fully lowered position. This is intended to provide an interlock as part of any future refurbishment of the gantry travel system.

The safe operation is achieved by using only approved gantry drivers who have received appropriate training and demonstrated competence in the use of the gantries

1.4. Safety considerations in the use of moveable bridges/access gantries

On commencement of the contract gantries will be handed over to the contractor at an agreed location in the fixed position. The contractor will then appoint a gantry manager. **The operation of gantries must be in full compliance with Forth Road Bridge (FRB) manual guidelines.**
As the gantry is in a fixed position, iIf the gantry requires moving during the contract the gantry manager must inform the FRB and FRB operatives will move the gantry. During any moves Alall management responsibilities will revert to the FRB.

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Each operative going onto the gantry must wear a safety harness, a safety helmet, appropriate protective and easily visible clothing, and industrial footwear. Also the wind speeds must be checked. If above 50mph the gantry must be vacated. The FETA safety boat must also be on station as the work is carried out over water. The gantry must not be used in wind speeds exceeding 35mph basic with gusts up to 40mph. At these wind speeds the gantry must be parked and the scaffold towers tied to the bridge. The replacement elevating working platforms must not be used in wind speeds exceeding 28 mph (12.5 m/s).

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Measures to be taken to Protect Members of the Public

All areas below gantries either on land or above the river will be kept clear during critical operations.

1.5.Plant

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All contractor plant, machinery and equipment being used must be maintained in a safe, secure and efficient condition. All dangerous parts of machinery must be guarded and the guards kept in place.

All ladders in use must be safe and secure and tied. Scaffolding must only be erected, altered or dismantled by a competent person and a record kept of all mandatory checks.

Particular care should be taken when using electrical, pneumatic or hydraulic equipment. Electrical equipment should be 110v CTE using a step down transformer at source.

240v equipment may only be used with the express permission of the Chief Engineer of the Forth Road Bridge or his nominee.

All mobile work equipment, used on the Project, which is assessed as being at risk from rolling over, shall have suitable protection measures fitted, for example a structure frame or cab, which, in the event of rollover will prevent the work equipment from crushing the operator or people being carried.

All equipment must be suitable for the purpose of the work. All power tools, plant and equipment must be switched off when not in use and removed to a safe place to avoid being tampered with.

1.6.Communications

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A minimum of two operatives on the gantry (the driver and one other) must carry a radio headset secured to their clothing using a belt attachment and lapel clip. Contact must be made to control or the supervisor every 30 minutes. It is the responsibility of the controller or supervising engineer to notify by radio to the operatives if the wind gust speed reaches 30mph and above. If wind speeds exceed 50mph the gantry will be immediately be vacated.

1.7.Power Supply

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1.7.1.Emergency supply arrangements

The following services are installed on the Bridge and will be made available to the Contractor where practical, though not for his exclusive use, during the period of the contract. Details of the charges and conditions which shall apply to the use of the supplies can be obtained from the Forth Estuary Transport Authority.

Where an existing service is utilised for the Works, the Contractor shall be responsible for the supply, connection, maintenance and use of all connection, power lines, flexible hoses and any other items installed by the Contractor for the purposes of the Works.

The supply of any of the following services cannot be guaranteed and in the event of a loss of the service for whatever reason, the Contractor will be required to make alternative arrangements at his own expense for the duration which the service is not available.

Electricity
A 100 amp fused terminal for a 415 Volt 3 phase power supply is available to the Contractor at the electrical switch gear cabinets located on the side span face of each tower leg, externally at road level. This connection may be used for lighting and small tools only.

Air
A compressed air ring main supply is located at deck level between the carriageway and the footway/cycle path. Air is delivered at approximately 100 psi through a 2 inch instantaneous connection from the ring main installation.

Water
A ring main is located at deck level between the carriageway and the footway/cycle path. The main provides a 1 inch instantaneous connection with the water pressure at the pump house, located below the approach viaduct being approximately 75 psi. The water supply is turned off and drained in winter for a period of approximately four months (November to March) depending on temperature.

1.8.Emergency breakdown arrangements/procedures

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Rescue procedures will be in place by the FRB by having a rescue team on site prior to the contract starting. As gantries will be in a fixed position, all access/egress is available from the bottom chord. All personnel on site must wear a suitable safety harness and have been trained in how to use it. They must also be familiar with the rescue plan. On the Forth Road Bridge the footpaths each side of the bridge can cater for vehicles apart from fire engines. A first aider if not already on the gantry will be called immediately to attend the incident. This first aider must be experienced at heights and be able to use a harness in line with the relevant training. All personnel are then expected to vacate the gantry in a safe way..

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1.9.Organisational responsibilities, e.g. Maintaining Authority

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The key responsibilities the Forth Estuary Transport Authority (FETA) have under any of the projects undertaken by external companies are:

- Notify contractor of all risks
- Stop work is found not obeying health and safety rules
- Supervise the work
- Appoint a CDMC
- Check the design
- Provide areas for accommodation of site offices, canteens, toilets etc.

2. MAINTAINING AUTHORITY

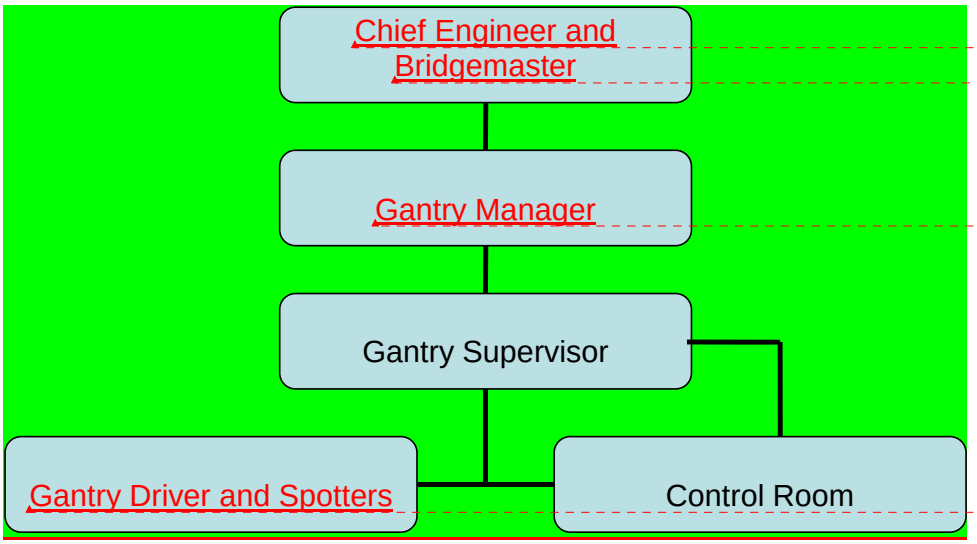
Introduction

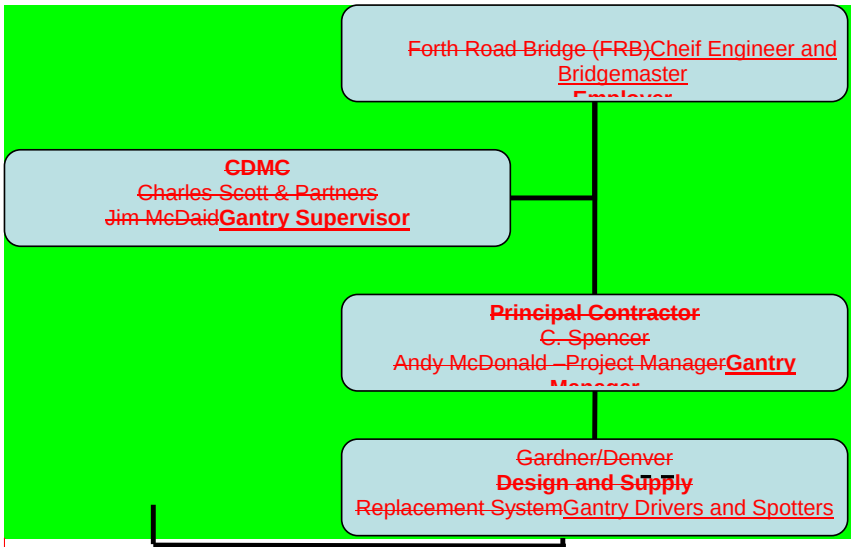
These following guidelines are not intended to be a comprehensive safety manual. They are a reminder to contractors of statutory requirements and safety procedures that must be complied with as part of their contractual responsibilities

Whilst the Forth Estuary Transport Authority (FETA)FRB has the responsibility for co-ordination of contractor's activities on site, this does not relieve the contractor of their own health and safety responsibilities towards their employees and others who may be affected by their acts or omissions.

The Forth Estuary Transport Authority Road Bridge expects all consultants/contractors co-operate in contributing to the efforts being made to ensure a safe and secure place of work.
As previously stated the Gantries will be managed and operated in compliance with the Forth Road Bridge Suspended Span Gantry operation and maintenance manual.

2.1.Lines of Communication





2.2.2.1. Documentation

2.2.1.2.1.1. Operator's Manual

The contractor must be in recognition and follow the guidance of the FRB operating manuals. The Operating Manual for the gantry shall be reviewed to include relevant information relating to the replacement elevating work platforms. Information relating to the original elevating work platforms shall be removed. In addition a general review of the gantry operating manual shall be undertaken to consider changes in legislation

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and best practice which may have become available since the previous manual review

2.2.2.2.1.2. Maintenance & Inspection manuals

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The contractor must be in recognition and follow the guidance of the FRB maintenance and inspection manuals. If during the contract the FRB wishes to inspect the gantry, the Project Manager Contractor wwill be informed by the FRB and he must allow access as soon as is practically possible.

The Maintenance Manual for the gantry shall be reviewed to include relevant information relating to the replacement elevating work platforms. Information relating to the original elevating work platforms shall be removed. In addition a general review of the gantry maintenance manual shall be undertaken to consider changes in legislation and best practice which may have become available since the previous manual review

The relevant documentation must be kept for all conditions monitoring on the bridge.

2.3.2.2. Day to day operations

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Induction

All contractors' employees shall undergo an induction before they are allowed to access the site.

Control of Access

All contractors must report to the Control Room Supervisor for authorisation prior to accessing any area of the bridge or grounds.

The Site

During works being carried out on the bridge or grounds tThe cContractor will have possession of the gantries in the fixed position. The Contractor will be responsible for managing the gantry including all security, access and health and safety on the site.
If at any point during the contract the gantries require to be moved, The contractor will make arrangements through the project manager or Project Supervisor.
During any moves all management responsibilities will revert to the FRB.

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2.4.Planned maintenance activities

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Other Contractors working on the Forth Road Bridge Construction Programmes are:

1. Works to erect a Dropped Object Canopy at the south main tower of the bridge are currently underway and are programmed to be completed by the end of May

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2. Works to install an under deck access to the expansion joints at the south main tower of the Bridge are due to commence from January 2010.

3. It is intended that works to remodel the car park area adjacent to the Forth Road Bridge Administration Office will commence in April 2010.

4. It is intended that works to replace the approach viaduct bearings will commence on the 1st June 2010.

General maintenance works on the Bridge will be ongoing during the period of the Works including painting of the main towers

2.5.2.3. Emergencies

An emergency on a gantry may take the form of an incident involving the gantry and/or personnel; a sudden illness amongst the personnel; a fire; an inability to move the gantry to an accessible egress point, either because of mechanical or electrical malfunction, or because of high winds.
FRB are providing Emergency rescue cover for the contract. The Contractor must contact FRB Gantry supervisor prior to accessing the gantry to ensure adequate rescue cover is available onsite.Refer to section 1.8.

2.6.Plant failures

Refer to previous section 1.8 for additional details which are similar. In order to prevent plant failures rigorous and regular inspections and testing must be carried out on a continual basis. At least one operative must be experienced in the functions of the mechanical and electrical systems of the gantry. A fitter/mechanical/electrical specialist who is experienced in the gantry on the bridge must be in the near vicinity should a piece of plant fail. The necessary inspections are:

- Plant failure emergency procedure test
- Electrical inspections in line with BS 7671
- Mechanical inspections
- Pre use inspections
- Weekly inspection
- Annual service/inspection
- Data log must be kept of all servicing and testing of plant

A plant failure will be treated as a very serious incident. It must be documented and made known to FRB as soon as possible. Every step will be taken to ensure a safe working environment for maintenance and construction staff on the bridge.

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3. TRAINING

As highlighted in Appendix D in The IStructE's "*The Operation and maintenance of bridge access gantries and runways*".
Professional and up to date training is essential to ensure operatives recognise the risks involved with erecting and dismantling gantries and their components. From Appendix D in The IStructE's "*The Operation and maintenance of bridge access gantries and runways*".

Operatives should be familiar with the following legal documentsTraining in the use of the elevating work platforms shall comply with the International Powered Access Federation requirements.:

- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER);
- Health and Safety at Work etc. Act 1974;
- Management of Health and Safety at Work Regulations 1999 (MHSW);
- Construction (Design and Management) Regulations 2007 (CDM);
- Work at Height Regulations 2005 (WAHR) and guidance;
- The Work at Height Regulations 2005;
- Personal Protective Equipment at Work Regulations 1992 (PPE); and
- The Supply of Machinery (Safety) Regulations 1992

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It is important to keep a record of all employees training records and certificates for future reference.

4. MAINTENANCE COSTS

Any costs of maintaining the gantry during the contract must be covered under the contract.

5. PROCEDURE TRIALS AND HANDOVER

5.1. Normal Use

Formal handover and return procedures should take place supported by inspections, defect schedules and relevant records. All parties should be satisfied that the work had been undertaken and finalised in a safe manner.

5.2. Emergency drill

An emergency drill shall be exercised at least once while on site at the early stages of the work. It is the contractors responsibility that emergency response procedures are planned and practiced at regular intervals.

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6. SIGNATURES

The provision and procedures described in this document, draft No (numbers) dated (date) were accepted by the working party (on date)

Signed _____

Chief Engineer and Bridgemaster of the Forth Road Bridge

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Name Barry R. Colford

Engineering Qualifications B.Sc. (Hons) C. Eng., M.I.C.E

Date _____

Signed _____
Designer (GND3 Engineering)

Name Gordon Neilson

Engineering Qualifications B.Sc (Hons) C.Eng., FIMechE

Date _____

Signed _____
Project Manager of the Contractor (C. Spencer Ltd)

Name Andy MacDonald

Engineering Qualifications _____

Date _____

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