VOLUME 5 CONTRACT DOCUMENTS FOR SPECIALIST ACTIVITES

SECTION 7 MECHANICAL AND ELECTRICAL INSTALLATIONS IN ROAD TUNNELS, MOVABLE BRIDGES AND BRIDGE ACCESS GANTRIES

PART 3

SERIES NG7000

NOTES FOR GUIDANCE ON THE STANDARD PERFORMANCE SPECIFICATIONS

SUMMARY

This Section of Volume 5 of the Manual of Contrat Documents for Highway Works covers the procedural, contratual and technical requirements for the mechanical and electrical installations for road tunnels, moveable bridges and bridge access gantries. Part 3 covers Notes for Guidance on the Standard Performace Specifications

INSTRUCTIONS FOR USE

1. Insert Part 3 into Volume 5 Section 7.

2. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from the Stationery Office Ltd.

MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS

THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

Mechanical and electrical installations in road tunnels, movable bridges and bridge access gantries

Part 3: Notes for Guidance on the Standard Performance Specifications

REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments

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PART 3

SERIES NG7000

NOTES FOR GUIDANCE ON THE STANDARD PERFORMANCE SPECIFICATIONS

Contents

Chapter

August 1997

1. GENERAL REQUIREMENTS

NG7000 INTRODUCTION

General

1 The 7000 Series clauses cater for the technical requirements for the mechanical, electrical and communications services associated with road tunnels, movable bridges and bridge access gantries.

NG7001 ABBREVIATIONS AND DEFINITIONS

Definitions

1 The terms used in the Standard Specifications may need to be supplemented or varied in the contract specific documentation depending on the type of Contract and the requirements of the particular project.

NG7003 EQUIPMENT, WORKMANSHIP, MATERIALS AND DESIGN

1 The details included in the technical clauses are intended to provide the basis for a high quality installation commensurate with good practice and to encourage the use of proprietary equipment to give the design life requirements and allow future maintenance.

2. MECHANICAL, ELECTRICAL AND COMMUNICATIONS WORK FOR ROAD TUNNELS

NG7100 INTRODUCTION

1 These notes for guidance convey as appropriate the reasoning behind the requirements in the specification where this is considered necessary or helpful. The information to be provided by Contractors in Tender documents is given in the form of sample appendices at the end of each section of the specification.

2 The clause numbers prefixed by the reference NG relate to the same clause numbers in the performance specification.

NG7101 HIGH VOLTAGE SWITCHGEAR

1 The most widely used construction for high voltage switchgear for tunnel applications is indoor cubicle type or indoor/outdoor metal clad ring main type served by underground cables. No other form of switchgear, eg outdoor type with bushings served by overhead power lines has been considered in the specifications. The HV network most generally encountered in the UK will be at 11kV and minimum requirements stated are based on this voltage.

2 The particular requirements for indoor cubicle type switchgear or indoor/outdoor metal clad type switchgear should be stated in Appendices 7101/2 and 7101/3.

Busbars and Connections

3 The rating and type of busbars should be stated in Appendix 7101/1.

Circuit Breakers

4 In view of the stringent fire regulations normally imposed on plant associated with tunnels the use of oil filled circuit breakers is not recommended.

Operating Mechanisms

5 The type of operating mechanism shall be stated in Appendix 7101/2.

Current Transformers

6 The type and class of current transformers for the respective applications shall be as stated in Appendix 7101/2.

Voltage Transformers

7 The type of voltage transformer shall be stated in Appendix 7101/2.

Protection, Relays and Instruments

8 The type of protection shall be stated in Appendix 7101/2.

Ring Main Switchgear

9 The type of ring main switchgear shall be stated in Appendix 7101/3.

NG7102 DISTRIBUTION TRANSFORMERS

Transformers

1 The choice of transformer type will depend on the electrical load, the location and requirements of local fire authorities. Oil filled transformer units may not be permitted in certain indoor situations and if permitted will require fire suppression equipment. Whenever oil or synthetic fluid transformers are used the appropriate catchment for the oil or synthetic fluid shall be provided.

Protection

2 The protection requirements shall be listed in the appendix 7102/1.

NG7103 LOW VOLTAGE SWITCHGEAR

General

1 The LV switchgear requirements for tunnels and movable bridges can be diverse. The performance and types of switchgear has therefore been limited to two types, cubicle and industrial and are required to be designed and constructed strictly to specified standards.

2 The particular requirements for LV switchgear should be stated in appendix A7103/2.

LV Cubicle Switchboards

3 Switchboards shall be designed and constructed to provide the form of separation and the type of protection indicated.

4 Switchboards should comply with the requirements of a Partially Type Tested Assembly or Type Tested Assembly.

5 Where a Partially Type Tested Assembly is offered, the tenderer shall clearly state which parts have been type tested, and which have been verified by extrapolation. The successful tenderer shall produce evidence which supports the method of extrapolation on which the offer is based.

6 The successful tenderer shall provide documentary evidence, in the form of test certificates, of type tests having been undertaken on assemblies similar to those offered.

Air Circuit Breakers

7 The short circuit certification shall supply when the circuit breaker is mounted in an enclosure representative of that provided by the switchboard, and with the terminal configuration used in the switchboard.

Fuse Switches and Switch Disconnectors

8 The short circuit certification shall apply when the switch or disconnector is mounted in an enclosure representative of that provided by the switchboard, with the terminal configuration used in the switchboard and with the maximum rating of short circuit protective device fitted in the switchboard.

Residual Current Devices (RCD's)

9 Where discrimination between RCD requires to be achieved, time delayed RCD's (type S) shall be utilised with the more usual non time delayed type G to afford discrimination.

Busbar Trunking

10 Busbar trunking systems shall be suitable for normal mechanical loads unless otherwise indicated, and they shall not be used to support other equipment unless specifically designed to do so and the equipment is part of that busbar system.

Tunnel Panels

11 Emergency communications and fire tunnel panels, shall be at 50 Metre intervals unless otherwise specified.

Motor Control Centres and Control Panels

12 Motor starters, control centres and control panels shall be designed and constructed to provide the form of separation and type of protection indicated.

13 The panels should comply with the requirements of a partially type tested assembly or type tested assembly.

14 Where a partially type tested assembly is offered the tenderer shall clearly state which parts have been tested and which have been verified by extrapolation.

15 The successful tenderer shall produce evidence which supports the method of extrapolation on which the offer is based.

16 The successful tenderer shall provide documentary evidence in the form of test certificates, of type tests having been undertaken on assemblies similar to those offered.

Cable Boxes

17 As power supplies to tunnels require high levels of security the provision of outdoor type transformers supplied at high voltage by overhead lines has not been considered.

NG 7104 HV AND LV CABLING AND DISTRIBUTION

General

1 The use of aluminium conductors in place of copper is not necessarily precluded particularly for high voltage types. Copper conductors are suggested to give smaller more manageable cables to the usually restricted confines of tunnels.

Low Voltage Cables

2 The type of cables stated are those suggested for use in the tunnel environment. Single core non-armoured or aluminium wire armoured cables may be required for heavy power loads such as the connections from the LV terminals of distribution transformers.

NG 7105 STANDBYGENERATORS

General

1 The specification clauses are based on diesel driven engine sets as the prime mover which is the predominant means used for standby generators.

2 Particular applications where other forms of prime mover are required should be subject to separate specification.

3 The particular requirements for standby generators should be stated in Appendices A7105/2.

Engine

4 Engine speeds for standby operation will normally be high speed, 1500rpm. medium or slow speed engines would only be considered where base Load or other similar applications are required.

5 The particular requirements for the engine should be stated in Appendix A7105/2.

Generator

6 The particular requirements for the generator should be stated in Appendix A7105/2.

Cooling System

7 Radiator cooled sets with the radiators mounted either or remotely from the unit or on the end of the plant main frame will be the most common requirement.

8 The particular cooling requirements should be stated in Appendix A7105/2.

Fuel System

9 Any special needs relating to the fuel storage and/ or transfer systems should be determined by consultation with the local fire authority.

Starting System

10 Electric starting has been considered as the normal means for standby sets. Air starting should be subject to a separate particular specification.

11 The type of battery should be stated in Appendix A7105/2.

Noise Emission

12 The noise emission criteria stated may be verified depending on the particular site.

Parallel Running

13 Engine governors on all sets must have similar response to both slow load variations and also transient load conditions to ensure proportionate kW load sharing. Preferably governors should be set up with maximum load/speed droop permitted by system frequency tolerances as an aid to improving load sharing.

14 AC generators on all sets should have suitable means for producing appreciable voltage droop resulting from lagging reactive currents. The degree of droop should be substantially the same for all machines relative to their individual ratings. This will ensure good reactive load sharing and prevent reactive circulating currents between machines.

15 If a neutral connection is required to supply single phase loads, the neutral of the largest of the parallel running machines should be used. Neutrals of the other generators should not be interconnected.

NG7106 UNINTERRUPTIBLE POWER SUPPLY EQUIPMENT

General

1 Where UPS using battery systems are specified, then ventilation in the battery room is also required, refer to Series 7110. Provision shall be made such that the ups equipment can be maintained without risk to personnel or the public.

2 Static type UPS systems are normally adequate for tunnel applications and requirements for rotary type UPS equipment has not been included.

Acoustic and Electronic Emission

3 Whilst maximum sound power levels are stated, these are still high and UPS equipment should not be located in office/control room areas, and sufficient insertion loss should exist between the UPS equipment and sensitive areas (ductwork and walls).

Rectifier and Battery Changer

4 To reduce electrical harmonics, circuits shall be arranged to present a balanced load.

Batteries

5 Safety notices, eye washing and hand washing/ sink facilities shall be provided in all battery/storage rooms. Flooring and all exposed metalwork shall be protected against acid fumes. Rooms shall be bunded and sumped to retain any spillage. Electrical installations shall normally be suitable to cater for the situation where an explosive gas-air mixture is present for short periods only Isolation facilities shall be provided for the battery supply.

Static Inverter

6 To reduce harmonics, circuits shall be arranged to present a balanced load.

NG7107 TUNNEL LIGHTING

General

1 The number of stages required and the lighting levels of these stages shall normally be based on an economic assessment of the particular installation taking into account the luminaire efficacy, capital, running and maintenance costs. This may comprise fluorescent, high pressure sodium, low pressure sodium lamps or a combination of these lighting sources. To keep costs to a minimum the use of luminaires with the highest lumen output at maximum permitted spacing would normally be used.

Performance Parameters

2 The final lighting design should be based on the data listed in Appendix 7107/1.

Tunnel Luminaires

3 Particular attention should be paid to the need for separation of dissimilar metals between the luminaire body and the support system. Aluminium alloy is the most popular material used by manufacturers of propriety luminaires which in contact with a steel support system has been a particular source of corrosion and a consequential maintenance problem.

4 Much research is being undertaken by manufacturers in this field with respect to durable finishes for alloys and means of support and this should be an important factor in specifications.

5 Attention should also be paid to the type of glazing. Some types of toughened glass have failed prematurely after installation and have been a continuing maintenance cost.

Control Gear

6 For fluorescent luminaires high frequency (HF) electronic type ballasts should be used for their efficiency and ease of maintenance features. Dimming of fluorescent luminaires as opposed to switching is unlikely to be economically viable and should only be used if it can be shown that the energy savings will be greater than the additional cost of the control gear, control system, cabling and maintenance.

Lamps

7 Fluorescent lamps for the staged boost lighting shall only be used if it is not possible to achieve the lighting levels specified by the use of discharge lamps.

8 The purpose of limiting the lamp operating hours is to extend maintenance periods and to ensure that the lower wattage discharge lamps used at night are not used during the day since they are less energy efficient.

9 Consideration should be given to the use of lamps designed on the induction lighting techniques which offer the potential of 60,000 hour replacement cycles. Twin arc high pressure sodium lamps should also be considered. due to the high cost of this type of lamp they should only be used on stages with annual burning hours in excess of 4,000 hours.

Lighting Control and Monitoring

10 Switchboards serving lighting stages are normally fitted with ammeters to indicate drawn load and hour run meters to establish usage and hence lamp change frequency.

11 Where applicable consideration should be given to emergency, counterflow situations and facilities shall be available to effect change of traffic pattern.

12 Where stages are permanently or extensively used ie stages 1 and 2 then consideration shall be given to rotate stages and hence provide even lamp usage. Changeover is normally effected on a timed basis, and the facility shall be incorporated in the control system where applicable.

NG7108 TUNNEL VENTILATION

General

1 Suitable access provisions shall be made in the form of fixed access ladders for isolation and maintenance of plant, greasing of bearings etc.

2 The number of additional jet fans required to compensate for any loss of fans in a fire situation will depend on the layout of the jet fans in the tunnel. If a number of fans are grouped closely together then it should be assumed that all of the fans in the group will be incapacitated in a fire situation. Grouping of jet fans is not recommended for this reason.

3 Only jet fans and axial fans have been considered in this section, since these are the types of fans most commonly used in tunnel ventilation applications.

Jet Fans

4 Jet fans shall be installed such that their removal for maintenance can be effected speedily ie all necessary lifting eyes are fitted.

NG7109 FIRE SAFETY ENGINEERING

Fire Alarms

1 For security of supply it is normal to install fire alarms in the form of a ring fed from two points.

Water Boosting Installations

2 Water boosting facilities are normally provided since it is a requirement of the Water Byelaws to provide a break cistern between the mains water supply and the fire fighting system pipework.

3 Carbon Dioxide Gas (Co_2) is no longer considered the preferred option for Gas Extinguishing systems.

Fire Hose Reels

4 Generally the fire services would provide their own hose reels to couple to the fire hydrants located in the fire point cabinets. If they are provided as part of the tunnel equipment they may present a maintenance problem. The requirement for hose reels should therefore be agreed with the fire authority.

NG7110 SERVICES BUILDINGS

General

1 The provision for tunnel plant and equipment and the extent of the associated mechanical and electrical services are subject to unique designs. The complexity of the services shall be such that the installation is fit for purpose.

Design Criteria

2 This section details ‘typical’ criteria for ‘generally used’ area types. For specific areas refer to the specification/codes of practice/British and/or European standards.

Lighting

3 Whilst colour rendering is important in the lighting/lamp selection, full consideration shall be given to luminaire efficiency and energy usage.

Emergency Lighting

4 Emergency lighting provisions shall be coordinated with all necessary local authorities/building inspectors.

General Power

5 General Power (with the exception of office) shall be complete with rugged fittings normally metal clad type.

Fire Alarm and Detection

6 Where fire alarm installation are required to be installed in flammable areas ie Battery Rooms it should be noted that the fire alarm system in this area should be to similar standard, ie zone 1/2 sounders/detectors/call points.

7 Fire alarm panels shall have the facility for manual override/zone installation hence allowing for maintenance works.

8 It is normal to include a first year maintenance period (including all consumable spares) as part of the contract sum.

Security System

9 Consideration should be given to the use of a single manufacturer for fire alarm/security systems hence reducing the need for separate maintenance visits.

Earthing and Bonding

10 Consideration should be given to the installation of 'test' earth pits and electrode to assist in future test procedures.

Pits

11 Where tape or rod is fitted where it is accessible by the public, anti-vandal covers shall be fitted.

12 Generally tape or rod is fitted with an LSF over sheath for extended life.

Heating

13 In view of the low levels of heating, and the intermittently occupied nature of many plant areas or switchrooms, background heating is normally provided by electric tubular types with integral thermostatic control.

Ventilation and Air Conditioning

14 Ventilation shall be primarily provided for personnel, as many areas are very infrequently manned, the installation should fully reflect that fact ie ventilation is not required for switchrooms that require habitation only for an hour or so, once a week.

15 Filtration shall be of a standard such that dust ingress to equipment is minimised.

16 Air conditioning shall only be fitted where necessary, primarily for removal of equipment heat gains. The use of humidification should be avoided wherever practicable. Where humidification is required it shall be of the direct steam injection type.

17 The choice of refrigerant gas shall take into account environmental effects. CFC's shall not be used.

Domestic Water Services

18 The quantity and layout of sanitary appliances requiring hot water may favour local electric water heaters rather than a centralised hot water system.

19 Where cold water storage is provided, the quantities of storage should be carefully assessed to avoid stagnation of stored water.

Drainage

20 The intermittent nature of usage of sanitary fittings may render permanent connection to the foul system uneconomic, this financial aspect shall be considered.

21 This appendix contains schedules of the main items of engineering services equipment that may be required in a tunnel services building. Where items are required which are not covered in the Appendices re, eg radiators, then similar schedules shall be produced.

NG7111 DRAINANG AND PUMPING

General

1 It is normal to use sumps which are capable of handling a 20 year maximum storm flow, with all pumps operating. All electrical supplies shall be fed from two sources of supply.

Pumps

2 The most widely used pump type are the submersible type, full provision should be made for maintenance access by the use of permanent hoisting features, manual or powered. This will involve lifting beams, and provision should be made for resting pumps on working platforms for maintenance. Local manual operation facilities shall be installed to allow maintenance staff to pump the sump dry prior to personnel access.

Pipework, Fittings & Valves for Pumping Stations

3 The most common valve type used is gate/parallel slide.

Electrical Services, Controls and Alarms

4 It is normal to house control panels and alarm equipment either in services buildings or otherwise in purpose made weatherproof enclosures.

Ventilation of Sumps

5 It is expected that fans used shall be external to the airstream and external to the sump or flameproof zone 1.

Level Regulators

6 Level regulators shall be suitable for zone 1 installations and be arranged to introduce switching differential for each pump. Hour run meters shall be provided. In addition to automatic changeover it shall be possible to manually rotate pump selection for even usage. A high level/flood alarm shall be provided.

Lighting in Sumps

7 The whole of the lighting/power installation shall be to zone 2 standards this includes the heavyweight galvanised conduit, boxes and light switches.

NG7112 COMMUNICATIONS

Standard Telephone Systems

Locations of Telephones and Equipment

1 The Designer shall specify in the project specific documentation the type, physical locations and the environment into which this equipment is to be installed.

Numbering

2 The Designer shall specify in the project specific documentation the numbering system for the telephones and associated equipment.

Associated Specifications

3 The Designer shall list any additional specification in the project specific documentation.

Emergency Telephones

Locations of Telephones

4 The Designer shall clearly show in the project specific documentation the physical location and spacings.

Telephone Responders for Interface Equipment

5 The Designer shall specify in the project specific documentation the type of telephone system. This shall be either NMCS2 or if for a non-motorway tunnel, it shall be an agreed alternative.

6 The Designer shall specify in the project specific documentation the numbers and locations of responders or interface equipment.

Configuration

7 The Designer shall specify in the project specific documentation cabling configuration in order to provide the agreed level of service security.

Housings and Enclosures

8 The Designer shall specify in the project specific documentation the type of telephone housing or enclosure and shall state if they are to be part of the emergency equipment cabinet or co-located in their own housing.

Performance

9 The Designer shall specify in the project specific documentation the type of telephone system required to meet the design criteria. This shall include noise cancelling method, transmission properties and the link to the tunnel control centre.

Numbering

10 The Designer shall specify in the project specific documentation numbering system for the telephones and associated equipment.

Signing

11 The Designer shall specify in the project specific documentation any specific telephone signing required to assist stranded motorists to locate an emergency telephone with the minimum effort or distress.

Associated Specifications

12 The Designer shall list any additional specification in the project specific documentation.

Smoke Control Telephones

Operation

13 The Designer shall specify in the project specific documentation how the system is to operate.

Locations of Telephones and Equipment

14 The Designer shall shown in the project specific documentation the type and physical locations of telephones and equipment. The environment into which this equipment is to be installed shall be specified in the project specific documentation.

Housings and enclosures

15 The Designer shall specify in the project specific documentation the type of telephone housing or enclosure.

Cabling

16 The Designer shall specify in the project specific documentation the cabling requirements.

Numbering

17 The Designer shall specify in the project specific documentation the numbering system for the telephones and associated equipment.

Signing

18 The Designer shall specify in the project specific documentation any specific telephone signing required.

Associated Specifications

19 The Designer shall list in the project specific documentation any additional specification.

Maintenance Telephone System

Operation

20 The Designer shall specify in the project specific documentation the operation of the maintenance telephones.

Locations of Telephones and Equipment

21 The physical location shall be determined by the Designer and clearly shown in the project specific documentation. The project specific documentation shall specify if telephones, jack sockets and Engineers portable handsets are required.

Housings and enclosures

22 The Designer shall specify in the project specific documentation the type of telephone housing or enclosure.

Performance

23 The Designer shall specify in the project specific documentation the type of telephone system required to meet the design criteria. This shall include noise cancelling method, transmission properties and the link to tunnel control centre.

Numbering

24 The Designer shall specify in the project specific documentation the numbering system for the telephones and associated equipment.

Signing

25 The Designer shall specify in the project specific documentation any specific telephone signing required.

Associated Specifications

26 The Designer shall list in the project specific documentation any additional specification in the project specific documentation.

Radio Rebroadcast Equipment

System Requirements

27 The Designer shall specify the equipment necessary for radio rebroadcast, in the tunnel and equipment rooms. This shall include the frequencies required to be rebroadcast.

Housings and Enclosures

28 Housings and enclosures for active equipment shall be specified in the project specific documentation and consideration given to the various access requirements of the various operating authorities.

System Performance

29 The Designer shall specify in the project specific documentation the radio coverage and performance levels of each individual system being provided.

30 The Designer shall specify in the project specific documentation any equipment being provided by others.

31 The project specific documentation must state whether or not public national or local radio is to be rebroadcast and shall specify what stations are to be included.

Associated Specifications

32 The Designer shall list any additional specification in the project specific documentation.

NG7113 CCTV

System Requirements

1 The Designer shall specify in the project specific documentation all the CCTV equipment and their locations uniquely numerically defined. The project specific documentation shall specify any existing equipment that the system shall interface to.

2 The designer shall state if an interface to the Tunnel Sub System is required and shall specify the preset slot selections.

System Performance

3 The Designer shall specify in the project specific documentation the timescales and quantity of the test results.

NG7114 TRAFFIC CONTROL

General

1 The designer shall specify in the project specific documentation the Traffic Control System.

Variable Message Signs

2 The Designer shall specify in the project specific documentation the type and locations of the VMS. The Designer shall specify in the project specific documentation the control system for the VMS and how flasher synchronisation is to be achieved. The Designer shall specify the materials to be used in and around the tunnel and what environmental conditions are expected to be found.

Lane Control Signals

3 The Designer shall state in the project specific documentation if lane control signals are required and specify the location and mounting arrangements. The Designer shall specify in the project specific documentation the method of achieving variation of the light output. The Designer shall specify in the project specific documentation the control system for the lane control signals and how flasher synchronisation is to be achieved. The Designer shall specify any special connection details in the project specific documentation. The Designer shall in the project specific documentation state how compatibility is to be demonstrated.

4 The Designer shall specify in the project specific documentation any special environmental requirements relating to all communications control equipment. The Designer shall specify in the project specific documentation the materials to be used.

NG7115 AUTOMATIC TRAFFIC MONITORING

General

1 The Designer shall specify in the project specific documentation the traffic monitoring systems.

Vehicle Detection Loops

2 The Designer shall specify in the project specific documentation the spacing and type of loops. The Designer shall state in the project specific documentation if a dedicated traffic counting loop site is required.

Above Ground Vehicle Detection Systems

3 The Designer shall state in the project specific documentation if applicable, the types and locations of above ground vehicle detection systems.

Vehicle Detection Algorithm

4 The Designer shall specify in the project specific documentation the vehicle detection algorithm.

Vehicle Counting

5 The Designer shall specify in the project specific documentation the equipment for vehicle counting.

Vehicle Measuring

6 The Designer shall specify in the project specific documentation the location and number of vehicle measuring sites.

Traffic Census Equipment

7 The Designer shall specify in the project specific documentation the location and number of traffic census sites.

Overheight Vehicle Detection

8 The Designer shall specify in the project specific documentation the criteria for overheight vehicle detection sites.

Toll Collection

9 The Designer shall specify in the project specific documentation, if applicable, toll collection facilities required.

NG7116 PLANT MONITORING AND CONTROL SYSTEM

1 The monitoring and Control Specification is based on a model of different layers of control. The most important aspect is the clear definition of the layers and the interface between the layers. Confusion as to which bit of equipment is responsible for what must be eliminated, resulting in a simplified system build, testing and integrations. Also future expansion and major system relocation can be implemented with the minimal effect on another part of the systems.

The layers and how they relate to this Specifications is:

Layer	Description	Specification chapter
0	The process environment.	All
1	The sensors and actuators that influence the outside world.	2 to 41
2	The safety layer.	42 to 60
3	The control layer - the first where software is acceptable.	61 to 141
4	The supervision layer.	142 to 270
5	The planning system.	n/a
6	Management information systems.	n/a
7	Group support decision systems.	n/a

2 An important factor in these levels of control, is that the control action takes place at the lowest level where all necessary information is available. This helps in specification writing and in its implementation, as functionality is clearly defined and loaded.

3 To write the contract specific documentation for a particular tunnel, write sections matching the sections detailed in this specification, and attach drawings and schedules as required. When a general requirement is not needed, state this in the particular specification. Maintaining the IEE s/w guidelines based format, and encourage the contractor to follow the IEE guidelines.

3. MECHANICAL, ELECTRICAL AND COMMUNICATIONS WORK FOR MOVABLE BRIDGE AND BRIDGE ACCESS GANTRIES

NG 7200 INTRODUCTION

1 These notes for guidance convey as appropriate the reasoning behind the requirements in the specification where this is considered necessary or helpful. The information to be provided by Contractors in Tender documents is given in the form of sample appendices.

2 The clause numbers prefixed by the reference NG relate to the same clause numbers in the performance specifications.

General

1 The use of petrol engines as a means of driving generators is considered too dangerous for this application.

Refer also to the Notes for Guidance under:

i) Series NG 7103 Low Voltage Switchgear

ii) Series NG 7104 Cables and Distribution

iii) Series NG 7105 Generators

NG7201 ELECTRICAL EQUIPMENT FOR MOVABLE BRIDGES

Bridge Control System

The extent and sophistication of the bridge control system depends on bridge size, importance and location. The performance requirements stated in the specification cover the maximum extent of controls expected to be encountered for hydraulically operated movable bridges.

Refer also to the Notes for Guidance under:-

Series 7101 High Voltage Switchgear

Series 7102 Distribution Transformers

Series 7103 Low Voltage Switchgear

Series 7104 HV & LV Cabling and Distribution

Series 7105 Standby Generators

Series 7106 Uninterruptible Power Supply Equipment

Series 7110 Services Building

NG7203 MECHANICAL EQUIPMENT FOR MOVABLE BRIDGES

General

1 Where practicable this contract shall ensure that unsafe areas are eliminated. However where this is not practicable permanent access from movable bridges etc. shall be provided.

2 Powered/mechanical bridges shall be arranged to fail safe and shall be suitably constructed or protected to serve the design life.

NG7204 MECHANICAL EQUIPMENT FOR BRIDGE ACCESS GANTRIES

General

1 Where practicable this contract shall ensure that unsafe areas are eliminated however where this is not achievable, permanent access from gantries etc. shall be provided.

2 Powered/mechanical gantries shall be arranged to fail safe and shall be suitably constructed or protected to serve the design life.

3 Reference should be made to the guide currently in the course of production entitled The Operation and Maintenance of Bridge Access Gantries and Runways by the Institution of Structural Engineers which concerns the operation, inspection, testing and maintenance of permanently installed bridge access gantries and their runways. It also describes the operation, inspection, testing and maintenance of bridge access systems more generally. The Guide provides a basis for operators to establish procedures and requirements for operation, testing and maintenance of the specific access facilities for which they are responsible.

NG 7205 COMMUNICATIONS, TRAFFIC &AND SHIPPING CONTROL

General

1 The full extent of the requirements relating to communications traffic and shipping control depends on usage, size and location, and needs to be agreed at the design stage with the respective authorities. The performance requirements stated in the specification covers the maximum extent of systems expected to be encountered for movable bridges and bridge access gantries.

2 Refer also to the Notes for Guidance under:

i) Series NG7113 CCTV

ii) Series NG7114 Traffic Control

Public Address System

3 The extent and size of the public address system depends on the size and location of the bridge. The system should be audible above the background traffic noise and wind at any location on the bridge.

4. TESTING AND INSPECTION FOR ROAD TUNNELS, MOVABLE BRIDGES AND BRIDGE ACCESS GANTRIES

NG7300 NOTES FOR GUIDANCE

1 These notes for guidance convey as appropriate the reasoning behind the requirements in the specification where this is considered necessary or helpful. The information to be provided by Contractors in Tender documents is given in the form of sample appendices at the end of each section of the specification.

2 The clause numbers prefixed by the reference NG relate to the same clause numbers in the performance specification.

NG7301 TESTING AND INSPECTION PRIOR TO DELIVERY

General

3 Before the equipment is despatched, all tests and works called for in the specification shall have been successfully carried out in the presence of the designated inspector.

4 If the equipment or any portion thereof fails under test to give the required performance such additional tests as are deemed necessary shall be carried.

5 Successful tendering and commissioning is the key to proving that equipment, components and plant actually perform to the requirements of a performance specification. It is important to maximise the benefits gained from works tests rather than to leave certain tests to be carried out during on-site commissioning since the latter option is likely to create programme delays in completing the installation should a malfunction be found.

6 Any equipment required to simulate loads etc. shall be provided together with method statements of all testing procedures.

High Voltage Switchgear

7 The complete switchgear assembly must be tested as a composite unit in order to prove that its performance meets the specified requirements.

Low Voltage Switchgear

8 The complete switchgear assembly must be tested as a composite unit in order to prove that its performance meets the specified requirements.

Standby Generators

9 The complete generator set assembly, including its control equipment and switchgear, must be tested as a composite unit at the generator set manufacturer's works in order to prove that its performance meets specified requirements, in so far as is practicable in the absence of the actual dynamic loads of the eventual building installation. This is particularly applicable to skid-mounted sets.

10 All reputable generator manufacturers have their own series of works tests and details of these should be sought from the particular manufacturer.

UPS Equipment

11 The complete UPS assembly must be tested as a composite unit in order to prove that its performance meets the specified requirements.

Tunnel Luminaires

12 Some manufacturer's produce a range of standard luminaires for tunnel applications which may obviate the need for pre-production model tests. For these cases only random tests as stated may be required.

Control Panels

13 There manufacturer's produce a standard control panel construction to proven ingress protection ratings this may be acceptable as the prototype unit without the need for further testing.

Communications Equipment

14 The assembly of the communications system need only be a simple temporary link-up to demonstrate satisfactory operation of all the various component parts of the system to be installed on site.

Traffic Control Equipment

15 The assembly of the traffic control equipment need only be a simple temporary link-up to demonstrate satisfactory operation of all the various component parts of the system to be installed on site.

Traffic Monitoring Equipment

16 The assembly of the traffic monitoring equipment need only be a simple temporary link-up to demonstrate satisfactory operation of all the various component parts of the system to be installed on site.

Plant Monitoring and Control Equipment

17 The objective of intermediate manufacturing inspection and electrical tests is to check that each individual item of equipment performs as specified prior to the preliminary factory tests.

18 The preliminary factor tests should prove all the correct functioning of the systems before the factory acceptance tests of the fully configured system.

NG7302 TESTING, INSPECTION AND COMMISSIONING ON SITE

General

19 Each completed system shall be tested and fully commissioned. The tests to be carried out and commissioning requirements should be scheduled prior to commencement and shall include:-

i) Commissioning sequences

ii) Commissioning procedures to be followed during the commissioning process

iii) Design conditions to be simulated within the systems

iv) Design tolerances permissible within the systems

v) Safety precautions required to be carried out during the commissioning process

Electrical Services

20 The electrical services associated with all the various systems shall have checks of the wiring to confirm insulation, earthing of equipment and cables and correct wiring alongside any controls specialist where there is an interface to controls equipment.

21 All interlocks associated with controls, particularly those required for safety, require checking.

Mechanical Services

22 The mechanical services associated with all the various systems shall have checks on correct location and identification of control valves, flow switches and system interlocks and functional checks on completed installations.

High Voltage Switchgear

23 A total mains failure of the incoming HV power supplies should be simulated to check that on mains failure and on switching the HV services back on that the systems and sequence of automatic operation function as designed. Similarly, faults on the protective systems should be simulated to check the protection grading.

Low Voltage Switchgear

24 If there is no HV service associated with the electrical distribution system then a total mains failure of the incoming LV power supplies should be simulated to check that on mains failure and on switching the LV service back on that the systems and sequence of automatic operation function as designed.

Standby Generators

25 It is desirable to carry out generator load tests with the generator supplying the full site load in conjunction with the simulated total mains failure tests.

UPS Equipment

26 The simulated mains failure and restoration of the mains for the UPS systems should be carried out with the actual site load connected.

Tunnel Lighting System

27 The lighting levels achieved in each of the difficult zones for each of the lighting stages shall be measured at approximately 25 metre intervals along the centre line of each lane to ensure that the design criteria has been met. The value of L20 of the stopping point shall also be measured to compare with the estimated value for calibration purposes.

Tunnel Ventilation System

28 Due consideration shall be given to prevailing winds when siting the smoke generators in the tunnel bores for the smoke clearance tests that the smoke has settled to ensure that the ventilation fans.

29 Care shall be taken that any adjacent active tunnel bores are being ventilated to clear any smoke leakage via interconnecting emergency escape doors.

Movable Bridges Mechanical Plant

30 The mechanical plant associated with movable bridges shall be tested on a system by system basis to ensure correct functioning before the full on-load testing of the completed bridge. The completed bridge tests shall be carried out with normal mains power supplies and, if applicable, standby power supplies.

Access Gantries Mechanical Plant

31 The initial inspection and mechanical and electrical testing methods should be carried out to the recommendations in the Institution of Structural Engineers draft document entitled the Operation and Maintenance of Bridge Access Gantries and Runways which covers the on-going inspection and testing as part of the safety regime.