

# **INCHINNAN BRIDGE** COMPLIANCE WITH: **MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS**

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**VOLUME 5      CONTRACT  
DOCUMENTS  
FOR SPECIALIST  
ACTIVITIES**

**SECTION 7      MECHANICAL AND  
ELECTRICAL  
INSTALLATION IN  
MOVABLE BRIDGES**

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## **PART 2**

**Series            7200**

**MECHANICAL, ELECTRICAL AND COMMUNICATIONS WORK FOR MOVABLE  
BRIDGES**

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## **DOCUMENT LAYOUT**

In this document, the left hand column is text taken from the Manual of Contract Documents .

The right hand column provides commentary on the compliance of Inchinnan Bridge with the Manual

## (7200) INTRODUCTION

1 - This Series of the Specification covers the mechanical and electrical performance requirements for the motive equipment associated with movable bridges and maintenance access gantries in the United Kingdom and is categorised under the following headings:

- i) Electrical equipment
- ii) Mechanical equipment
- iii) Communications, Traffic and Shipping control

2 - These performance specification clauses are intended to indicate the minimum standards for mechanical, electrical and communication services for:

- i) movable bridges - swing, bascule or vertical lift type
- ii) bridge maintenance access gantries - span or column type

3 - They shall be used in conjunction with contract specific documentation which shall define the design, extent and type of plant and equipment for the proposed application.

4 - Movable bridges shall be activated by hydraulic cylinders or motors driven from electro-hydraulic pump sets under the control of an operator, although activation by electronically controlled direct driven motors

1 - Inchinnan Bridge is a listed structure. As a consequence it is expected to retain its original appearance. The most notable mechanical/electrical feature to be preserved is the rack and pinion driven opening and closing mechanism. Most of the matters covered by the Specification apply to Inchinnan Bridge. This column is used to explain the method of compliance adopted.

Because of the age of the bridge there are instances where the method of complying with the requirements of the Specification is unusual by present day practice. These are mostly in the category of items which are no longer commercially available. In this respect the drum controller which is the multipurpose device for operating the bridge is a notable example. They are nevertheless old but found to be extremely reliable. They include items which are:

- i) Electrical,
- ii) Mechanical and
- iii) Communications, Traffic and Shipping.

2 - The bridge is designed so that it opens by rolling backwards onto a rolling track. The accepted names for this type are Scherger or Roll Back Bascule. As the bridge opens it also rolls so that when fully open it is closer to Renfrew Cross than when it was closed.

3 - The recent works undertaken were of a restorative nature and were not the subject of design or re-design.

4 - The activation is by means of two 50HP electric motors. These are of the slip ring type and are used in conjunction with three staged banks of cast iron resistors. The motors are connected to gear boxes, one on

should also be considered.

each side of the carriageway, and these are connected by a synchronising shaft. The output of the gear boxes is by driving pinions which engage on racks.

5 - Where bridge access gantries are required to be powered they shall be operated under the control of an operator by motorised pulley equipment or by transferring power to the driving wheels using electric or hydraulic motors. The operating mechanisms may be supplied from electric mains, generator, or hydraulic pump source.

5 - Not applicable

6 - The list of the Standards and Codes of Practice to which the equipment shall comply is included within the Appendices at the end of each section of the specification.

6 - The equipment complies with Standards and Codes of Practice as they exist for the equipment in question.

**(7201) ELECTRICAL EQUIPMENT  
FOR MOVABLE BRIDGES**

**General**

1 - The requirements and extent of electrical power distribution associated with movable bridges depends on the size, importance and type of drive selected in the contract specific documentation. Provision of High Voltage intakes may be applicable.

2 - The electrical plant for the motive power for movable bridges shall be low voltage suitable for use on three phase and neutral 50Hz systems. High Voltage Switchgear

3 - The requirements for high voltage switchgear shall comply with Series 7101 of this Specification as applicable. Distribution Transformers

4 - The requirements for distribution transformers shall comply with Series 7102 of this Specification as applicable. Low Voltage Switchgear

5 - The requirements for low voltage switchgear shall comply with Series 7103 of this Specification as applicable. HV and LV Cabling and Distribution

6 - The requirements for HV and LV cabling and distribution shall comply with Series 7104 of this Specification as applicable.

**Standby Generators**

**General**

1 - The system is four wire, 415/240V, 50Hz and is derived from the local distribution network. Power requirements are theoretically only these necessary to overcome friction. There is no potential energy stored in the bridge or its counterweight when the bridge is either fully opened or fully closed.

2 - There is no HV supply necessary or provided.

3 - There is no HV supply provided.

4 - There is no transformer necessary since the operating voltage is the same as the supply voltage.

5 - The LV equipment complies with the requirements of Series 7103 of the Specification. There are however some items of switchgear for which no standards apply. These are mainly focused on the motor control and include a traditional drum controller similar to that used on dockside cranes and two slate insulated switchboards with contactors controlling cast iron resistance banks for motor starting.

6 - There is no HV cabling and all LV cabling complies with the Specification as applicable.

7 - The requirements for standby generators shall comply with Series 7105 of this Specification as applicable. Uninterruptible Power Supply Equipment

7 - The intention is to make use of an existing generator on site but which is in need of an appraisal and servicing.

8 The requirements for UPS equipment shall comply with Series 7106 of this Specification as applicable

8 - There is no need for a UPS.

### **Services Building**

### **Services Building**

9 The requirements for mechanical and electrical services shall comply with Series 7110 of this Specification as applicable.

9 - The two machine houses comply with the specification.

### **Bridge Control Systems**

### **Bridge Control Systems**

10 The requirements for controls associated with motor drives and control of the bridge shall comply with Series 7103 of this Specification with respect to equipment and construction of motor control centers and control panels.

10 - The bridge main operating motors are slip ring type induction motors with assisted / soft start employing banks of cast iron resistances. The motors are started employing slate mounted contactors and a timing relay to connect and short out banks of cast iron resistances. The entire starter for each motor is of open construction and can be viewed in operation. A substantial steel mesh construction provides protection by separation.

11 The bridge shall be operated from a console located in a control room or other location defined in the contract specific documentation on which there shall be located controls for the operating motors; bypass switches; instruments; position indicators or meters; indicating lights; and all other control devices and apparatus necessary or pertinent to the proper operation and control of the bridge and its associated safety, locking and braking systems.

11 - The control room houses a drum controller of traditional design. It is constructed of cast iron, brass and steel. This metalwork encloses the drum and finger contacts. It provides protection from live parts and is earthed. Instruments, indicating lights and a mechanical bridge position indicator are provided. Braking is provided by spring push "on", electromagnetic "off" brakes with hand would brakes provided as backup.

12 Where feasible the console shall be located in a control room which has a clear view in all directions. Where not feasible CCTV shall be provided to provide views of the traffic.

12 - the control position is elevated and permits direct view of the hazardous parts of the structure during movement.

13 The control system circuits may be

13 - The controls are based on relay logic.

individually wired or the system may be microprocessor PLC based.

14 - Indicators shall be installed on the console which will show to the operator the various positions and status of the bridge, especially the fully closed, fully open, nearly closed, and nearly open positions, and also the closed and open positions of the traffic gates, bridge locks and end lifting devices as applicable. Indicators shall also be provided to show when the brake to each span is released, the overload or overheat tripping of drive motors and the status of other alarms as required to alert the operator to emergency conditions.

15 - The control system shall operate at SELV DC or 110 volts AC and the system controls shall be backed with an uninterruptible power supply unit.

16 The control system shall implement the following modes of operation:

- i) Manual - for test running, maintenance or emergency
- ii) Automatic - normal operation
- iii) Semi-automatic - during failure of sub-systems
- iv) Maintenance - planned bridge closures

17 The control console shall be fitted with key controlled master locks for overall control and switching modes to the remote control positions. Activation of all control systems and indicators shall be from the console incorporating the indicators and alarms, together with provision for testing all circuits. All barrier and light controls, telephone, radio and CCTV controls as applicable shall also be from the console.

18 Supervision of all emergency features shall be located at the console where override, indication and alarm facilities shall be incorporated. Indication of the main

14 - Bridge locking in the closed position is confirmed by indicator lamp and the position of the bridge is visible from the elevated control room and further confirmed by mechanical indicator.

15 - The need for a SELV, 110V, 24V or 12V system is obviated by combining the control logic into the power circuits.

16 - The following means of operation are possible:

- i) Manual – meaning the motive power as well as the controls is manual. Four operatives are necessary for this method of operation.
- ii) Fully automatic opening from the control position.
- iii) Closing can be fully automatic from the control position but semi-automatic is employed in order to ensure gentle closure.

17 - Access to the control room is locked and the control room is a restricted area. The bridge power supply is locked “off”. (Building services are independent.) The control room is equipped with VHF radio operating on the marine band. Call up frequency is channel 16 and an operating frequency is chosen according to requirements thereafter. The staff are trained in marine band VHF radio and are provided with cellular telephones.

18 - Supervision of emergency features is carried out from the control room.

Power supply status is indicated at the

incoming power supply status shall also be from the main control desk, together with monitoring and transfer of power load to the standby generator.

19 In the event of failure of the main incoming power supply the bridge shall stop, the standby generator shall automatically start and automatically transfer the load to the standby generator. The bridge movement shall then be manually restarted by the bridge operator.

20 - Controls, monitors and indicators for close monitoring and adjusting the operation of the bridge machinery shall be located in cubicles in the bridge machinery room.

21 - Unless otherwise specified the electrical equipment shall be interlocked by suitable contactors, relays, limit switches etc., so that only the following general sequence of operation is possible for opening of the bridge.

- i) Set traffic signals (lights and bells)
- ii) Close incoming barriers for traffic.
- iii) Close exit barriers and all pedestrian barriers.
- iv) Pull locks or wedges (where applicable)
- v) Release brakes (where applicable)
- vi) Open span
- vii) Lock span (where applicable)

22 For closing operations, the following sequence shall be used:

- i) Release span lock (where applicable)
- ii) Release brakes (where applicable)
- iii) Replace wedges?
- iv) Insert locks or wedges
- v) Open all traffic barriers
- vi) De-energise traffic signals (lights and bells)

23 All limit switches and contacts shall be fitted in a fail safe mode. In general, for limit switches this will result in the limit switch breaking a circuit. The limit switch should be arranged such that the contacts are

control room.

Standby generator does not apply at present.

19 - Failure of the main incoming power supply results in the bridge stopping. Connection of an alternative supply would result in a need to reset the controls for subsequent movement.

20 - These controls are all situated in the bridge machinery room and contained in cubicles as appropriate.

21 - Electrical equipment is interlocked as described by suitable contactors, relays, limit switch equipment so that the requirements as described are met with one exception:

due to the rolling aspect of the “roll back bascule bridge” it is considered that a team needs to be present at each opening to ensure that no member of the public or an animal is caught in the “quarter wheel” as the bridge is opened or closed.

Consequently a trained team requires to be present to supervise the opening and the closing of gates.

22 - The control equipment and the operational staff follow the sequence outlined for closing the bridge.

23 - Limit switches are mechanically driven into the open or closed position. The contact arrangement is such that limit switches circuits would fail to open or “safe” condition.

Independent contacts for proving status of equipment shall be arranged such that contacts are normally open and closed when the barrier is in the indicated position. Emergency switches shall be provided which shall free the various motors from the prescribed interlocking in case of an emergency. These switches shall be mounted on the console to be within convenient reach of the operator. Each such emergency switch shall be sealed or locked.

A main isolating switch is within easy reach of the driver. In addition there is a panel-mounted isolator.

Operation of either of these switches removes power from the equipment and causes stored energy brakes to be applicable.

**A7201.2) : Control Equipment for Movable Bridge**

The Contractor shall insert below details of the equipment proposed.

Item No	Description	Detail
1	Manufacturer of VMS	
2	Manufacturer of automatic barriers	
3	Supplier of CCTV system	
4	Manufacturer of control and safety systems	
5	Manufacturer of PA System	

Not applicable

**(7203.) MECHANICAL EQUIPMENT FOR MOVABLE BRIDGES**

**General**

1 - The mechanical equipment for movable bridges shall be of simple design and substantial construction suitable for the harsh environment and 120 year projected design life of bridges. The arrangement of parts shall permit easy erection, adjustment, replacement of defective parts and shall be accessible for inspection, cleaning, lubricating and repairing. Suitable drainage shall be provided to facilitate fluid changes.

1 - Inchinnan Bridge is approximately 87 years old. The period which has elapsed since its completion is one in which the various technologies involved in the construction of a movable structure have advanced. The design life anticipated at construction is not known. Improvements to comply with this Specification will assist in achieving a long life, for example automatic greasing of gearboxes and other moving parts.

2 - The fastenings shall be adequate to hold

2 - The most harsh condition to which the

the parts in place under all conditions of service. Each group of machinery shall be self-contained mounted on a rigid structural support.

3 The locations of the equipment shall allow easy access for maintenance, future removal and replacing. The equipment shall be located on the stationery parts of the bridge.

4 - The list of the Standards and Codes of Practice to which the equipment shall comply is included within the Appendices at the end of this section of the Specification.

### **Hydraulic Systems**

5 Hydraulic systems shall permit the bridge operator to control from the console, the direction of hydraulic fluid flow for span movement and the operation of auxiliary equipment such as span locks, brakes, wedges, barriers and other devices associated with the movement of the span. Controls shall be of the type that will automatically maintain constant fluid flow, without operator assistance, regardless of normal operating pressure fluctuations, except during periods of acceleration and deceleration.

6 Methods of operating and controlling the hydraulic system may be manual, semi-automatic or automatic, as follows:

i) Manual control is defined as any system in which the operator must manually control the span acceleration and deceleration in addition to the initiation of each of several major interlocked functions to be carried out in sequence.

ii) Semi-automatic control is defined as

bridge is called upon to cope is probably the exceptionally heavy road traffic unlikely to have been anticipated at original design: and that is a structural matter. As regards machinery, it is integral with the structure. The gearboxes for example are integral and only the drive motors, drum controller and slate switchboards are easily removed.

3 - The equipment is easily accessed and maintained.

4 - Due to the nature of the bridge and the age of the principal parts, including machinery there are no standards published to which the bridge may conform.

### **Hydraulic Systems**

5 - There is one packaged item of equipment and it is hydraulic. It is built in conformity with present day standards and is only unusual in that it makes use of non polluting hydraulic fluid.

The purpose of the unit is to act as an actuator for a bolt which retains the bridge in the “down” position. It engages the sliding bolt when the bridge is in the closed position. The bridge cannot be opened until the bolt is withdrawn

The bolt is referred to as the “nosebolt”.

6 - The operation of the nosebolt is Semi-automatic in that it is interlocked with the bridge motion but its movement is brought about by use of the drum controller by the driver.

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any system where the fluid flow automatically increases from zero to the required operating rate and back to zero again for span acceleration and deceleration, by the single operation of a push-button or hand lever. However, the operator must initiate each of the several interlocked functions in sequence.

- iii) Automatic control is defined as any system where the operation in sequence and the hydraulic system fluid flow automatically increases from zero to the required operating rate and back to zero again for span acceleration and deceleration, all by the operation of a single push button or hand lever.

7 Flows produced by fixed displacement pumps shall normally be controlled by varying the speed of the pump drive motors. If pressure compensated flow controls are specified to control fixed displacement pump flow, the hydraulic system shall be designed to minimise heat build-up. 7 - Not applicable.

8 Variable displacement pump flows shall normally be automatically controlled. If flows are specified as being remotely controlled, this shall be by a closed loop control system. 8 - Not applicable.

9 - Closed loop control systems shall be analyzed to verify that the control system will perform as required. Each component manufacturer shall furnish all necessary instructions on how to adjust and maintain the individual components. 9 - The description of the method of operation is appropriate to a hydraulically opened and closed bridge. Inchinnan bridge is rack and pinion actuated.

10 - The control system supplier shall furnish all necessary details on how to adjust and maintain the control system. 10 - This information is provided by means of drawings.

11 The hydraulic systems shall be designed, and hydraulic components proportioned, such that the maximum allowable system pressures shall not exceed the following: 11 - Not applicable.

Normal operation	200 bar
Operation against maximum specified loads	200 bar
Holding against maximum specified wind loads	350 bar

12 Minimum working pressure ratings for hydraulic components shall be as follows: 12 - Not applicable.

Pipe, tubing and their fittings	250 bar
Flexible hose and hose fitting	
For pressure lines:	350 bar
Cylinders, pumps, valves and all other components	350 bar

### Hydraulic Motors

13 Hydraulic motors shall be of the fixed displacement type. Speed control of the motors shall be accomplished by controlling the volume of fluid to the motors. 13 - Not applicable.

14 Gear type hydraulic motors shall be of the hydraulically balanced type. 14 - Not applicable.

15 Hydraulic span driving motors shall be reversible and shall be provided with variable, stepless speed controls with smooth acceleration/deceleration characteristics. 15 - Not applicable.

### Hydraulic Pump Sets

16 Hydraulic pumps sets shall comprise hydraulic pumps driven by electric motors complete with valves and interconnecting pipework all mounted on a common base frame complete with readily drainable drip tray. 16 - Not applicable.

17 Pumps shall be positive displacement of either the variable or fixed displacement type. Pumps shall be equipped with integral or add-on relief valves to prevent damage to pump and hydraulic system from high pressure. Relief valves shall not discharge into pump intake ports. 17 - Not applicable.

18 Piston type pumps shall be used in hydraulic systems where maximum operating pressures exceed 140 bar. 18 - Not applicable.

19 Where noise control is an important consideration, such as when the hydraulic power unit is to be located in the bridge control area. The system supplier should pay particular attention to attenuating hydraulic noise. This may involve the use of flexible hoses and anti-vibration mountings etc. 19 - Not applicable.

20 Electric motors used for driving of hydraulic pumps shall be AC squirrel cage induction types, types with embedded winding temperature sensitive devices as specified. Motors shall have grease lubricated antifriction shaft bearings and shall be equipped with lubrication fittings. 20 - Not applicable.

### **Hydraulic Pipework and Fittings**

#### *General*

21 Piping shall include all pipe, tubing and flexible hose. Piping, fittings and manifolds may be made of carbon steel, stainless steel or alloy seamless tube. The materials used shall be consistent with the pressures and environmental conditions to which the hydraulic system will be subjected. Steel fittings shall be used with steel piping, stainless steel fittings shall be used with stainless steel piping and 'alloy' fittings shall be used with alloy piping. Use of fittings which are of softer material than the piping shall not be permitted. Piping, fittings and manifolds shall not be galvanised. 21 - Not applicable.

22 Fittings used for piping connections shall be of the type to permit rapid assembly and disassembly of all components. Fittings shall also permit repeated disassembly and reassembly of a connection without loss of sealing quality or strength. Lockable facilities shall be provided for all valves and cocks to prevent unauthorised resetting. 22 - Not applicable.

23 Pipe shall have welded flange fittings. Use of threaded pipe fittings in pressure lines rated above 200 bar and/or 25mm diameter shall not generally be permitted. 23 - Not applicable.

24 Tubing shall have straight thread O-ring face seal, propriety sealing washer or flareless or welded flange fittings. Use of flared fittings will not be permitted. Straight thread O-ring face seal fittings may be used for tubing sizes up through 38mm nominal outside diameter. Welded flange fittings shall be used for tubing of greater than 38mm nominal outside diameter. 24 - Not applicable.

25 Hydraulic velocity shall not exceed 4.5 metres per second generally in pressure and return line piping and pump suction line velocity shall not generally exceed 1.5 metres per second. 25 - Not applicable.

26 Test ports shall be provided to bleed the system of air, and to check system pressure at control valves as well as other locations where a pressure governing component is not so equipped. 26 - Not applicable.

27 Flexible hose shall be provided to connect the hydraulic power unit to the rigid piping system. Where separate valve stands are provided, flexible hose shall be used to connect the valve stands to the hydraulic power unit and to the rigid piping system. 27 - Not applicable.

#### *Pipework*

28 Pipe shall be seamless with plain ends. Use of threaded pipe ends will not be permitted, without prior written approval. 28 - Not applicable.

29 Welded flange fittings shall be 4-bolt minimum flanges, utilising a captive O-ring pressure sealing system. Socket or butt weld flanges shall normally be used. 29 - Not applicable.

30 Flange connection bolts shall have sufficient strength for the working pressure 30 - Not applicable.

rating of the flanges. Stainless steel bolts shall be used with stainless steel flanges. A lockwasher shall be used at every bolt.

31 Threaded fittings and threaded flange fittings, used for field connections and field erected piping systems, shall utilise a gasket or other form of face seal. 31 - Not applicable.

#### *Tubework*

32 Tubing shall be seamless, have a carbon content below 0.25% and be annealed to facilitate bending. Straight thread O-ring face seal fittings shall use a captive O-ring pressure sealing system and designed for unlimited break and remake or tubing connections without springing or cutting lines. 32 - Not applicable.

33 Flareless fittings shall be of the type that bites into the outside surface of the tubing when the fitting assembly is tightened or of a welding nipple design. 33 - Not applicable.

#### *Flexible Hoses and Fittings*

34 Only extra high or high pressure hose and fittings having the working pressure ratings specified in Clause 7203.12 shall be used. Hoses shall be seamless, oil and weather resistant and have steel wire reinforcement. 34 - Not applicable.

35 Hose fittings shall be made of steel and be of the swaged (non-reusable) type. Hose fittings shall have flange style ends for connection to other hydraulic components. Flange head style fittings shall use split flanges with bolts and O-ring sealing. Threaded fittings may only be used for connection to threaded drain ports. 35 - Not applicable.

#### **Hydraulic Reservoirs**

36 Reservoirs shall be of heavy duty welded construction non-corrodible steel. They shall be structurally rigid to resist 36 - Not applicable.

warping and damage from the mounting of equipment on the reservoir top, handling during shipping to and erection at the bridge site.

37 Bladder type breathers, to prevent the mixing of outside air and reservoir air shall be provided for hydraulic reservoirs located in environments having airborne contaminants such as dust, chemicals and condensing water vapour which could damage the hydraulic system. 37 - Not applicable.

38 Reservoirs shall have drains which permit a complete hydraulic fluid change without disconnecting any components. 38 - The single reservoir is so constructed.

39 Reservoirs equipped with large removable covers shall have separate filler openings to permit the adding of fluid to the reservoir without removal of the cover. 39 - The single reservoir is so constructed.

### **Hydraulic Valves**

40 To prevent unintentional misadjustment, adjustable valves shall be equipped either with protective caps, or with locking nuts on the adjusting screws. 40 - Not applicable.

41 Directional control valves and blocking valves may be provided with adjustable pilot control chokes to increase valve opening and closing time, for shock and surge pressure control. 41 - Not applicable.

42 Flow dividing valves used for actuator synchronisation shall be of the type that will always permit flow to all actuators simultaneously, regardless of the magnitude of pressure differential between the actuators being loaded. 42 - Not applicable.

### **Rotary Actuators**

43 Rotary actuators shall produce an output torque over a limited range of rotation and shall self-lock when the flow of pressurised fluid to the actuator is stopped or operating pressure is lost due to line leakage or 43 - Not applicable.

breakage. Provision for manual operation of actuators shall be provided. Vane type rotary actuators shall be hydraulically pressure balanced.

44 Actuators shall have keyed output shafts and be connected to driven equipment with couplings. 44 - Not applicable.

45 Cylinder type rotary actuators having internal chain and sprocket mechanisms shall have automatic chain tensioning devices incorporated into the actuators. 45 – Not applicable.

46 Actuators shall be coupled to driven equipment in a manner that eliminates overhung and thrust loads on the actuator shaft bearings. 46 - Not applicable.

47 Self-contained hydraulic actuator units shall consist of a heavy duty cylinder or other type of actuator, electric motor, pump, reservoir and control valving. Units shall be completely closed systems, requiring no external piping to supply or remove hydraulic fluid. 47 - Not applicable.

48 Self-contained hydraulic actuators shall not be used for span operation. Such actuators may be used only to operate auxiliary equipment such as locks, lifting devices, wedges and barriers. 48 - Not applicable.

49 Protective flexible sleeves shall be provided for cylinder rods which are normally extended. 49 - Not applicable.

### **Hydraulic Cylinders**

50 Cylinders shall have a minimum theoretical static failure pressure rating of 1.5 times the working pressure. 50 - Not applicable.

51 Cylinders shall have engraved permanent nameplates securely attached to the head of the cylinder. The nameplates shall clearly indicate as a minimum the manufacturer, model number, cylinder bore, rod diameter, 51 - Not applicable.

stroke length, and theoretical static failure pressure rating symbol.

52 Protective flexible sleeves shall be provided for all cylinders that are oriented such that the rods are normally extended. 52 - Not applicable.

53 Piston rod seal assemblies shall be replaceable without cylinder disassembly. 53 - Not applicable.

54 Gland seals and wiper seal replacements shall be provided by removable rod end clevis or other compatible arrangement. 54 - Not applicable.

55 The use of rotating type or telescoping cylinder shall not normally be permitted. 55 - Not applicable.

#### **Accumulators**

56 Gas accumulators shall be charged with an inert gas. The use of oxygen, air or other active gases will not be permitted for accumulator charging. 56 - Not applicable.

57 Clamps or straps used for accumulator mounting shall not restrict thermal expansions, or distort the shell of the accumulator. 57 - Not applicable.

#### **Pressure Gauges**

58 Gauges shall be of durable construction. Dial faces shall be clearly calibrated for pressure ranges 50% beyond the maximum design operating pressures of the hydraulic system. Gauges shall be accurate and permit continuous monitoring. They shall have a minimum diameter of 100mm. Shut-off valves shall be provided at each gauge. 58 - Not applicable.

59 Portable gauges shall be provided for maintenance and adjustment of the hydraulic system. The pressure ranges shall cover all possible values that will be needed for the 59 - Not applicable.

system. One gauge shall be provided for each pressure range such that the test pressure will be within the mid-half of the total pressure range of the gauge.

60 Connections for portable gauges shall be of the quick self-sealing disconnect type. Test ports in the hydraulic system shall be equipped with removable, protective caps, secured by chains to the component.

60 - Not applicable.

### Hydraulic Fluids

61 Hydraulic fluid shall be suitable for the operating pressure, temperature and lubrication requirements of the system. The selection of the hydraulic fluids shall be based wherever possible on the performance data or actual experience in other heavy duty hydraulic systems subjected to similar operating pressures and temperatures and having similar hydraulic equipment. The fluid shall be that acceptable or recommended by the pump manufacturer and shall be compatible with all hydraulic components and seals.

61 - The hydraulic fluid fulfills all of these requirements and in addition is chosen so as to avoid introducing harmful substances in the case of a leak – it is inherently non toxic.

62 Hydraulic fluid shall be either petroleum based oil type, or oil-water emulsion type fire resistant fluid type. Pure synthetic, high water contents fluids, synthetic blends or water glycol mixtures shall not normally be permitted.

62 - See 61 above.

63 Fluid systems shall not normally contain more than one fluid type. If more than one type is specified then the risk of adding the wrong fluid to a reservoir shall be minimised by warning labels.

63 - Full compliance.

64 Hydraulic fluids shall have the following properties:

64 - The hydraulic fluid is for the nosebolt only. It complies with all of i) to vii).

- i) the correct viscosity range for the operating requirements of the hydraulic system
- ii) a high viscosity index to resist changes

- in viscosity due to anticipated temperature ranges
- iii) prevent wear on working parts
  - iv) resist foaming
  - v) resist oxidation and formation of sludges
  - vi) retain original properties in use
  - vii) optimum service life

65 Provisions shall be made to collect or contain fluids from damaging the environment due to any leaks or line breakage.

65 - This is achieved by extra robust construction, replacement of sub system once every five years approximately and environmentally friendly hydraulic fluid.

66 Full flow and/or off-line filtration shall be provided

66 - Provided.

67 Filters, including pump intake strainers if required by the contract specific documentation, shall be equipped with an indicator to show when the filter needs servicing.

67 - The filter is replaced every six months since the retaining can is in a corrosive atmosphere.

68 The degree and quality of filtration shall be determined by the control system supplier to ensure correct component function.

68 - This is done.

69 Filter flow capacity ratings shall be as recommended by the pump manufacturer.

69 - This is done.

70 Bypass valves should be provided on filters to limit the differential pressure across the filter elements. Bypass valves shall be sized for the maximum flow that could be expected through the filter without excessive differential pressure. Non-bypass type filtration shall be used only where required by the hydraulic equipment manufacturer, and shall be equipped with warning devices to provide remote indication at the operator's console of an impending clogged condition.

70 - The principle specified is fulfilled.

### **Safety Systems**

71 Suitable interlocking arrangements shall be provided to ensure that operations can only be performed in a safe sequence e.g.

71 - Interlocking is provided so that opening and closing in the correct sequence occurs only.

operations to open the bridge cannot commence until all barriers are down.

The location of the bridge is such that interlocking of the gates is likely to cause malfunction due to physical effects and vandalism.

72 Brakes shall be arranged to operate in a fail safe manner, eg spring on, power off.

72 - This is how they operate.

### **Locking System**

73 Movable bridges, depending on the type, shall be equipped with suitable mechanisms to align the bridge and roadway surface accurately and to fasten the bridge securely in position so that it cannot be displaced either horizontally or vertically under the action of traffic and wind loads etc. Effective end lifting devices shall be used for swing bridges and bascule bridges. Span locks shall also be provided for vertical lift bridges when specified.

73 - Correct alignment is provided by two rolling tracks with integral dogs. The rolling part of the bridge has slots coinciding with the dogs. The full weight of the bridge is employed in maintaining the correct alignment

### **Braking Systems**

74 Provisions shall be made to hold the span stationary against unbalanced loads and the wind pressures specified. Cylinder locks shall prevent structural damage due to overloads.

### **Braking Systems**

74 - The pinions of the rack and pinion thrusters are locked when not moving due to the application of the brakes of the electric drive motors.

75 The hydraulic system shall provide the necessary dynamic braking to stop the span as specified for motor brakes.

75 - The system described above (74) provides for this requirement.

76 Machinery brakes, cylinder locks or counterbalance valving shall provide the static braking capacity as stated in the contract specific documentation for the combined motor and machinery brakes.

76 - Static braking is provided as per (74) and can be reinforced by application of large hand wound band brakes.

77 Spans normally left in the open position shall also be provided with locking devices to hold the span stationary at the fully open position, against the wind or water etc loads specified.

77 - This is adopted.

**(7205.) COMMUNICATIONS,  
TRAFFIC AND SHIPPING CONTROL**

**General**

1 VMS (Variable Message Sign), automatic barriers, closed circuit television and their associated control systems to be used for movable bridges shall comply as applicable to the relevant parts of Series 7100 of this specification.

2 This specification covers the requirements of traffic control equipment located on and in the vicinity of any movable bridge in order to ensure its safe operation.

3 All installed equipment shall be supported by record documentation, to the requirements of Clause 7014, consisting of manufacturers technical literature, schematic drawings, testing and commissioning results. This documentation shall be contained in ring binders with rigid covers, be original documentation, not photo copies, and be in the English language. The quantity of copies of these documents will be indicated as a site specific instruction.

**Wig-Wag Signals**

4 Wig-wag signals shall be installed on the approaches to the movable bridge on both sides of the road next to the barriers complying to the relevant regulations listed in the Appendices. All wig-wag signals must be clearly visible to approaching traffic and must be accompanied by appropriate fixed signing prior to the wig-wag signals.

5 All signals must be installed with red lamp monitoring such that a major fault alarm will be communicated to the bridge operator if one or more of the lamps on a wig-wag fail.

6 The wig-wag controller shall be located

1 - None of these are provided. The use of wig wag signaling is under review. At present traffic lights on each of three roads are provided and are found effective in practice. The bridge is always well manned during openings and there is no need for CT television. The traffic barrier gates screen from ground level to 1.5 meters to prevent children or animals entering the danger zone during opening. Post type automatic barriers would be insufficient.

2 - Traffic lights are provided for this purpose.

3 - Drawings and operating instructions are provided and a set kept on site. A log is kept of all openings. An annual inspection/service is carried out involving:  
Council operatives (up to five).  
An Electrical Engineer  
A mechanical Engineer  
An overseeing Engineer Surveyor.

4 - The provision of Wig Wag signals is under review. They are not provided at present and may not be appropriate.

5 - Not applicable meantime.

6 - See (4) & (5) above.

at convenient locations near to the wig-wag signals, and in positions that do not impede the access-ways. Power shall be derived from a suitable source.

7 Wig-wag signals shall be mounted in an appropriate manner that allows easy access for maintenance. Wig-wag signals shall be of the appropriate size and colours.

7 - Not applicable meantime.

8 Housings and enclosures shall comply with the harsh environments encountered in these exposed locations, and shall be of a distinctive colour for easy identification.

8 - This practice adopted for all equipment associated with the bridge.

9 Cabling shall be laid such that it does not interfere with or it cannot be damaged by the movement of the bridge. Cables shall be terminated in the signal heads and wig-wag controller.

9 - Not applicable meantime.

However this is an opportunity of raising the matter of street lighting cables, power to the nosebolt and signals to the nosebolt which are carried in trailing type cable and which rest on the roadway when the bridge is open to river traffic.

10 Each wig-wag signal and wig-wag controller shall have a unique number. This unique number shall be clearly displayed on the equipment enclosure, so that it is clearly visible from the carriageway.

10 - Not applicable meantime.

11 A maintenance procedure shall be proposed for routine and breakdown requirements.

11- A routine examination is made at every opening. A thorough invasive inspection and service is carried out at least once per year

12 All equipment shall be tested prior to any connection being made to the network. Each individual wig-wag signal and each controller shall be tested to ensure that it is fully functional.

12 - Not applicable meantime

13 After satisfactory testing, the local elements of the installed system shall be commissioned as a whole. After completion of commissioning the equipment can be integrated into the network. Following total integration the wig-wag equipment shall be commissioned as part of the whole bridge system to insure correct interlocking with both the bridge control system and the

13 - Not applicable meantime.

barriers.

### **Automatic Barriers**

14 Barriers are required at both ends of a movable bridge to prevent vehicles and pedestrians entering on to the bridge structure whilst the bridge is being moved. The barriers shall be located on the approaches to the bridge sufficiently far back from the bridge structure so as not to hinder the movement of the bridge. When the barriers are raised they shall not obstruct the flow of traffic across the bridge. When the barriers are lowered they shall close the road to prevent vehicles and pedestrians going around the barriers.

15 Barrier controllers shall be located beside the barriers, in a positions that do not impede the accessways. Power shall be derived from a suitable source.

16 Barriers shall be remotely monitored for failure and incorrect operation.

17 Barriers shall be of such height as to discourage persons from climbing over and shall be fitted with skirts to prevent persons from going under. Barriers part of the total system in accordance with Series 7300.

18 Barriers shall be positioned appropriately that allows easy access for maintenance. A means shall be provided of raising and lowering the barriers manually by means of a handle located in an easily accessible location.

19 Housings and enclosures shall be protected to classification IP65 as defined in the appropriate standards and suitable for the harsh environments encountered in these locations, and shall be of a distinctive colour for easy identification.

### **Automatic Barriers**

14 - The barriers are in conformity with the requirements detailed with the following necessary exceptions:

- i) The barriers are wire mesh plated and extend from ground level to a height of approximately 1.5 meters. In this way small children or pet animals cannot gain entry to the danger zones.
- ii) Rising spar type barriers would not offer sufficient safety. The barriers are manned during all openings.

16 - The barriers are manned and checked for proper operation.

17 - Skirts are fitted. The barriers are manned.

18 - The barriers are manually operated.

19 - The manual supervision and operation of the barriers obviates the need for electrical equipment and IP65 housings.

20 Cabling shall be laid such that it does not interfere with, or cannot be damaged by the movement of the bridge. Cables shall be terminated in the barrier control box. Not applicable.

21 A maintenance procedure shall be proposed for routine and breakdown requirements. 21 - This is done at every opening.

22 All equipment shall be tested in accordance with Series 7300 prior to any connection being made to the network. Each set of barriers shall be tested to ensure that it is fully functional. All tests shall be documented in an agreed format, and testing documentation presented within agreed time scales. 22 - Not applicable.

23 After satisfactory testing, the local elements of the installed barrier system shall be commissioned as whole. After completion of Commissioning the equipment can be integrated into the network. Following total integration the new equipment shall be commissioned as part of a total system in accordance with Series 7300 in order to insure correct interlocking with both the VMS and bridge controller. 23 - Not applicable

#### **Closed Circuit Television (CCTV)**

#### **Closed Circuit Television (CCTV)**

24 Cameras shall be provided as an operational requirement where pedestrian, vehicle and shipping movement on or in the vicinity of the bridge cannot be clearly observed, without obstruction from the Bridge Control Office. When all cameras are connected together to form a system, the system shall provide visibility of the full length of the bridge and its approaches. The visibility viewed from the system video monitors, connected to the camera system shall meet the requirements in accordance with Series 7 11 3 of this specification. 24 - No cameras are required. The trained staff are present at each opening and have a clear view of all potentially hazardous areas.

25 Cameras shall be positioned to provide the bridge control office operator with 100 percent viewing coverage of the bridge and the bridge approaches. As a minimum, at 25 - Not applicable.

least one camera should be provided at each end of the bridge to cover its approaches and traffic barriers, with further cameras provided on the bridge structure to provide full coverage of the bridge.

- 26 Additional cameras shall also be provided to where any obstruction hinders visibility or where there are separate pedestrian walkways across the bridge structure. 26 - Not applicable.
- 27 CCTV controllers shall be located at convenient locations next to the bridge structure, and in positions that do not impede the access-ways. Power shall be derived from a suitable source. 27 - Not applicable.
- 28 Cameras shall be mounted in an appropriate manner that allows easy access for maintenance. Cameras shall be mounted in their own equipment housing and be easily removable for maintenance. 28 - Not applicable.
- 29 Housings and enclosures shall be protected to classification IP65 as defined in the appropriate standards and suitable for the harsh environment encountered in these exposed locations, and shall be of a distinctive colour for easy identification. Housings and enclosures shall not impede the operation of the camera in any respect. 29 - Not applicable.
- 30 Cabling shall be laid such that it does not interfere with or cannot be damaged by the movement of the bridge. Cables shall be terminated in a junction box that shall allow the cameras to terminate. 30 - Not applicable.
- 31 Each camera and camera controller shall have a unique number. This unique number shall be clearly displayed on the equipment enclosure, so that it is clearly visible from the carriageway. 31 - Not applicable.
- 32 A maintenance procedure shall be proposed for routine and breakdown requirements. 32 – This is carried out twice a year.

33 All equipment shall be tested prior to any connection being made. Each individual camera shall be tested to ensure it is fully functional. Each controller shall be tested. All tests shall be documented in an agreed format, and testing documentation presented within the agreed time scales.

33 – Not applicable.

34 After satisfactory testing, the local elements of the installed system shall be commissioned as a whole. After completion of Commissioning the equipment shall be integrated into the network. Following total integration the new system shall be commissioned as part of the total system in accordance with Series 7300.

34 – Not applicable.

### **Control and Safety System**

35 Control and safety systems shall be as stated in the contract specific documentation. The traffic control system shall monitor the barriers and signals for faults and status and provide the information in a suitable format to the bridge operator. The control system shall ensure the safe interlocking for the operation of the wigwag signals and the barriers with the bridge movement control system.

35 – Interlocks are provided as appropriate and operations are suitably manned.

36 The traffic control system shall allow the bridge operator to safely control the opening and closing of the bridge with respect to boat traffic as well as vehicles and pedestrians.

36 – Full marine VHF provision by trained operatives.

37 The traffic control system shall only lower the barriers after the wig-wag signals have been flashing the red aspects for a defined period in accordance with the project specific requirements. Only when the barriers are fully lowered on both sides of the bridge shall the bridge be capable of being moved.

37 – Not applicable.

38 The traffic control system shall monitor the bridge movement and shall only raise

38 – Not applicable.

barriers and turn off the wig-wag signals when the bridge is locked into the correct position on both banks.

- |    |  |  |
|----|--|--|
| 39 | When the red wig-wag aspects are flashing, the traffic control system shall sound an audible device to warn pedestrians that the barriers will be lowered.   | 39 – Not applicable.                     |
| 40 | The bridge shall be controlled by one of the following methods depending on the project specific requirements:<br><br>i) locally controlled from a control office building located at the bridge<br>ii) remotely controlled from a central office elsewhere from the bridge<br>iii) automatically controlled by a boater operating a keyswitch<br>iv) automatically controlled by the detection of boats requiring the bridge to be moved. | 40 – Item i) applies.                    |
| 41 | The traffic control system shall be used with the CCTV system to ensure the bridge is clear of traffic before opening and closing of the bridge. Separate monitors shall be provided in the bridge control office for each camera located at and on the bridge.  | 41 – Not applicable. Staff present.      |
| 42 | The supplier shall ensure the safety integrity on the traffic control system and its interface with the bridge control system.   | 42 – Not applicable. Staff present.      |
| 43 | A maintenance procedure shall be proposed for any routine and breakdown requirements.  | 43 – Staff on standby.                   |
| 44 | The traffic control system shall be tested prior to installation on site. All tests shall be documented.   | 455 – Not applicable.                    |
| 45 | After satisfactory testing the system shall be installed, connected to the other traffic equipment and commissioned as a whole. Following this test the traffic control system shall be integrated into the bridge   | 45 – Team fully trained and experienced. |

control system and shall be commissioned as part of the total system in accordance with Series 7300.

### **Shipping Control**

46 Navigation lights for movable bridges as stated in the contract specific documentation shall be installed on the moving sections, landing piers and at the river approaches, controlled and monitored by appropriate status indicators from the control console. 46 - Need for navigation lights considered. Bridge brightly lit for decoration / definition purposes.

47 Navigation lights for bridge access gantries shall be mounted on the lower parts of the gantry if required. 47 – Not deemed necessary.

48 All lights and controls shall meet the requirements of enclosure classification of IP 67 as defined in the appropriate standards. 48 – Satisfied as far as required.

### **Public Address System**

49 A Public Address System suitable for external use, shall be provided if specified in the contract specific documentation for bridges which have pedestrian access. The system speakers shall meet the minimum enclosure requirements of IP65 as defined in the appropriate standards. The system console may be incorporated as part of the bridge control console. 49 – No public address system.

### **Anemometers**

50 Approved anemometer shall be provided to measure wind velocity and direction where specified. 50 – Deemed unnecessary.

### **Sample Appendices: (A7205/2) : Communications, Traffic and Shipping Control**

The Contractor shall insert below details of the equipment proposed.

**(7302.) TESTING INSPECTION AND COMMISSIONING AT SITE**

**General**

- |   |  |
|---|--|
| <p>1 Testing shall be carried out during normal site working hours as far as practicable. Tests which involve existing apparatus and power outages may take place outside normal working hours. Testing of an item to be concealed or buried should be pretested in stages prior to concealment.</p>  | <p>1 - Regular testing is carried out with a fully trained staff present.</p> <p>Every opening constitutes a test with full staff present and with a log of the opening being completed.</p> |
| <p>2 Adequate notification to all parties who may require to witness the tests shall be given. Reference should be made to consulting the operating authority if works involve existing road networks.</p>  | <p>2 - The witnessing parties would obtain the same notice as the Emergency Services. This is dependant on the requests made by firms wishing to use the river.</p>                          |
| <p>3 The requisite experienced testing personnel and all relevant test equipment shall be provided.</p>   | <p>3 - This is done.</p>   |
| <p>4 Details of the tests to be carried out and the methods to be adopted shall be in accordance with the contract specific documentation. A complete set of approved test forms shall be provided before testing commences.</p>  | <p>4 - Details of tests are distributed to all relevant parties and signed off as having been completed.</p>   |
| <p>5 A test form shall be provided for each item of plant and/or test. The test forms shall show the type of plant and serial number or other identifying mark. Test forms shall also show details of the test equipment and instruments used. Provision shall be made on the form for recording all the test results.</p>  | <p>5 - Paperwork as described is produced. Minor testing is done when the bridge is opened for a river purpose. More thorough tests are carried out about twice per year by arrangement.</p> |
| <p>6 The results of the test shall be recorded clearly on the test form with clear references to the equipment and items to which they refer, so that the record form can be used as the basis for maintenance tests during the working life of the equipment. The required number of site test result records shall be provided as soon as possible after completion of the tests, and prior to offering the</p> | <p>6 - Test results are recorded.</p>  |

installations for acceptance and final inspection.

- 7 Test equipment shall be of satisfactory quality and condition and, where necessary, shall be appropriately calibrated to the appropriate standards specified. 7 - Complied with.
- 8 The testing requirement details may be subject to some variation upon the instruction or agreement, where necessitated, by changed conditions at site or by differing design, manufacture or constructional techniques. 8 - Complied with.
- 9 All tests shall be carried out and witnessed in accordance with the contract specific documents. 9 - Complied with.
- 10 Any defects of workmanship, materials and performance, maladjustments or other irregularities which become apparent during testing and/or commissioning shall be rectified, then retested and/or recommissioned. 10 - Complied with.
- 11 A method statement for the testing and commissioning of all life and health safety systems shall be provided. 11 - Method statements are completed.
- 12 All life safety systems shall operate in conjunction with all new and/or existing life safety systems. The life safety systems may include some or all of the following systems: 12 - Complied with.
- i) Fire Alarms
  - ii) Gas Extinguishing System
  - iii) Pressurisation of escape routes for smoke control
  - iv) Ventilation shut down
  - v) Mains failure back-up
  - vi) Stand by power
  - vii) Environmental monitoring
  - viii) Barrier closing
- 13 Operational tests of all life safety systems in association with all other systems shall be carried out to ensure compatibility and correct operation. 13 - Complied with.

14 If the tests fail to demonstrate the satisfactory nature of the installation or portion of it, then alterations, or replacements as required to effect a further test when such alterations have been made shall be carried out.

14 - Complied with.

### Electrical Services

### Electrical Services

15 All sections of the electrical services shall be tested as each section of the work is completed on site in order to verify that the results obtained are fully compliant.

15 - Complied with.

16 Where the results are found not to comply with the requirements of the appropriate standards specified remedial work shall be carried out without delay.

16 - Complied with.

17 A visual inspection of the remedial action shall be initially carried out. Any defects or necessary remedial action identified shall be put in hand immediately.

17 - Complied with.

18 The following tests shall be carried out prior to the connection of the supply to the installation:

18 – Full IEE testing carried out regularly embracing all of the items i) to ix) listed.

- i) Continuity of ring final circuit conductors
- ii) Continuity of protective conductors, main and supplementary bonding
- iii) Earth electrode resistance
- iv) Installation testing
- v) Insulation resistance
- vi) Insulation of site-build assemblies
- vii) Protection by electrical separation
- viii) Insulation of non conducting floors and walls
- ix) Polarity

Full IEE testing carried out.

19 The following test sequence shall be carried out after the supply has been connected:

- i) earth fault loop impedance
- ii) operation or residual current operated devices and fault-voltage operated devices

iii) operation of all plant and equipment

20 – Testing is comprehensive.

20 The testing requirements detailed may be subject to some variation upon the instruction or agreement where necessitated by changed conditions at site or by differing design, manufacture or constructional techniques.

**Mechanical Services**

*Cleaning*

21 - Complied with.

21 Immediately prior to the testing and commissioning of the completed works or part of all parts of each system and related plant shall be thoroughly cleaned internally and externally.

22 - Complied with.

22 Before commencing such work all equipment which could be damaged shall be isolated and all terminal points at ends of pipe circuits cross connected to ensure circulation during the cleaning process.

23 - Complied with.

23 Attention shall be paid to the protection of plant, particularly sensitive or fragile items, from the activities of other trades during construction, from the ingress of dirt and from unauthorised operation during commissioning.

*Site Tests*

24 - Not applicable.

24 All pressure tests shall be carried out before the application of thermal insulation, but where this would prejudice the completion of the installation, the section concerned shall be individually tested before the application of insulation.

25 - Complied with.

25 Due allowance shall be made for any sectional testing of the Works that may be required to suit the contract programme and, in the case of systems requiring hydraulic pressure testing, for any subsequent draining and refilling that may be required due to the ambient conditions.

*Commissioning*

26 - Complied with.

26 - Before any commissioning is commenced, it shall ensured that the installation has been cleaned, inspected and pressure tested.

27 – Complied with.

27 Having ensured that electricity, water, fuel and other necessary supplies are available, the completed Works or part of it shall be set into operation, and all necessary adjustments to ensure correct functioning shall be made.

28 - Complied with.

28 After the installation or part of it has been set into operation the operation of the installation shall be demonstrated.

29 – Complied with.

29 The tests shall demonstrate:

- i) that the equipment etc. provided complies with the Specification in all particulars and is of adequate capacity for its full rated duty.
- ii) that all items of plant and equipment meet the specified requirements for noise limitation.
- iii) that all electrical circuits are properly fused and protected and conduit systems are electrically continuous and properly earthed.

*Performance Testing*

30 - Complied with.

30 Performance testing may be required to demonstrate, by measurement and recording, that the installation functions correctly and maintains internal environmental conditions, within the specified limits, under varying plant loading.

31 -This procedure adopted.

31 Performance testing of an installation shall only take place on completion of commissioning.

32 - Complied with as appropriate.

32 The site tests shall be of the specified duration which shall be long enough to allow the taking of all measurements required and to demonstrate the performance of the installation.

### High Voltage Switchgear

33 After completion of the installation tests on the complete switchboard assemblies shall be carried out in accordance with the appropriate standards specified. The tests shall also include, but not limited to, the following:

- i) Measurement of the resistance of all parts of the main circuit
- ii) Verification of correct wiring
- iii) Dielectric tests on all auxiliary and control circuits
- iv) Full operational check of local and remote control and monitoring functions, interlocks and relay settings
- v) Functional tests of protection and circuit breaker operation, which shall include primary and secondary current injection tests as appropriate.
- vi) Full operational check of all indicating and metering equipment.

### Transformers

34 After installation on site, each transformer shall be subjected to the following tests:

- i) Dielectric tests
- ii) Measurement of sound level
- iii) Check for correct operation of gas and oil actuated alarms, relays and indicating instruments
- iv) Check for operation of interfaces with plant monitoring and control systems

### Low Voltage Switchgear

35 Pressure tests in accordance with the appropriate standards specified shall be carried out on all distribution equipment. The insulation resistance of all secondary circuits shall also be measured and recorded.

36 Operation of all switches controls

### High Voltage Switchgear

33 - Not applicable.

### Transformers

34 - Not applicable.

### Low Voltage Switchgear

35 – Comprehensive IEE tests carried out.

36 - Not applicable

indicating and metering equipment shall be demonstrated.

37 - Not applicable

37 Secondary injection tests shall be carried out on protection relays.

38 – Full EE testing carried out.

38 Tripping, closing at normal and reduced voltages, also other operational checks on all circuit breakers and associated secondary circuits.

39 - Not applicable.

39 Checks on all local and remote indication and alarm circuits shall be carried out.

40 - Not applicable.

40 Interlocks and intertrip sequence operations shall be carried out.

41 – Not applicable.

41 Recommendations and setting up of the time and current settings of all protection relays to provide satisfactory discrimination in each circuit. Calculations used to obtain settings shall be made available

#### **Standby Generators**

#### **Standby Generators**

42 - There is no standby generator.

42 The generator plant, including its associated fuel, cooling, exhaust, electrical and fire safety systems shall be thoroughly checked for correct operation in both manual and automatic modes during and upon completion of site installation. The initial checks will consist largely of static checks to ensure that installation has been carried out correctly in readiness for full testing and commissioning.

43 - Not applicable.

43 The engine/alternator shaft alignment shall be checked where the set is not skid-mounted or where the assembly has been dismantled for transportation to the site.

44 - Not applicable.

44 The generator output voltage, frequency and phase rotation shall be checked before further tests are carried out and before final connection to the electrical distribution system.

45 - Not applicable.

45 A load test with the standby generator supplying the full site load shall be carried

out. As an alternative to the full site load a multi-stage load bank capable of offering loads at power factor 0.8 lagging shall be used.

46 - Not applicable.

46 The duration of the site load test shall be at least 4 hours for all sets above 100kW. Sets rated at less than 100kW shall be tested for 1 hour.

47 - Not applicable.

47 In all cases, the test shall be carried out at varying loads up to the full rated load, with instrument readings recorded every 15 minutes. These readings shall include jacket water temperature, exhaust temperature, lubricating oil level, temperature and pressure, output voltage and frequency. The room temperature shall also be monitored.

48 - Not applicable.

48 Multiple set installations shall be commissioned to demonstrate synchronisation with any combination of sets available and, where appropriate and by prior agreement, in parallel with the supply authority.

49 - Not applicable.

49 All local/remote controls, emergency stop and all protection devices/interlocks etc. shall be proved during on-site commissioning tests.

50 - Not applicable.

50 The time interval should be noted between initial start up and load acceptance for the lead machine and, for multiple set installations, the time taken for the remaining sets to synchronise and accept load. Load sharing between sets shall also be checked.

### **UPS Equipment**

#### **UPS Equipment**

51 - Not applicable.

51 Tests on the complete UPS system shall be carried out in accordance with appropriate standard specified.

#### **52 – No UPS**

52 These tests shall include, but not be limited to, the following:-

- i) Functional check of the equipment, protective devices and instruments

- ii) Operation from the normal mains supply, and from the standby supply (if this is available)
- iii) Simulated mains failure and return at specified load
- iv) By-pass switch operation at specified load (where applicable)
- v) Verify battery discharge and recharge periods by carrying out a discharge/charge/discharge cycle.

### **Movable Bridges Mechanical Plant**

134 After final installation, but before connection to the piping system or valve stands, power units shall be checked for correct rotation of drive motors and pumps.

135 Reservoirs shall be hydraulically filled with fluid to the correct level. Portable filtration units shall be used during reservoir filling.

136 After completion of all piping and tubing assembly work, the entire system shall be flushed prior to connection to the system operating elements.

137 All controls shall be tested for design intent.

138 Associated communication devices shall be tested and the electrical installation shall be tested to the appropriate standards specified.

139 When the entire installation is completed, the movable span, including all accessories, shall be tested through not less than ten complete cycles using normal power, prime movers, and controls. These tests shall be repeated for alternate operating modes if provided.

140 During these tests, equipment shall be inspected for external fluid leakage, and to determine whether all features are in proper working order and adjustment, and whether

### **Movable Bridges Mechanical Plant**

134 - Not applicable.

135 - Complied with as regards the nosebolt. Not applicable to bridge actuating system which is entirely mechanical.

136 - Not applicable.

137 - Complied with.

138 - Complied with.

139 - A mechanical equivalent exercise is carried out.

140 - Not applicable.

they meet the requirements.

141 - Not applicable.

141 Portable pressure gauges shall be used at all test stations of the hydraulic system, including the power unit.

142 - Not applicable.

142 During all the above tests, the level of the hydraulic fluid in the reservoir shall be closely monitored. Proper fluid level shall be maintained at all times to prevent pump cavitation. Air shall be bled from the hydraulic system and make-up fluid added to the reservoir as required, using portable filtration units.

143 - Complied with.

143 In the event tests show that any features are defective or inadequate, or function improperly, all necessary corrections, adjustments or replacements shall be made.

144 - Not applicable.

144 When all the components are in an agreed proper working order and adjustment, the pressure readings taken at each test station shall be recorded, and certificates provided.

145 - Not applicable.

145 After completion of final tests hydraulic fluid shall be removed, properly discarded, replaced with new fluid, and air bled from the entire hydraulic system. New fluid shall be added using portable filtration Units.

146 - Not applicable.

146 After completion of final hydraulic testing, and either fluid replacement or the continued use of fluid which has passed contamination level testing, filter elements shall be replaced and strainers and magnets cleaned.

### **Test Certificates**

#### **Test Certificates**

149 - Tests are carried out approximately twice each year and certificates are produced.

149 Certified copies of test results and certificates stating that the plant and materials comply with the specifications and standards shall be provided for all mechanical, electrical and communications plant and insertion in the test/operation and maintenance manuals.

### **River Traffic**

*(150) This section is written to complete the safety practices adopted by the Council with regard to river traffic. It does not form part of the Highway Agency's specification.*

### **River Traffic**

150 Note: Due to the heavy traffic on the A8 it is necessary to minimise the time from the closing of the traffic gates until their subsequent opening. It is also vital that there should be no collisions between the bridge and any river traffic.

For that reason the operatives are provided with hand held marine band VHF radios. These are used to establish contact with river traffic and the operatives, principally the bridge driver. Initial contact is established using channel 16. This is also the Emergency Channel and a switch to an agreed working channel is established as soon as possible.

It is possible that the Coast Guard will notice the radio traffic and a working relationship should be established. Using the radios, the intentions of river traffic can be monitored and the bridge opening period kept to a minimum.