NORTHUMBRIAN WATER GROUP

ENGINEERING STANDARD E0702

DESIGN MANUAL

FOR

TWO PUMP SEWAGE PUMPING STATIONS

ON

SEPARATE SEWERS

ABBEY ROAD
PITY ME
DURHAM
DH1 5FJ

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CONTENTS

AMENDMENT RECORD

ISSUE NUMBER	DATE	DESCRIPTION
1	March 1996	New Specification
2	January 1998	Appendix A8.1 - Serck Proteus PS1 “Termination and Compile Sheet” shall supersede any reference to Telemetry Input Signals indicated on E0702 Drawings 127 and 128.
3	August 2000	Modified in line with Issue No4 Sewers for adoption.
4	July 2001	Sections 1.6 & 8.2 Add “or an innovative impellor design which has been approved by NWG”.
5	June 2005	Document converted to pdf and drawings embedded.
6	June 2017	Modifications to requirements for Hydraulic testing of pipework in appendix A12. Clarification of System Test Pressure to bring in line with E0102 and reference to CESWI.
7	August 2017	Further amendments to Appendix A12 following discussions with Framework Partners. Clauses added regarding requirements to accommodate future requirements and bolting torque applied to pipework fasteners.
8	January 2020	Modifications or Additions to the following:

FOREWORD

This standard provides guidance on the requirements for Two Pump Sewage Pumping Stations, that are to be constructed by Northumbrian Water Group (NWG), or that are intended for adoption by NWG, where the pumping station is on a separate sewer, and each pump is rated at 30 kW or less. NWG has other requirements and specifications for larger sewage pumping stations, and for combined sewer installations.

Compliance with this NWG Standard does not of itself confer immunity from legal or statutory obligations.

WARNING
This is a Northumbrian Water Guidance document, and will be subject to revision from time to time. Uncontrolled paper copies will not be updated, so users are recommended to check with NWG that they have the current Standard prior to use.

INTRODUCTION

Guidance for Consultants employed on behalf of NWG and for Developers is provided on the issues and matters requiring consultation, including where to seek advice and details of specifications normally acceptable to NWG.

Information is taken from other industry specifications, and NWG Specifications to minimise the need to cross reference to other sources, and to provide detailed interpretation with respect to two pump submersible pumping stations on separate sewers.

These are the standards that NWG applies to its own projects and expects from Developers who are constructing pumping stations for later adoption by NWG.

Developers are reminded however that they are responsible for all aspects of design for any particular pumping station and must furnish NWG with satisfactory and complete design, testing and operating information before any station can be adopted.

ALLOWANCES FOR INNOVATION

NWG recognise that Suppliers will continually develop products as part of their business processes, and this specification does not intend to stifle such innovation. It is understood that innovations within this field could contribute to the following benefits:

1. Intelligent pump monitoring and control.
2. Reduction in panel /kiosk size for areas that are sensitive.
3. Reduction in whole life cost.
4. Removal of risks from confined space entry or lifting operations.
5. A package solution to simplify installation.

Any deviations from this Specification shall be submitted to NWG using the Engineering Deviation Request form available on NWG Sharepoint, the deviations will be assessed against the benefits described above (1-5).

SECTION A1 : DEVELOPER GUIDELINES

1.0 INTRODUCTION

1.1 Guidance is provided on the requirements for two pump Submersible Pumping Stations to be adopted and operated by NWG, including information for Developers, Designers and Procurement Engineers.

1.2 No combined systems will be adopted by NWG, only separate systems are permitted.

1.3 This document shall be used in conjunction with 'Sewers for Adoption' (a design and construction guide for developers). Where there is a conflict between this document and Sewers for Adoption, this document shall take precedence.

1.4 A summary of the main requirements for Developers is provided, together with general Design Requirements and Civil, Mechanical and Electrical specifications.

1.5 NWG New Development/Asset Investment, can provide advice to Developers and should be contacted at the earliest possible stage of project development to minimise difficulties in the eventual adoption of the Pumping Station.

1.6 The pumping of sewage is to be avoided wherever possible and the number of stations is to be kept to a minimum . All options are to be explored and discussed with NWG before the decision to build a pumping station is taken.

1.7 NWG will only adopt those installations which conform to the agreed designs.

2.0 SCOPE

2.1 This document is intended to provide guidance on the preferred design and equipment requirements for two pump Submersible Pumping Stations, using pumps of up to a maximum of 30 kW each. NWG should be consulted if larger stations are necessary.

Developers must provide fully detailed designs and specifications for each proposed Pumping Station.

3.0 OTHER APPLICABLE DOCUMENTS

3.1 This document contains the main requirements for two Pump Submersible Pumping Stations and must be read in conjunction with:

- Sewers for Adoption - WSA
- Water Industry Mechanical and Electrical Specification No 1.02 (WIMES 1.02)
- Civil Engineering Specification for the Water Industry (CESWI) - WSA/WRc

- Water Industry Act (1991) Sections 102-104 Adoption of Sewers and Disposal Works

- Environmental Permitting (England & Wales) Regulations 2016
- Construction Industry Research and Information (CIRIA) Reports
- NWG Electrical Safety Procedures E0303
- Flammable Liquids in Drainage Systems 'FLIDS'
- Environmental Permits: https://www.gov.uk/government/publications/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows

4.0 ROLES AND RESPONSIBILITIES

4.1 The **Developer** in addition to the items listed below shall carry out all roles and responsibilities as stated in the latest edition of Sewers for Adoption.

(a) Be responsible for all aspects of the design and construction and for obtaining the required approvals from the relevant statutory and consultation bodies. This includes ensuring that all the duties of the Designer and Contractor referred to in this document are fully discharged.

(b) Discharge all costs associated with design, construction and adoption of the Submersible Pumping Station.

(c) Liaise closely with, and provide detailed design, operation, maintenance and test information to NWG.

(d) Carry out an assessment of surge potential in the installation from the data provided on the pumping requirements.

(e) Propose any modifications considered necessary to the basic design to eliminate surge and, in the event of elimination being impossible, consult with NWG regarding surge control measures.

(f) Be responsible for the operation and maintenance of the Pumping Station until it is formally adopted by NWG.

(g) Demonstrate to NWG that the Submersible Pumping Station complies fully with the requirements of this document. Any deviations require the prior approval of NWG.

(h) Be responsible for taking any measures to overcome odour problems prior to adoption.

4.2 **NWG New Development/Asset Investment** shall.

(a) Provide reasonable advice relating to design requirements and equipment selection to the Developer.

(b) Provide advice on, and co-ordinate the provision of, any telemetry equipment or services purchased by the Developer from NWG.

(c) Provide advice on the range of services that can be purchased from Northumbrian Water.

(d) Be the point of contact for all formal communications with NWG.

NWG will not re-design inadequate submissions from Developers/Designers or re-check sub-standard equipment or construction without charge.

5.0 CONSULTATION BODIES

5.1 Developers shall consult with NWG at the project inception in order that the requirements of Section 104 of the Water Industry Act 1991 can be fulfilled.

5.2 Consent to discharge the Developer shall comply with the latest edition of Sewers for Adoption

(a) The Developer shall contact the EA at the earliest possible time, to ensure that any consent requirements relating to the Pumping Station emergency overflow are included at the design stage.

(b) Emergency overflows should not be proposed in the design unless specifically requested by NWG. The developer shall contact NWG's Asset Investment appointed Pumping Station Engineer to decide if an overflow is required. If an overflow is required and agreed with NWG, the developer shall contact the EA to gain advice on appropriate storage volumes.

(c) The consent will relate to the final outfall of the surface water sewer and not to the point where the emergency overflow connects to another sewer. The consent may also stipulate additional storage, standby power supply and/or restrictions on particular size of solid matter discharged.

(d) A discharge consent, confirmed as valid by the EA, must be in force prior to adoption. The proposed terms or the consent shall be submitted by the Developer to NWG for agreement **six weeks** before the time limit for objections expires.

(e) All EA discharge permits require that the frequency and duration of all emergency overflow discharges are monitored. When a Developer applies for a consent he will be responsible for reporting to the EA any operation of the emergency overflow that has occurred during the period prior to adoption..

(f) If the emergency overflow is connected to a public surface water sewerage system, NWG will be required to log failures. The Developer will be required to supply any relevant data to NWG for the period when the station is not connected to the NWG Control Room by telemetry.

(g) Costs for the Consent, including the annual substance charge, will be borne by the Developer until the Pumping Station has been adopted. The amount charged will be based on the EA's national charging scheme.

5.3 Consultation with the following bodies/organisations should be undertaken at project design stage, prior to construction/installation:

(a) The Regional Electricity Company (REC) to confirm the availability and characteristics of the supply, as described in the Design Requirements section and the Electrical and Telemetry Specification. The Developer shall consult with NWG where the REC is able to provide a choice of tariffs.

(b) The Local Authority, to obtain building consent and approval under the Town and Country Planning Act 1971.

Note: The external appearance and features of an installation must blend satisfactorily with the rest of the development.

(c) NWG for information regarding the capacity of downstream sewer systems.

(d) NWG for telemetry requirements, as described in the Design Requirements section and the Electrical and Telemetry Specification.

(e) NWG for emergency overflow monitoring details, where pumps or power failure has occurred as detailed in the Electrical and Telemetry Specification.

(f) NWG for details of Hazardous Areas risk assessments "FLIDS", as described in the Design Requirements section B11.

(g) Crown Commissioners, MAFF (Ministry of Agriculture, Fisheries and Farms) and RASWA (Roads and Street Works Act) to ensure that all other relevant consents/approvals/fees or legislation are in place before construction commences.

5.4 The Developer will need to ensure that he/she complies with all other legislation which affects his proposal including, but not limited to, those covering conservation areas, SSSIs and ancient monuments.

6.0 PROGRAMME OF WORKS AND INFORMATION TO BE PROVIDED

6.1 The Developer shall advise NWG of the intended construction and commissioning programme for the Pumping Station.

6.2 The programme shall contain the following information:

(a) Construction start date, in order that NWG, can monitor progress.

(b) Date on which the station control equipment is to be installed, and when the telemetry is required.

(c) Dates of the Pumping Station commissioning period.

6.3 **Prior to Construction**

(a) All design data and the programme of work will be provided to NWG at least one month prior to work commencing on site.

6.4 **Prior to Adoption**

The following information must be given to NWG prior to Adoption:

(a) The documentation detailed in sub-sections 2 and 3 of the Documentation section.

(b) All conveyances/transfers and agreements relating to land occupied by, and having access to, the Pumping Station. All such documents shall be sealed/signed by all parties and be ready for completion.

(c) The original copy of the EA Consent to Discharge.

(d) Name and address of the Developers legal representative(s).

7.0 ADOPTION PROCEDURE

The following must be achieved before NWG will adopt any Pumping Station.

7.1 **Documentation**

(a) The documentation specified in the Documentation Section shall be provided to NWG in order that an assessment for adoption can be carried out.

7.2 **Adoption Inspection**

(a) Prior to adoption NWG, or its appointed representative, will conduct an inspection of the civil, mechanical, electrical and telemetry installations, and may request detailed testing to be carried out to ascertain satisfactory operation of the Pumping Station and conformity to the design specification. The Developer will be responsible for meeting all costs, and the provision of resources, necessary for carrying out the tests.

(b) Any defects will be corrected by the Developer and at his/her cost.

NWG reserve the right to impose charges on the Developer for further inspections or tests that may be required to check corrective work or modifications.

(c) Arrangement for the Adoption Inspection will be made by the Developer with NWG New Development/Asset Investment , giving at least one months written notice from the date the documentation is provided.

(d) If the pumping station is more than 5 years old, NWG require the developer to replace the pumps for new models in accordance with correct pump selection procedures. This can be contested if the developer can demonstrate the required performance by means of a flow test and presentation of sufficient maintenance regimes. NWG reserve the right to accept/deny any objections based on the performance and maintenance content provided by the developer.

Inspections will not be made without the documentation being in NWG's possession.

7.3 **Land Ownership**

(a) The freehold of the land occupied by the Pumping Station will be conveyed/transferred to NWG for a nominal consideration of £1.00. Unobstructed access rights for vehicles along approach roads, from highways, must be provided at all times.

(b) Where appropriate the freehold ownership of any land occupied by Pumping Station approach roads will be transferred with the Pumping Station, free of charge to NWG.

(c) Where approach roads are shared, agreement must be obtained from the other owners to give NWG unobstructed access rights.

8.0 DEVELOPER ADVICE

8.1 Advice on consultation issues can be obtained from the contacts provided in Appendix A9.

SECTION A2 : CONSULTANT GUIDELINES

1.0 INTRODUCTION

1.1 Guidance is provided on the requirements for two pump Submersible Pumping Stations to be built for and operated by NWG.

1.2 This document shall be used in conjunction with 'Sewers for Adoption' (a design and construction guide for developers). Where there is a conflict between this document and Sewers for Adoption, this document shall take precedence.

1.3 A summary of the main requirements is provided, together with general design requirements and Civil, Mechanical and Electrical specifications.

1.4 The pumping of sewage is to be avoided wherever possible and the number of stations is to be kept to a minimum . All options are to be explored and discussed with NWG before the decision to build a pumping station is taken.

2.0 SCOPE

2.1 This document is intended to provide guidance on the preferred design and equipment requirements for two pump Submersible Pumping Stations, using pumps of up to a maximum of 30 kW each. NWG should be consulted if larger stations are necessary.

2.2 The guidelines are generic and intended as a minimum standard only.

3.0 OTHER APPLICABLE DOCUMENTS

3.1 This document contains the main requirements for two Pump Submersible Pumping Stations. The documents below are referred to, or will provide additional detailed information on particular aspects:

- Sewers for Adoption - WSA
- Water Industry Mechanical and Electrical Specification No 1.02 (WIMES 1.02)
- Civil Engineering Specification for the Water Industry (CESWI) - WSA/WRc
- Water Industry Act (1991) Sections 102-104 Adoption of Sewers and Disposal Works
- Environmental Permits: https://www.gov.uk/government/publications/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows/water-companies-environmental-permits-for-storm-overflows-and-emergency-overflows
- Environmental Permitting (England & Wales) Regulations 2016
- Construction Industry Research and Information (CIRIA) Reports

4.0 ROLES AND RESPONSIBILITIES

4.1 The **Consultant** shall:

(a) Be responsible for all aspects of the design and construction and for obtaining the required approvals from the relevant statutory and consultation bodies with the exception of the EA. This includes ensuring that all the duties of the Designer and Contractor referred to in this document are fully discharged.

(b) Liaise closely with, and provide detailed design, operation, maintenance and test information to NWG.

(c) Carry out an assessment of surge potential in the installation from the data provided on the pumping requirements.

(d) Propose any modifications considered necessary to the basic design to eliminate surge and, in the event of elimination being impossible, consult with NWG regarding surge control measures.

(e) Demonstrate to NWG that the Submersible Pumping Station complies fully with the requirements of this document. Any deviations require the prior approval of NWG.

(f) Be responsible for recommending measures to overcome any odour problems.

4.2 **NWG New Development/Asset Investment** shall:

(a) Provide reasonable advice relating to design requirements and equipment selection to the Consultant.

(b) Provide advice on, and co-ordinate the provision of, any telemetry equipment or services available from NWG.

5.0 CONSULTATION BODIES

5.1 Discharge Permits: :

(a) NWG shall contact the EA at the earliest possible time, to ensure that any permit requirements relating to the Pumping Station overflow(s) are included at the design stage.

(b) The permit will relate to the final outfall of the surface water sewer and not to the point where the emergency overflow connects to another sewer. The permit may also stipulate additional storage, standby power supply and/or restrictions on particular size of solid matter discharged. Discharge permits may be refused if the location is in a sensitive environment.

(c) All EA discharge permits require that the frequency and duration of all emergency overflow discharges are monitored.

(d) NWG will be required to log failures at a NWG Control Room by telemetry.

5.2 Consultation with the following bodies/organisations should be undertaken at project design stage, prior to construction/installation:

(a) The Regional Electricity Company (REC) to confirm the availability and characteristics of the supply, as described in the Design Requirements section and the Electrical and Telemetry Specification. The Consultant shall consult with NWG where the REC is able to provide a choice of tariffs.

(b) The Local Authority, to obtain building consent and approval under the Town and Country Planning Act 1971.
Note: The external appearance and features of an installation must blend satisfactorily with the rest of the development.

(c) NWG for information regarding the capacity of downstream sewer systems. Also the capacity of receiving Sewage Treatment Works and their compliance.

(d) NWG for telemetry requirements, as described in the Design Requirements section and the Electrical and Telemetry Specification.

(e) NWG for emergency overflow monitoring details, where pumps or power failure has occurred as detailed in the Electrical and Telemetry Specification.

(f) NWG for details of Hazardous Areas risk assessments “FLIDS”, as described in the Design Requirements section B11.

(g) Crown Commissioners, MAFF (Ministry of Agriculture, Fisheries and Farms) and RASWA (Roads and Street Works Act) to ensure that all other relevant consents/approvals/fees or legislation are in place before construction commences.

5.3 The Consultant will need to ensure that he/she complies with all other legislation which affects his proposal including, but not limited to, those covering conservation areas, SSSIs and ancient monuments.

6.0 PROGRAMME OF WORKS AND INFORMATION TO BE PROVIDED

6.1 The Consultant shall advise NWG of the intended construction and commissioning programme for the Pumping Station.

6.2 The programme shall contain the following information:

(a) Construction start date, in order that NWG can monitor progress.

(b) Date on which the station control equipment is to be installed, and when the telemetry is required.

(c) Dates of the Pumping Station commissioning period.

6.3 **Prior to Construction**

(a) All design data and the programme of work will be provided to NWG at least one month prior to work commencing on site.

6.4 **Prior to Take-over by NWG**

The following information must be given to NWG prior to Take-over:

(a) The documentation detailed in sub-sections 2 and 3 of the Documentation section, excluding the evidence of land ownership.

7.0 TAKEOVER PROCEDURE

The following must be achieved before NWG will take-over any Pumping Station.

7.1 **Documentation**

(a) The documentation specified in the Documentation Section shall be provided to NWG.

7.2 **Take-over Inspection**

(a) Prior to adoption NWG, or its appointed representative, will conduct an inspection of the civil, mechanical, electrical and telemetry installations, and may request detailed testing to be carried out to ascertain satisfactory operation of the Pumping Station and conformity to the design specification.

(b) Arrangement for the Take-over Inspection will be made by the Consultant with NWG, giving at least one months written notice from the date the documentation is provided.

(c) If the pumping station is more than 5 years old, NWG require the developer to replace the pumps for new models in accordance with correct pump selection procedures. This can be contested if the developer can demonstrate the required performance by means of a flow test and presentation of sufficient maintenance regimes. NWG reserve the right to accept/deny any objections based on the performance and maintenance content provided by the developer.

Inspections will not be made without the documentation being in NWG's possession.

SECTION B : DESIGN REQUIREMENTS

1.0 GENERAL

1.1 No combined systems will be adopted by NWG, only separate systems are permitted.

1.2 Arrangement layout and details shall generally be in accordance with the drawings provided in Appendix A1, and incorporate, as appropriate, NWG Standard Details as provided in Appendix A2.

1.3 The Designer shall satisfy himself/herself as to the practicability of the pipework and proposed sump arrangements whenever these differ from the standard layout shown in Appendix A1.

1.4 Effects of the Pumping Station on nearby residents must be taken into account, and where necessary preventative measures put in place to avoid odour and noise problems.

1.5 Hedging and/or landscaping shall be agreed at the planning stage With the Local Authority to improve the appearance of the installation. Any such contribution shall have minimum maintenance requirements.

1.6 On completion, the installation is to be suitable for its intended use, within the environment in which it is to operate. The installation is to ensure safety, and shall operate in a reliable and efficient manner between equipment manufacturers' recommended maintenance intervals, without the need for attention or inspection.

1.7 The pumping station shall operate automatically as described in Appendix A8.2.

2.0 SPECIFICATIONS

2.1 General civil, mechanical and electrical specifications have been extracted from NWG's suite of standards and are provided herein. Particular Specifications will need to be drawn up by the Designer for each proposed Pumping Station.

3.0 LOCATION AND SITE ACCESS

3.1 The choice of site for a Pumping Station is very important, being influenced by the configuration of the development it serves, the type of sewerage system connected to it, and the requirement to minimise pumping head.

3.2 The Pumping Station design shall take into account the requirement for an emergency overflow, and adequate storage in the event of equipment failures.

3.3 The Pumping Station will need to be sited in a secure enclosure. NWG's preferred standard arrangement is 2.4m high palisade fencing with gates of

sufficient size to allow vehicle access for maintenance and repair purposes. (See Appendix A2).

The gates shall have a locking facility allowing entry to both NWG and REC personnel. NWG should be consulted on the detail of this arrangement.

The enclosure shall be of a suitable size and layout to allow vehicles such as tankers and vehicle mounted cranes to manoeuvre. This will ensure that pumps can be removed/installed at the wet well, and temporary mobile pumps and generators can be conveniently sited when required.

Protective and decorative finishes shall be agreed with the local planning authority and NWG.

3.4 All Pumping Station installations shall have an all-weather access road of 3.5m minimum width, and a turning circle suitable for a sludge tanker with an axle loading of up to 11.5 tonnes.

3.5 All pumping stations must have 24 hour vehicular access. Access should preferably be directly from the public highway but where this is not possible a private access route shared with other users must contain provisions to give NWG unobstructed access rights.

3.6 All areas within the pumping station operational site are to have a low maintenance finish. Any requirements to incorporate soft landscaping (e.g. hedging, tree planting) should be outside the security fence.

4.0 PUMPING STATION CAPACITIES AND SEPTICITY CONTROL

4.1 The capacity of the pumping units shall be consistent with the capacity of the rising main and capacity of any downstream gravity sewers.

The Designer cannot assume that downstream sewer capacity is adequate, this must be confirmed directly with NWG.

4.2 For stations with no Emergency Overflow, the following formula for storage is applied. Where stations have an Emergency Overflow, storage volume shall be agreed with the EA. To ensure that sewage flooding does not occur at, or upstream of, the pumping station during plant or power failure, additional storage shall be provided.

A storage volume of 4 hours at Dry Weather Flow (DWF) shall be provided with DWF being calculated as follows:

DWF (m3/day) = PG + E + I

Where: P = Population in Catchment

G = Domestic Consumption m3/hd/day)

E = Industrial Flows (m3/d)

I = Infiltration (m3/d)

* Infiltration is assumed as 50% of the populations daily consumption

* Domestic Consumption (G) = 0.18m3/hd/day shall be used

4.3 NWG require the storage volume to be contained within the wet well to avoid any risk of blockages in the upstream network. The base of the storage level shall start at the level of the standby trigger, and the top of the storage shall be below the invert level of the wet well inlet pipe.

Should this requirement result in the wet well depth exceeding 6m then NWG shall be consulted to decide upon alternative storage options (i.e. use of upstream network capacity).

4.4 If it is expected that further development will take place in the drainage area, the Pumping Station design shall allow for additional or different pumps to be added and increased storage capacity. This will be by provision of extra space in both the wet well and valve chamber and, if necessary, allowance for the duplication of the rising mains. Consideration should also be given to the electrical design. Detailed arrangements should be agreed with NWG.

Where provision is made for any future increase in flow, effects of initial low flows shall be considered. The system is required to maintain a self cleansing velocity in the rising main and at the same time pump sewage often enough to avoid septicity occurring.

The holding of sewage in the wet well or rising main for periods of time exceeding 6 hours is to be avoided, as this may result in septic conditions.

5.0 EMERGENCY OVERFLOW

5.1 **This will require the consent of the EA**. In the unlikely event of consent being given the overflow will be set as high as possible in the wet well in order to satisfy the conditions stated in the EA consent and, at the same time, avoid excessive surcharging of the sewerage system upstream.

5.2 In most cirmcumstances a discharge permit from the EA will not be authorised. If agreed, the typical allowance for storage is 4 hours at Dry Weather Flow. The actual volume would be agreed through the permit application process followed in guidance on the gov.uk website.

5.3 Should an overflow permit be given by the EA, then as far as possible solids shall be retained in the flow. Normally a screen with a scum board shall be fitted as indicated in Appendix A1 Civil drawings schedule is adequate, unless more stringent requirements are imposed by the EA.

6.0 RISING MAINS

6.1 The consequences of hydraulic surge in the rising main shall be taken into account when designing the Pumping Station, and appropriate measures taken

to ensure that surge effects are reduced to an acceptable tolerance level for the pipes and fittings subjected to such effects.

6.2 A copy of calculations on surge assessment shall be made available to NWG.

6.3 Where plastic pipes are used, the consequences of cyclic loading on fatigue life shall be considered.

6.4 Due regard for ease of maintenance shall be made when installing air valves.

6.5 The Designer will be responsible for demonstrating by site test, prior to adoption, that surge effects are not detrimental to the operation and maintenance of the system.

6.6 Further details may be found in the Civil Specification.

7.0 WET WELL DESIGN

7.1 The depth of the wet well should be kept to a minimum. The capacity should be designed for a maximum of seven pump starts per hour.

7.2 The preferred arrangement shall generally be in accordance with that shown on the drawings in Appendix A1. Circular construction wet wells are normally the most cost effective, but the designer may consider other options to suit the local ground conditions and make proposals to NWG.

7.3 Incoming sewers shall discharge into an inlet manhole adjacent to the wet well. From the manhole, the inlet into the wet well shall be at least 150 mm above the duty pump start level.

7.4 Benching shall be provided with a significant gradient in order that solids cannot settle around the outer edges of the well. Benching should not be completed until the pump supports have been installed.

7.5 The walls of the wet well shall be fair faced to a smooth finish. Ledges and platforms that might collect solids shall be avoided.

7.6 Provision of handrails shall be made around all openings in the Pumping Station roof slabs where the depth is 2 m or more; gates or removable sections shall be incorporated as required.

The handrails shall be constructed from either heavy duty galvanised steel or aluminium, and shall be of two rail type, with the upper rail set 1.1 m above floor level. Toe Boards shall be fitted. Handrails below ground level shall be of solid section.

7.7 Hinged, lockable access covers shall be selected with due regard for loading, security and manual handling limitations. For guidance on access covers please refer to Engineering Standard E0209 - ‘Galvanised Mild Steel Access Covers for Wastewater Applications’.

7.8 Suitable provision for ventilation of the wet well shall be made. Generally this will be via the emergency overflow, but if no overflow exists then arrangements

must be incorporated to suit local site conditions and to avoid causing odour problems.

8.0 PUMPS

8.1 Pumpsets are to be selected in accordance with the Water Industry Mechanical and Electrical Specification (WIMES 1.02), included in Appendix A3. This document requires inputs from both the supplier and the purchaser.

8.2 Designers shall select Pumpsets from suppliers that are on NWG's Pump Tender Framework.

8.3 Pumps must be fit for purpose, and NWG normally require raw sewage pumps to be capable of passing 100mm diameter spheres.

Where pumps with a lesser solids handling capability are offered, the Designer will be required to demonstrate, by design and satisfactory operation of the pumping station, that the pumps are capable of prolonged, reliable, and trouble free operation on raw unscreened sewage.

8.4 Pump rates shall be calculated at 6 times Dry Weather Flow.

Formula: 6PG +3E + I (See Section E, Clause 1.1).

8.5 When the pumping rate is 7 l/s or less, such that centrifugal pumps cannot be used, a macerator pump or other approved proprietary system may be considered. This shall be in consultation with NWG.

8.6 Further details may be found in the Mechanical Specification.

9.0 VALVE CHAMBER

9.1 A separate valve chamber is required. This will allow for the siting of the pump electrical junction boxes as well as the valves (see drawing in Appendix A1).

10.0 MATERIAL CORROSION

10.1 Materials used shall be selected to prevent galvanic corrosion. Special precautions shall be taken to prevent corrosion at joints, or points of intimate contact, between metals of differing electrochemical potential. Wherever possible electrochemically compatible materials shall be used. Contact between stainless steel fixings and galvanised fittings shall be prevented by plastic sleeves and washers.

11.0 HAZARDOUS AREAS

11.1 Potentially flammable atmospheres can arise in sewerage systems. It is essential that a risk assessment is undertaken to identify possible hazardous areas in order to allow proper design and selection of electrical equipment.

11.2 The Designer shall be responsible for ensuring that a risk assessment is carried out prior to commencing detailed design of the Pumping Station.

11.3 The risk assessment shall be carried out using Water Research Council (WRC) methodology "F.L.I.D.S."(Flammable Liquids In Drainage Systems) to identify and describe any Hazardous Areas.

All calculations and any assumptions shall be forwarded to NWG Company Electrical Engineer for approval prior to the ordering of any electrical/Instrument equipment. Appropriate NWG Confined Space warning signs shall be fitted at all points of entry.

11.4 A standard electrical installation shall not be used unless the assessment concludes that the probability of a flammable atmosphere arising is negligible.

12.0 ELECTRICAL INSTALLATION

12.1 The Electrical and Telemetry Specification, which is to be read in conjunction with the accompanying drawings and schedules in Appendix A8.3, details the standard electrical installation for two pump submersible sewage pumping stations. These drawings can be provided on disk by NWG. The prescribed standard installation is to be provided for pumping stations which satisfy all of the criteria specified in the sub-section 'Application of Standard Installation' F 2.0.

12.2 The specified standard electrical installation provides levels of functionality, maintainability and safety acceptable to NWG, and replaces the general guidance provided in 'Sewers for Adoption' published by the Water Services Association (WSA).

12.3 The user of the specification is responsible for ensuring that the requirements of the specification are properly implemented, and that they are appropriate for the intended application.

12.4 The detailed electrical design of the Pumping Station, including all electrical drawings, shall be submitted to NWG for review, **prior to construction and manufacture.**

12.5 Application of the standard electrical installation specification will reduce, but not eliminate the need for, detailed design, construction and approvals. It is essential that the standard be properly and competently applied, and that on completion of construction, the installation be verified through inspection and testing for compliance with relevant standards, including BS 7671 (IEE Wiring Regulations) and NWG Periodic Inspection and Testing (PIT).

12.6 There shall be no departures from the specified standard electrical installation except where formally agreed with NWG. All such departures shall be technically justified and normally confined to installations which do not meet the application criteria detailed in the sub-section 'Application of Standard Installation' F 2.0.

12.7 In **exceptional** circumstances NWG may, at their discretion, approve a proposal to employ a non-standard arrangement.

12.8 Full discrimination shall be provided between the overcurrent protection devices within the installation and, unless otherwise constrained by the REC, the REC service cut-out fuse shall fully discriminate with these devices.

12.9 The standard electrical installation provides for the use of either direct-on-line or star-delta starting method. The starting method employed shall be appropriate to the specific application, and selection criteria shall include the starting torque requirement of the pump, any starting restriction imposed by the REC and the need to ensure discrimination of the REC service fuse with other overcurrent protective devices in the installation.

12.10 For electrical services up to 20 kW, the REC will normally restrict the rating of the service fuse to 100A, or less. In certain cases the REC may uprate the service fuse to accommodate discrimination requirements. Where the REC proposes a 100A service fuse, full discrimination cannot be achieved where the pumpset FLC exceeds 17A (approximately up to 5.9 kW) with DOL starting or exceeds 29A (approximately 5.9-15 kW) with star-delta starting. Unless the REC is prepared to increase the service fuse rating, star-delta starting should be employed where practicable for pumpsets having a FLC exceeding 17A. Similar restrictions apply to lower service fuse ratings.

12.11 For electrical services between 20kW to 30kW, the Developer shall consult the REC for the service fuse size they will provide for the variable speed drives to be installed.

12.12 The control panel shall be sited in a weatherproof housing. NWG would prefer this to be of 'walk in' proportions (brick or GRP construction – see Section F, Clause 11.5). The minimum acceptable standard of housing is a GRP 'road-side' type. Further details can be found in the Electrical and Telemetry Specification.

Housings with a volume not exceeding 29m^3, based on external dimensions, will not normally require planning approval, though this must be confirmed with the local planning authority.

12.13 Cable ducts to the control panel shall terminate flush with the concrete plinth of the weatherproof housing at the positions shown on the drawings (see Appendix A8.3).

12.14 Where cable ducts pass under roads NWG shall be consulted.

12.15 Where an emergency overflow is to be installed, the Designer shall consult with NWG on the need to provide an additional monitoring facility to supplement the standard arrangement. The additional facility will be required in cases where the emergency overflow discharges into sensitive receiving waters, and is detailed in the Electrical and Telemetry Specification.

13.0 ELECTRICITY SUPPLY

13.1 The Designer shall arrange for the provision of a suitable electricity supply from the Regional Electricity Company (REC). In particular the Designer shall ensure that:

(a) the characteristics of the proposed supply meet all constraints detailed in the sub-section 'Application of Standard Installation' (F2) to permit the use of the standard electrical installation

(b) any limitations imposed by the REC, including preferred motor starting method, are identified.

(c) the specific characteristics of the proposed supply are ascertained, in particular the prospective short circuit current (PSCC), type of earthing (TN-S or TN-C-S), earth fault loop impedance external to the installation (Ze) and type and rating of the REC fuses.

13.2 Where the REC requires the installation to incorporate RCD protection, or is not able to provide an earth connection, the Designer shall not employ a standard electrical installation and the matter shall be referred to NWG.

13.3 The Designer shall liaise with the REC to ensure that where practicable the REC selects a service cut-out fuse rating which will provide full discrimination with the overcurrent protective devices incorporated in the installation.

13.4 Routing and protection arrangements for the supply cable shall be agreed with the REC, however where reasonably practicable the cable shall follow a route which is adjacent to the site perimeter rather than cross the site. The concrete plinth of the weatherproof housing shall incorporate a duct which shall terminate directly below the intended mounting position of the REC cut-out.

13.5 The Contractor/Designer shall record routing information and provide NWG with an as-installed record drawing.

13.6 The REC requires the Contractor/Designer to submit a Notice to Connect/Certificate of Compliance prior to connecting a supply to the installation. This declaration requires the electrical Contractor to certify that the installation complies with BS 7671 (IEE Wiring Regulations). The Designer should note that compliance cannot be confirmed unless the electrical Contractor has carried out certain inspection and testing activities required by BS 7671.

13.7 The Designer shall consult with NWG where the REC is able to provide a choice of tariff.

13.8 Further details may be found in the Electrical and Telemetry Specification.

14.0 TELEMETRY FACILITY

14.1 The Designer shall consult with NWG on the telemetry issues before commencement of detailed design.

14.2 NWG shall be consulted on equipment procurement issues, programme of works and equipment and service charges for the following:

(a) Telemetry outstation and directly associated standard components, where it is intended to procure these items from NWG.

(b) Communications medium between the outstation and the NWG telemetry system. The communications medium is to comprise either a radio link or a PSTN (telephone) line, and NWG will determine on a site-specific basis which of these alternatives is to be provided. Where a radio link is applicable, requirements for a radio mast shall be included for. This determination will affect the site infrastructure provisions and the facilities to be afforded at the control panel.

(c) Mandatory inspection, acceptance testing and commissioning services provided by NWG.

(d) Other telemetry services available from NWG (Project Management, Installation and Supply of Hardware).

14.3 Further details may be found in the Electrical and Telemetry Specification.

15.0 DESIGN DATA

15.1 The detailed design of the Pumping Station, including all mechanical, electrical and civil drawings shall be submitted to NWG New Development / Asset Investment prior to construction.

15.2 A suitably scaled plan showing all properties served by the Pumping Station and a copy of the calculations used to establish DWF and pumping rates shall be supplied to NWG.

15.3 A ground condition survey shall be carried out to confirm suitability and stability of the site.

16.0 TESTING AND INSPECTION

16.1 The Contractor shall be responsible for ensuring that all pumping station pipes and fittings, and the rising main, are hydraulically tested, in accordance with Appendix A12.

16.2 The Contractor will be responsible for provision of all properly calibrated and suitably scaled equipment required to carry out the above tests.

16.3 The electrical installation shall be tested in accordance with the 'Inspection and Testing' sub-section of the Electrical and Telemetry Specification.

16.4 Where the installation is over three years old (from the date of connection to the electricity supply) an additional BS 7671 Periodic Inspection and Test shall be undertaken by a NICEIC - approved contractor. Documentation in the form prescribed in BS 7671 including NWG Periodic Inspection and Testing (P.I.T.) shall be submitted to NWG. For P.I.T. test sheets see appendix A13.

16.5 After completion of the installation, and following receipt by NWG of satisfactory 'as-constructed' record documentation, NWG will formally inspect the installation for adoption or take-over purposes. The electrical Contractor(s) shall be present during this inspection to satisfactorily demonstrate the

operation of the complete system and to undertake such additional demonstrations and/or tests as directed by NWG.

16.6 The above tests and results thereof will be documented and shall form part of the Take-over Documentation.

17.0 STANDBY POWER GENERATION

17.1 Permanently installed standby electrical power generation is not normally required provided adequate storage is given in the wet well, however this must be confirmed with NWG. A plug connection suitably rated for the station supply requirements to connect a temporary power generator is required and shall conform to BS EN 60309-2.

18.0 LIFTING PLANT

18.1 The preferred means of pump removal is with the aid of a crane, but davit sockets shall be provided for use in situations where a crane is not available. Only NWG standard davits are acceptable as per Appendix A4.

19.0 CONDITION & PERFORMANCE MONITORING

19.1 A flowmeter shall be installed on all pumping stations. The output values of a flowmeter shall be displayed on the control panel and the value linked back to SCADA. The flow monitoring device shall also have a low flow alarm which links into SCADA.

19.2 Pumps that are 50kW or above shall all have vibration monitoring protection. The vibration monitoring equipment shall be connected to the control panel, and the alarms linked back to SCADA.

SECTION C : DOCUMENTATION

1.0 PRIOR TO CONSTRUCTION

1.1 All design data and the programme of work shall be provided to NWG New Development / Asset Investment at least one month prior to work commencing on site.

2.0 PRIOR TO ADOPTION OR TAKEOVER BY NWG

The following information must be provided to NWG:

2.1 Information in accordance with the EnGarde Assets System (see Appendix A6 for sheet).

2.2 Copies on A3 paper and AutoCAD disk (AutoCAD release 14) of the following:

(a) Scale 1:200 site plan

(b) Scale 1:1250 and 1:500 Location Plans (see Appendix A7 for typical location plan)

2.3 The documentation required to satisfy all health and safety legislation including the Safety File as defined by the Construction (Design and Management) Regulations 1994 (CDM Regulations).

2.4 Load test certificates and inspection records for lifting plant.

2.5 Written schemes of examination and operating instructions for pressure systems.

2.6 Three copies of the Operation and Maintenance Manuals.

2.7 A copy of the connection agreement with the electricity supplier.

2.8 Evidence of planning permission and building control approval.

2.9 Evidence of land ownership.

2.10 A certificate signed by the relevant personel to confirm that the rising main has been tested sufficiently for its operating loads.

2.11 If an overflow discharge permit has been obtained, the transfer of ownership document shall be provided.

3.0 OPERATION AND MAINTENANCE MANUALS

These manuals are to contain as a minimum the following:

3.1 Detailed description of the Pumping Station, with sufficient information to allow NWG personnel to locate the installation, and understand the operation.

3.2 Instructions for the operation, maintenance and overhaul of the plant

3.3 Specific details of manufacturers, plant types and capacities, serial numbers and model numbers, and the weight of all main plant items and pumps.

3.4 Detail of plant equipment performances, including pump curves and test sheets etc, shall be supplied to aid in fault diagnosis.

3.5 All relevant manufacturers' data. **Note: Generalised instructions are not acceptable.**

3.6 A list of all programmable and adjustable settings associated with the plant (e.g. level control settings, timer settings, overloads, trips, alarm points etc). See Appendix A5 for specimen sheet of level control settings.

3.7 Recommendations for consumable items e.g. packings, lubricants etc for the installed plant.

3.8 Parts lists and recommended operational spares lists.

3.9 A summary sheet of lubrication and maintenance requirements (preferably a one sheet schedule).

3.10 Fully completed WIMES 1.02 data sheets and certificates of factory and site tests, inspection, conformity and pump tests as detailed in WIMES 1.02.

3.11 Risk assessments and other documentation called for in the CDM Regulations.

3.12 A complete set of "as built" drawings for the Pumping Station and rising main.

The Drawings and associated documentation will:

(a) Show the internal construction of the major items, with parts lists and reference numbers for ordering spares.

(b) Include complete assembly drawings of machinery and ancillary plant showing all pipe connections and fittings.

(c) Include General Arrangement drawings showing all equipment, cabling, traywork, etc.

(d) Show cable routing information, including REC and PSTN (telephone) cables.

(e) Include all electrical schematics and schedules as detailed in the Electrical and Telemetry Specification.

3.13 A complete set of relevant design calculations relating to:

(f) Structural design

(g) Lifting beam, davit socket and davit lifting block

(h) Pump Station and rising main hydraulic calculations including surge suppression calculations and report, if undertaken.

(i) Wet well and pump design

(j) Storage calculation, to verify EA requirements.

(k) Electrical system design documentation, including calculations to verify compliance with the requirements of the IEE Regulations for Electrical Installations (BS 7671), control panel inspection and test certificate and NICEIC Completion and Inspection Certificate including Schedule of Test Results, as detailed in the Electrical and Telemetry Specification.

(l) Drainage plan, flow calculations and information used in the design of the Pumping Station.

3.14 Hydraulic testing results as required by the Civil and Mechanical Specifications (see Appendix A12).

3.15 The format for the manuals shall be that of loose leaves inserted into durable plastic covers and contained in suitable A4, 4 hole type ring binders. There shall be a title page and index and use will be made of file dividers and clear plastic wallets for holding drawings, schematics, manufacturers booklets and leaflets as necessary. Drawings should be supplied in both paper version and electronically on C.D. disk in AutoCAD release 14 format.

SECTION D : CIVIL SPECIFICATION

1.0 GENERAL

1.1 The civil engineering specification for the Pumping Station and Wet Well shall be in accordance with the most recent versions of 'Sewers for Adoption' and 'CESWI'.

2.0 ACCESS ROADS

2.1 The minimum standard of construction for access roads to Pumping Stations will:

(a) Incorporate a granular compacted sub-base laid on a geotextile such as Terram, the depth of the sub base will depend on the exist ground conditions. The depth of the sub base shall be approved by a Structural/Civil Engineer.

(b) The geotextile bottom sheet shall be laid with a 1000mm minimum overlap between sheets.

(c) The sub base shall be covered with a 1000 gauge impermeable plastic sheeting with a minimum 500mm overlap between sheets.

(d) The concrete slab shall have two layers of mesh reinforcement the design of the slab and reinforcement shall be carried out by an approved Structural/Civil Engineer.

(e) The depth of cover from the road surface to the mesh reinforcement shall be 50mm+/- 10mm.

(f) Road surface shall be laid to ensure satisfactory draining, with no retention of standing water.

(g) The road surface shall have a wood float finish.

(h) The mesh reinforcement shall terminate 60mm+/- 20mm from the edge of the slab.

3.0 PIPES, VALVES AND FITTINGS

3.1 The Pumping Station pipes, valves and fittings shall be in accordance with Appendix A10.

4.0 RISING MAINS

4.1 The diameter of rising mains shall be such that the velocity of flow is sufficient for self cleansing, with the rate of discharge being in the range of 0.75 m/s to 1.8 m/s.

4.2 Rising mains of less than 100 mm internal diameter will not normally be acceptable unless macerating pumps are employed. NWG must be consulted at the Design Stage if Rising Mains less than 100mm are proposed.

4.3 The pipes used must be capable of withstanding the maximum pressure developed within the system, including any additional allowance for the effects of surge.

4.4 A rising main should normally achieve a steady rise from the valve chamber up to the discharge manhole. Where this is not possible, washouts are required at low points, and air valves at high points. The nominal depth will be 1.2 m in highways, or 0.9 m on Greenfield sites.

4.5 Rising mains shall, where necessary, be provided with access for cleaning, and washout facilities at any low points. Washout should be taken from a "T" junction and valve; the main discharging to a nearby foul gravity sewer or to a specially constructed sump if this is not possible. Washout chamber details are given in Appendix A2.

4.6 A means for marking changes of direction in the pumping main will be required either by marker posts, or manholes with sealed hatch boxes. Access points should be fitted to the rising main at a nominal 100 m apart.

Warning tape coloured green should be provided ("Caution Pressure Main Below") set not less than 300 mm above the crown of the pipe.

For non metallic mains the marker tape should incorporate a tracer wire which should be brought to the surface at access points and connected to terminals on the marker post (continuity must be maintained in the wire as reels are usually only 100 m long). At the pumping station the tape should be terminated with a one metre coil inside the valve chamber, entry being through a sealed duct 300mm below the finished paved area. At the discharge end of the main the wire should be terminated in a similar manner, and in a suitable chamber to enable a signal to be induced for tracing. The rising main should be kept within a public open space or a highway.

4.7 The permissible range of materials for construction of rising mains is as defined in Sewers for Adoption.

4.8 The calculation of head loss and values of pipe roughness shall be as defined in Sewers for Adoption.

5.0 ANCHORAGES AND THRUST BLOCKS

5.1 Where anchors are required to resist thrusts produced on mains and pipework at changes of direction, tapers, tees and valves, these shall be designed in accordance with CIRIA Report 128 - Guide to the Design of Thrust Blocks for Buried Pressure Pipelines.

6.0 AIR VALVES

6.1 All air valves, which are required either as a surge alleviation device or to vent high points on the rising main, shall be suitable for a sewage application and designed so that liquid contained in the lower chamber cannot contact the sealing face(s). Clean water type valves are not acceptable.

6.2 The valves must be capable of being isolated to enable removal for cleaning or replacement.

6.3 Valve chamber details shall be in accordance with those given in Appendix A2.

6.4 Valve materials shall be in accordance with details given in Appendix A10.

7.0 PENSTOCKS

7.1 All penstocks shall be in accordance with the details given in Appendix A10.

8.0 FASTENERS AND FIXINGS

8.1 All fasteners and fixings shall be in accordance with Appendix A11.

9.0 CABLE DUCTS

9.1 Separate continuous underground ducts shall be installed for the services listed below. Ducts shall be laid a minimum of 450 mm below ground level. Typical minimum diameters are given below but these should be checked against the size of the cable which is to be installed into the duct for ease of pulling, bending radius etc.

	Service	Dia (mm)	From	To
(a)	REC Supply Cable	100	Service Connection	Control Panel
(b)	PTSN (Telephone) Cable	65	Service Connection	Control Panel
	Service	**Dia (mm)**	**From**	**To**
(c)	Earth Electrode	65	Electrode Chamber	Control Panel
(d)	Pump Supplies, Level Control	100	Control Panel	Valve Chamber
(e)	Pumps, Supplies Level Control	100	Valve Chamber	Wet Well

9.2 Long radius bends shall be employed for vertical terminations and changes in direction. The duct route shall eliminate acute changes in direction wherever possible. Where this cannot be avoided, a pull-in chamber shall be installed at the change in direction.

9.3 At a position approximately 150 mm below final ground level, a yellow 'Electricity Services' marker tape shall be installed along the whole length of the duct run.

9.4 A draw cord shall be installed in each duct.

10.0 ACCESS COVERS

10.1 For guidance on access covers please refer to Engineering Standard E0209 - 'Galvanised Mild Steel Access Covers for Wastewater Applications'.

11.0 STEEL PALISADE FENCE AND GATES

11.1 Where provided these shall be in accordance with NWG standard details in Appendix A2.

11.2 Consideration of the access road camber and slope shall be given to allow 50mm clearance under the gates.

SECTION E : MECHANICAL SPECIFICATION

1.0 PUMP SPECIFICATION

The capacity of the pumping units shall be consistent with the duty required of the Pumping Station, the capacity of the rising main and the capacity of any downstream gravity sewers.

Submersible sewage pumps shall be specified in accordance with the Water Industry Mechanical and Electrical Specification - WIMES 1.02 using the Data sheet therein (see Appendix A3) and with due regard for the requirements of this document. The pump purchaser and the pump supplier shall fully complete the relevant sections of the Data Sheet.

1.1 Pumps

The Pumping Station will incorporate two identical pumps, with one duty pump and one standby pump.

Pumps and control gear installed at the Pumping Station shall be rated for a minimum 15 starts per hour.

Pumps shall be selected to meet the highest best efficiency point based on the design pump rate for the station. Pump rates shall be calculated as follows:

PUMP RATE (m3/day) = 6PG + 3E + I

Where:
P = Population in Catchment
G = Domestic Consumption m3/hd/day)
E = Industrial Flows (m3/d)
I = Infiltration (m3/d)

* Infiltration is assumed as 50% of the populations daily consumption

* Domestic Consumption (G) = 0.18m3/hd/day shall be used

1.2 Pump Data Plate (WIMES 1.02, Clause 1.4.4)

The Pump shall have a securely fixed data plate containing, as a minimum, the following information:

Serial Number

Pump Type

Rated Flow

Rated Voltage

Frequency

Number of Phases

Full Load Current

Speed of Rotation

Weight of Pump

Note: An additional plate shall be supplied for attachment to the Control Panel.

1.3 **Guide Rail System (WIMES 1.02, Clause 1.5.1)**

The guide system shall be of the rigid tube type and will be located by spigots at the bottom. The spigots shall have a minimum engagement of at least the internal diameter of the tubes.

The guide rails shall not have an unsupported span greater than 3 m and shall be of the galvanised steel tube type. The top of the guide rails shall locate into a suitably designed bracket, having a minimum engagement into the tube equivalent to the inside diameter of the tubes used.

Hooks shall be provided at the top of the guide system for securing the cable support sleeves and parking the suspension chain.

The hooks shall be manufactured from appropriately sized galvanised steel, and shall have sufficient upstand to adequately retain the chain and cable support.

1.4 **Lifting System (WIMES 1.02, Clause 1.5.2)**

(a) Lifting chains shall be made from heavily galvanised low carbon steel (grade 30 or 40) having 50 mm, or larger, diameter rings every metre. The chains shall be securely fixed to the pump using galvanised fittings. The length of the lifting chain shall be such that when the pump is in position the chain extends at least one metre above the top of the well.

The chain shall be rated to lift twice the weight of the pump.

(b) The NWG preferred method for the removal of pumps from the wet well is by vehicle mounted crane. A davit socket will be provided in accordance with the NWG standard detail for use in emergency situations. (See Appendix A4). The davit socket must be rated to lift twice the weight of the pump.

1.5 **Flushing System (WIMES 1.02, Clause 1.6)**

This will not normally be required unless significant scum and fat problems are anticipated. Where there is a problem the device shall be specified by the Designer.

1.6 **Impeller Speed and Solids Handling (WIMES 1.02, Clause 2.1)**

The maximum speed of rotation shall not exceed 1450 rpm for pumps with discharge branch diameter up to 150 mm, 960 rpm for pumps having discharge

diameters greater than 150 mm and up to 200 mm, or 750 rpm for larger discharge diameters.

Pumps must be fit for purpose, and NWG normally require raw sewage pumps to be capable of passing 100mm diameter spheres.

Where pumps of a lesser solids handling capability are offered, the Designer shall be required to demonstrate, by design and satisfactory operation of the Pumping Station, that the pumps are capable of prolonged, reliable and trouble free operation on raw unscreened sewage.

1.7 **Seal Arrangements (WIMES 1.02, Clause 6.13)**

Leakage detection is required for specific pump units, refer to WIMES 1.02, Clause 6.13 (Point 2) for guidance. .

1.8 **Cables and Connectors (WIMES 1.02, Clause 3.9)**

NWG require junction boxes in the valve chamber. Connectors are not acceptable.

1.9 **Tests (WIMES 1.02, Clause 5)**

Pump tests should be carried out prior to the units leaving the factory, in accordance with the requirements of BS 5316 Part 1, to show that the pumps are capable of achieving the specified operating conditions.

Test Certificates shall be provided to NWG.

Note: NWG has additional testing requirements for the Pumping Station prior to adoption or take-over.

2.0 PIPES, VALVES AND FITTINGS

2.1 The pipes, valves and fittings shall be in accordance with Appendix A10, the layout shall generally be in accordance with that shown in Appendix A1

3.0 FASTENERS AND FIXINGS

3.1 All fasteners and fixings shall be in accordance with Appendix A11.

4.0 HYDRAULIC TESTING

4.1 The Contractor shall be responsible for ensuring that all pipework is hydraulically tested, in accordance with Appendix A12.

SECTION F: ELECTRICAL AND TELEMETRY SPECIFICATION

1.0 GENERAL

1.1 This specification, which is to be read in conjunction with the accompanying drawing and schedules (Appendix A8.3), details the standard electrical installation for two pump submersible sewage pumping stations. The prescribed standard installation is to be provided for pumping stations which satisfy all of the criteria specified in the sub-section 'Application of Standard Installation' below.

1.2 The installation shall comply with all applicable statutory requirements including the Electricity at Work Regulations. The installation is to be designed, constructed, inspected and tested in accordance with BS 7671, and shall comply with the requirements of all other relevant British Standards.

1.3 All on-site electrical installation work, including inspection and testing to BS 7671, shall be carried out by a contractor registered with the National Inspection Council for Electrical Installation Contracting (NICEIC).

1.4 Nothing in this specification shall imply any obligation on the part of NWG to ensure that the installation, or any part of the installation, is properly designed, constructed, inspected or tested, or that the installation conforms to statutory requirements.

2.0 APPLICATION OF STANDARD INSTALLATION

Application of this standard electrical installation is restricted to pumping stations:

(a) having two submersible pumpsets, one duty and one standby each of the same capacity, arranged for automatic operation where the starting arrangements for such pumpsets will be either DOL or Star/Delta arrangements to a maximum of 20kW and where the REC supply is adequate for such an arrangement.

The maximum size of pumpset to be used in this application is 30kW, where pumpset are between 20kW and 30kW a frequency inverter starting method shall be adopted. **NWG should be consulted if larger stations are necessary.**

(b) which the Designer has confirmed through a risk assessment using NWG methodology that a potentially explosive atmosphere is unlikely to arise, and as a consequence no part of the installation will require classification as a Hazardous Area within the meaning of BS 5345.

(c) where the installation is to be supplied by a Regional Electricity Company (REC) from a low voltage network at 400 volts ± 10%, 3-phase and neutral via a fusible cut-out having fuses to BS 1361 Type II or BS 88 Part 2 or Part 6 and a maximum prospective short circuit current (PSCC) of 16 kA at the supply terminals.

(d) where the REC is able to provide an earth connection to the installation, and the value of the earth fault loop impedance external to the installation (Ze) is 0.4

ohms maximum for a TN-S system, or 0.35 ohms maximum for TN-C-S (PME) system.

(e) where the pumpsets are to be started by direct-on-line or star-delta method up to 20kW and variable-speed -drive between 20kW to a 30Kw maximum, and the chosen starting method is acceptable to the REC and appropriate for the pumpset.

(f) where the REC does not require the installation to be equipped with power factor correction equipment, or penalise the consumer for poor power factor by way of applied tariff.

(g) where the installation does not require provision of electrical services to equipment other than the two pumpsets, associated control and level monitoring system, telemetry and minor lighting and heating services within the weatherproof housing provided for the control panel.

(h)

3.0 TELEMETRY FACILITY

The installation shall incorporate a Standard NWG telemetry outstation and communications system, these systems will require acceptance testing and commissioning by NWG.

Details of the telemetry signal requirements are provided within this specification.

4.0 EXTENT OF INSTALLATION

The electrical installation shall include:

(a) REC mains supply service, fusible cut-out and metering equipment

(b) Floor standing control panel incorporating incoming mains and standby supply arrangements, starters, distribution, control and telemetry system.

(c) Weatherproof housing for (a) and (b). ‘walk in’ proportions see drawing in Appendix A8.3.

(d) Lighting and heating to (c).

(e) Earthing and bonding system, including the establishment of an equipotential zone within the weatherproof housing, and the valve and wet well chambers, and the installation of a consumer’s earth electrode system with connecting duct.

(f) Ultrasonic level monitoring system and, where required, float switch for monitoring the emergency overflow.

(g) Cabling and ancillaries including ducts etc.

(h) Telemetry outstation and communications system, PSTN (telephone) line or radio system, as directed by NWG.

5.0 CONFIGURATION OF STANDARD INSTALLATION

The specified standard electrical installation, as detailed in Appendix A8.3, is to be configured by the Designer to suit the particular application. Such configuration shall take account of pump motor full load current and starting method, and will include the following:

5.1 **Mains Supply - BS 88 Fuse Rating**

This section of the supply changeover switch shall be equipped with BS 88 fuses selected to provide satisfactory discrimination with the upstream REC fuses and downstream motor circuit fuses.

5.2 **Standby Supply - BS 88 Fuse Rating**

This section of the supply changeover switch is to be equipped with BS 88 fuses selected to provide satisfactory discrimination with the downstream motor circuit fuses

5.3 **Pump Motor Starters**

5.3.1 Up to 20kW

(a) Selection of the fuses, contactor(s) and overload for motor short circuit protection is to be appropriate to motor full load current and method of starting, and afford Type 2 co-ordination to BS EN 60947-4.

(b) Selection of direct-on-line or star-delta starting method, according to REC starting current limitations, service cut-out fuse rating and suitability for the pump.

(c) Selection of current transformer for digital load monitor.

(d) Selection of other components, as provided for in the schedule, including fuse switch assembly rating and wiring size.

5.3.2 Between 20kW and 30kW

(a) Selection of the fuses, contactor(s) for motor short circuit protection is to be appropriate to motor full load current and method of starting, and afford Type 2 co-ordination to BS EN 60947-4.

(b) Selection of variable speed drive, according to REC starting current limitations, service cut-out fuse rating and suitability for the pump.

(c) Selection of ammeter scale for 4-20mA input.

(d) Selection of other components, as provided for in the schedule, including fuse switch assembly rating and wiring size.

5.4 **Pump Motor Cables**

Selection of motor cables to suit motor full load current and starting method.

The selection of suitable components is to be based on the pump motor full load current as confirmed by the pump manufacturer, and not the quoted kW or HP rating.

5.5 **Telemetry Outstation and Communications System**

As directed by NWG the Designer will provide for a PSTN line or radio system.

6.0 STANDARD ELECTRICAL COMPONENTS

6.1 Except where detailed below, the Designer may use components of different manufacture to those indicated in the schedules or drawings. However, where an alternative is proposed, the component shall be equivalent in all respects to that specified and the performance requirements of the relevant British Standard. Additionally, the Designer shall ensure that all alternatives meet any physical constraints as to layout and accommodation. In respect of motor starter components the Designer shall demonstrate that any proposed alternative is properly selected to achieve Type 2 co-ordination to BS EN 60947-4.

6.2 The installation shall incorporate the following standard components.

(a) Wet Well Level Monitoring System based on Ultrasonics: including a transducer head IP66 rated for mounting in the wet well. It shall be installed vertically, an isolation adaptor shall also be used. The head shall be mounted at a suitable distance from the wet well wall to take into account the beam angle. A ratio of 10 to 1 for depth of well to wet well wall distance shall apply for a 12 degree beam angle, 20 to 1 for 5 degree beam angle.

(b) Phase Failure Relay: suitable for the incoming REC supply + Neutral.

(c) Telemetry Outstation: to be specified by the NWG IS Telemetry Engineer This equipment can be obtained from NWG.

(d) Radio System: Radio and aerial to be specified by the NWG IS Telemetry Engineer.

(e) Telemetry Ancillaries:

	Yuasa NP2.1AHr - 12V
Mains Filter	MTL Telematic MA03
Lighting Protection Unit or similar	MTL Telematic MTL 376 (Where PSTN line is applicable)
Disconnect Terminals	Klippon SAKD 2.5/35 or Phoenix Polyamide UK3

The components in (c) and (d) may be purchased from NWG as part of the telemetry outstation.

7.0 ELECTRICITY SUPPLY

7.1 Where the REC intends to install an earth electrode, it shall be separated from the consumer's earth electrode by a distance not less than the effective length of the longest electrode.

7.2 The REC cut-out, metering equipment and earth terminal are to be mounted on a timber board located to the left hand side of the control panel. This equipment shall be located within the weatherproof housing.

7.3 Unless otherwise directed by the REC, the Contractor/Designer shall provide 25mm^2 phase and neutral conductor double insulated 'tails' to BS 6004. The earthing conductor shall be not less than 16mm^2. All conductors shall be adequately supported; where trunking is employed it shall not be metallic. Tail length shall not exceed 1.5m unless approved by the REC.

7.4 The Contractor/Designer shall record routing information and provide NWG with an as-installed record drawing.

8.0 EARTHING AND BONDING

8.1 **Main Equipotential Bonding**

An earthed equipotential zone is to be established which shall extend from the control panel weatherproof housing into the valve chamber and wet well. PVC insulated, main bonding copper conductors of minimum size 16 mm^2 shall connect the following metallic parts to the Main Earth Terminal (MET) of the installation:

(a) Any exposed metallic structural parts of the weatherproof housing.

(b) Metallic sheath of the telecommunication cable, where provided, subject to consent by the PSTN service provider.

(c) Radio mast, where provided as directed by NWG.

(d) Pipework, guard-rails, and other metallic parts within the valve chamber and wet well.

8.2 **Bonding within Valve Chamber and Wet Well**

One main bonding conductor is to be installed into the valve chamber and wet well, and looped to the bonding points shown in the drawing in Appendix A8.3. The bonding conductor shall be continuous and not cut at each connection. All earth bonding in the valve chamber shall be terminated on to earth bar inside a GRP IP54 rated enclosure. All earth cables entering this junction box shall do so via suitable rated stuffing glands.

The surfaces of all bonding points are to be cleaned free from paint and other non-conducting material, and the surfaces coated with petroleum jelly. All connections shall be made using tinned compression lugs, Denso taped on completion to prevent corrosion and labelled as required by BS 7671.

8.3 **Earth Electrode**

An earth electrode shall be installed. Where the REC also installs an electrode, physical separation shall be as previously specified.

The electrode shall be of the rod type and shall be driven into the ground external to the weatherproof housing. Rods shall be copper skinned, 15 mm diameter, installed in 1.25 m lengths and fitted with hardened steel tips and driving caps.

The resistance of the electrode system shall not exceed 20 ohms. Additional electrodes are to be installed where this resistance cannot be achieved with a single electrode.

Earthing lead connection(s) shall be PVC copper conductor 16 mm^2 minimum routed in a 65 mm diameter duct. Each rod is to be provided with an inspection pit with removable cover.

The earth lead/rod connection is to be protected against corrosion and labelled as detailed above.

The electrode earthing conductor shall be connected to the earthing arrangement via a disconnectable test link.

8.4 **Circuit Protective Conductors**

The circuit protective conductor (CPC) arrangement shall be as detailed on the drawings. XLPE or PVC/SWA/PVC cables for pump motors shall incorporate an integral CPC core of identical size to the live cores; cable armour and braid is to be connected to the CPC.

8.5 **Control Panel Earthing Arrangement**

An earth bar shall be installed in the central cable way of the control panel. All circuit protective conductors, equipotential bonding conductors, gland plates and control panel bonds shall be connected to this earth bar. This earth bar shall be the MET for the installation and a 16 mm^2 main earthing conductor shall connect the MET to the earth terminal provided by the REC.

All connections to the earth bar shall employ compression lugs and be bolted.

9.0 CONTROL PANEL

General

9.1 The control panel shall conform with the arrangements specified in the accompanying drawings and schedules (Appendix A8.3).

9.2 The control panel shall be a factory built assembly of bolted and welded construction, providing IP54 degree of protection to BS EN 60529. The specified assembly shall comply with BS EN 60439 and, except where otherwise provided for in the drawings, be of Form 4 construction, suitable for use with an electricity supply having the characteristics specified above, including a PSCC of

up to 16 kA. Electrical components of the assembly shall comply with their relevant British Standard, including BS EN 60947.

Location and Construction

9.3 The control panel shall be a self-supporting, multi-section, floor fixed assembly providing front access. The assembly construction, floor fixings and component and wiring fixing arrangements shall not require access from the rear of the assembly.

9.4 Bottom cable entry into the cableway shall be provided for valve chamber/wet well cabling and a vermin board fitted on completion. Entry arrangements for other circuit cables shall be as detailed on the drawings.

9.5 The assembly shall be bolted to the concrete floor of the weatherproof housing, using a minimum of four fixings. The control panel shall be located to the right hand side of the timber board provided for the REC equipment. Clearance between the rear face of the control panel and the wall of the housing shall be a minimum of 50 mm.

9.6 Assembly frame, doors and panels are to be constructed from 2 mm zintec sheet steel. Doors and panels are to be single folded with welded corners. Component mounting plates and metallic gland plates are to be 3 mm sheet steel. The plinth, which is to be a minimum height of 100 mm, shall be constructed from 'C' channel and shall be hot dip galvanised to BS729.

9.7 The protective coating is to provide a minimum 20 year life expectancy. Exterior finish colour shall be BS 4800 reference 18 E 51, blue, semi gloss. Internal component mounting plates shall be finished OO E 55, white, semi gloss. The plinth shall be finished OO E 53, black, semi gloss.

9.8 The gland plate within the central cableway for valve chamber/wet well cabling is to be located a minimum of 300 mm above floor level.

9.9 The central cableway shall be provided with two separate trunking arrangements, one for busbar cabling and one for other intercubicle wiring. All inter-section wiring is to be via insulated, grometted holes.

9.10 The central cableway is to incorporate the earth bar and a support system for outgoing cables.

Additional Safety Requirements for Operation and Maintenance

9.11 Incoming supply and starter compartment fuse switches shall be suitable for acting as isolators for mechanical maintenance, and shall be capable of being padlocked in the OFF position.

9.12 The OFF, ON and TEST positions of all isolating switches shall be clearly, permanently and unambiguously marked.

9.13 Except for the common controls/telemetry section, enclosure doors shall be mechanically interlocked by their functional unit isolating fuse switch. Interlock

mechanisms which permit entry into a functional unit with the switch handle in the padlocked OFF state are not acceptable.

9.14 Isolating fuse switch assemblies for incoming supplies and starters are to employ a double contact action such that the fuses are fully isolated from live parts when the switch is OFF. The live terminals of fuse switches are to be shrouded to IP3X minimum.

9.15 The fixed assembly of a functional unit fuse switch shall provide clear, unambiguous indication of switch position.

9.16 In addition to handle padlocking, fuse switch assemblies for motor starters shall provide for a padlock to be attached directly to the fixed part of the fuse switch when in the OFF position.

9.17 Isolating devices mounted within the common controls/telemetry section are to be fully enclosed assemblies padlockable in the OFF position. The radio communications isolator, when required, is to be similarly equipped.

9.18 Except as required by 9.14, all terminals and fuses of fuse switch assemblies are to be equipped with insulating shrouds and terminal covers which provide, as a minimum, IP2X degree of protection. Live terminal shrouds shall be equipped with a warning label.

9.19 All parts of a functional unit which operate above 50 V shall provide IP2X protection as a minimum. Any component which provides IP2X protection from live parts by virtue of its construction is not required to be provided with an additional shroud. The requirement for IP2X shrouding shall also apply to functional units provided with a door interlocked isolating arrangement.

9.20 Terminals for 230/400 V conductors shall be segregated from terminals provided for extra low voltage conductors. Low voltage terminals shall be labelled and shrouded in accordance with the above.

9.21 One of the tee type handles for each functional unit door is to incorporate a barrel lock, keyed LF 92369. Doors shall be restrained in a minimum 90 degree open position with stays.

9.22 Screw fixed Traffolyte or Reverse Screen Printed labels, incorporating black lettering on a white background, shall identify each internal and external component by reference and/or function, as appropriate, as detailed in the drawings. Labels shall not be fixed to removable components, e.g. removable junction box covers.

9.23 Danger and warning labels shall conform to the Safety Signs Regulations. Self adhesive safety signs may be used.

Components

9.24 The ‘Mains/Off/Generator’ incoming supply fuse switch shall provide a positive mechanically interlocked 4-pole switching arrangement for each supply source. The operating handle, which shall be door interlocked, shall be coloured red and

yellow. Electrical isolation of the complete installation shall be provided in the 'OFF' position. The assembly shall comply with BS EN 60947-3.

9.25 The standby generator intake arrangement shall incorporate a BS EN 60309-2, 5 pin appliance socket inlet providing IP 54 or greater degree of protection. The RCD for the standby supply circuit shall have a rated operating current of 300 mA with 100 mS time delay.

9.26 Individual radial circuits shall be employed between the busbar section and the functional units.

9.27 Starter fuse, contactor and overload combination shall be selected to provide Type 2 co-ordination to BS EN 60947-4. The selected thermal overload shall provide single phasing protection, hand/auto reset option (set to auto) and manual test facility. Starter RCD rated operating current shall be 30 mA instantaneous. The RCD shall be of a type suitable for 3-phase 3-wire use which does not require a neutral connection or an external resistor to permit testing of the assembly using its integral test push-button. Starters shall be rated for a minimum 15 starts per hour.

9.28 Where the pump or its motor incorporates additional protection or monitoring devices such as thermostat, moisture detection (seal failure) etc, these shall be incorporated into the standard installation of the station.

9.29 Indicating lamps, push-buttons and selector switches shall be of the 22mm diameter standard, colours shall be as detailed on the drawings. Indicating lamps shall be multicluster LED type.

9.30 Digital load monitoring unit shall measure the shaft power of the pump motor. This unit shall be mounted in such a way that it can be interigated via the control panel compartment door while the pump is running.

9.31 An analogue Ammeter shall be installed on the control panel for each pump unit. Where Variable Speed Drives are installed, this removes the requirement for an Ammeter.

Internal Wiring

9.32 Wiring shall comply with BS7671. Conductors shall be copper and of not less than 1.0 mm^2 c.s.a. Details of power wiring are given in the drawings and schedules in Appendix A8.3.

9.33 Wiring shall be identified by colour code as follows:

(a) Phase - Brown,Black,Grey according to phase

(b) Neutral - Blue

(c) Protective conductors – Green and Yellow

(d) Power and control circuit conductors (excluding neutrals): 50V to 150V AC and DC - Red

(e) ELV control and signal circuit conductors (excluding neutrals): < 50V AC and DC - Yellow

(f) Telemetry - Pink

(g) Intrinsically Safe Circuits - Light blue

(h) Supply voltage independent circuits [see clause 9.34 below) - White

9.34 Supply voltage independent circuits are those not directly connected to a control circuit supply, and shall include the following:

- current transformer circuits
- instrument sensor to transmitter circuits (e.g. 3 or 4 wire RTDs) where screened cabling is not necessary
- motor thermistor circuits
- motor thermostat and seal leak circuits connected to multifunctional relays
- conductivity probe circuits

9.354 All wiring shall be ferruled, and each end numbered to correspond with the schematics. Cable numbers may be colour coded or black on white.

9.365 Wiring at terminal rails shall be fitted with compression connectors or terminal lugs according to terminal type.

9.376 Wiring shall be protected from sharp edges or abrasion, and shall be located clear of moving parts.

Telemetry Facility

9.387 The telemetry outstation and communications medium shall be defined by the NWG IS Telemetry Engineer.

9.38 Telemetry signals shall conform with (as a minimum) those specified in 'Telemetry Compile Sheet' (supporting document to E0702 in NWG SharePoint). Deviation from this signal set will require agreement with the NWG IS Telemetry Engineer.

9.39 The 'Wet Well Overflow Operating' alarm shall only be provided when directed by NWG.

9.40 The 'intruder' alarm shall be derived from proximity switches mounted on the doors of the weatherproof housing. The circuit shall be directly connected to the telemetry outstation.

10.0 LEVEL MONITORING SYSTEM

10.1 For wet well level monitoring and pump control purposes the installation shall incorporate an ultrasonic system, including transducer head IP66 rated, with potted cable RG 62 A/U (93ohm), and head mounting system and fixings. The length of potted cable shall be sufficient to allow direct connection into the common controls section of the control panel, without the need for an intermediate junction box within the valve chamber or wet well. The depth of the well shall determine the beam angle to be used The Ultrasonics system shall be configured as follows:

Relay 1& 3: Set at Duty Level

Relay 2 :	Set at Standby Level
Relay 1 & 2 :	Programmed for Sequential Loop control (DE9)
Relay 3 :	Programmed for pump control (DE8)
Relay 4 :	Programmed for Wet Well High Level to Telemetry
Relay 5 :	Programmed for Ultrasonics System Healthy

10.2 **Monitoring of Emergency Overflow**

Where directed by NWG a float switch, shall be installed in the wet well to provide a 'Wet Well Overflow Operating' alarm condition to the telemetry system. The float switch shall be arranged to operate at a water level indicative of the emergency overflow being in use.

10.3 Control philosophy for the pumping station requires; when the duty pump fails, the standby pump shall automatically activate as the duty pump.

11.0 CONTROL PANEL HOUSING

11.1 The control panel and REC equipment shall be located in a vandal resistant, weatherproof, ventilated housing of either brick or GRP construction. Where necessary under consultation with NWG a suitable steel kiosk may be used (kiosk construction details must be approved by NWG before manufacture may commence) A 'walk-in' type housing is preferred. The minimum acceptable standard of housing is shown in the drawings in Appendix A8.3

11.2 The housing shall not be located where it might be susceptible to flooding. The housing shall be suitably positioned in relation to the wet well, valve chamber and the vehicular access, the drawings in Appendix A1 show a typical site layout. The location shall take account of the need to offload and position a standby generator adjacent to the housing. Additionally, the access doors to the housing are to be positioned a minimum of two metres from any manhole provided with handrails and a minimum of three metres from any manhole not provided with handrails.

11.3 The housing shall be erected on a concrete plinth which is to extend 150 mm above the surrounding ground level. Where a GRP housing is used, its base shall be sealed with mastic to prevent the entry of water and vermin.

11.4 Cross ventilation of the housing is to be afforded by one high and one low level vermin and weatherproof grill, on opposite sides of the housing.

11.5 GRP housings, unless otherwise agreed by NWG, shall be constructed from high density chipboard, sandwiched between glass fibre laminate using fire-retardant resin class 1. The nominal thickness shall be 25 mm. The housing shall have a cast-iron finish and the colour shall be Spruce Green , reference 12-B-25 toBS 4800.

11.6 GRP housing doors shall be provided with stainless steel hinges. One door shall have stainless steel shot bolts at both the top and the bottom. The doors shall be fitted with two Abloy hasp and staple locks. Each door shall be provided with a stay to restrain it in the 90 degree position when open.

11.7 GRP housings shall provide IP55 degree of protection to the control panel and REC equipment.

11.8 In the case of a GRP housing, other facilities including a REC meter reading hatch and a standby generator cable access hatch shall be as detailed on the drawing in Appendix A8.3. The meter reading hatch shall open outwards and be secured by a rim latch equipped with a lock barrel provided by the REC.

11.9 Walk-in housings shall provide a minimum clear working distance of 750 mm between the front of the control panel and its facing wall.

11.10 Where a housing of brick construction is to be provided, a wall mounted REC meter cabinet shall be incorporated. The position of the cabinet shall be equivalent to the position shown occupied by the REC meters on the drawings in Appendix A8.3. The timber board arrangement shall be altered accordingly.

11.11 Brick housings shall incorporate outward opening door(s) generally to NWG standard detail SDD7/01 or approved equivalent manufacture, equipped with one Abloy lock and other furniture including mortise dog bolts, all as directed by NWG.

11.12 Walk-in housings shall be equipped with a BS EN 61111:2009rubber insulating mat of 750mm minimum width extending the full length of the control panel and REC equipment.

11.13 A first-aid electric shock resuscitation notice shall be fixed within the housing interior.

11.14 One or more IP65 fluorescent light fittings shall be installed within the housing at roof level. In the case of a walk-in housing the switch shall be located adjacent to the housing door.

11.15 Suitable tubular heating shall be provided for the housing. One 60W heater is sufficient for road-side kiosks, however high rated heaters will be required for larger housings. Heaters shall be controlled via an adjustable thermostat

allowing settings between 5°C and 25°C. The heater shall be set at 5°C unless otherwise specified.

12.0 CABLE DUCTS AND SEALING SYSTEM

12.1 Separate continuous underground ducts shall be installed for the services listed below. Ducts shall be laid a minimum of 450 mm below ground level. Typical minimum diameters are given below but these should be checked against the size of the cable which is to be installed into the duct for ease of pulling, bending radius etc.

	Service	Dia (mm)	From	To
(a)	REC Supply Cable	100	Service Connection	Control Panel
(b)	PTSN (Telephone) Cable	65	Service Connection	Control Panel
(c)	Earth Electrode	65	Electrode Chamber	Control Panel
(d)	Pump Supplies, Level Control	100	Control Panel	Valve Chamber
(e)	Pump Supplies, Level Control	100	Valve Chamber	Wet Well

12.2 Directly buried cables are not permitted.

12.3 A draw cord shall be installed in each duct. In the case of the duct to the valve chamber an additional draw cord shall be pulled in during cable installation for future use. Draw cords shall not pass through duct sealing arrangements.

12.4 On completion of cable installation work, every duct end shall be sealed to provide a barrier against vermin, and to prevent the transmission of any gas or vapour which may arise.

The duct between the control panel and the valve chamber shall enter the chamber at right angles, and shall be sealed at the valve chamber using a Hawke, or equivalent, cable transit mechanical compression seal.

Effective sealing of all other ducts shall be carried out using Denso Mastic or other approved method. Polyurethane foam is not acceptable.

All ducts shall have joints which are of a water tight construction.

13.0 CABLING AND ANCILLARIES

13.1 Pump motor cables, for installation between the control panel and valve chamber junction boxes (JBs) shall be selected from the Schedule in Appendix A8.3, according to motor full load current and method of starting. However, the

Schedule shall only be used where the maximum length of cable from the panel to each pump motor does not exceed 25 m.

13.2 The earthing conductor, for equipotential bonding purposes within the valve chamber and wet well, shall be 16 mm^2, installed and terminated in accordance with the 'Earthing and Bonding' sub-section.

13.3 The Ultrasonics level monitoring system transducer head cable shall be RG 62 A/U (93ohm), and of sufficient length to allow direct connection into the common controls section of the control panel.

13.4 Where required, the emergency overflow float switch cable shall be terminated at a JB in the valve chamber. A PVC/SWA/PVC cable shall be installed between this JB and the control panel. Where necessary, to prevent mechanical damage within the wet well, the float switch cable shall be run in plastic conduit to a position adjacent to its mounting bracket. This conduit must not pass through the duct seal.

13.5 Cables within the valve chamber shall be installed on medium duty GRP or heavy duty PVC tray plate throughout the whole of their length. Pump motor flexible cables shall be suitably supported and protected from mechanical damage; these cables shall be cut to remove excessive spare length prior to termination at their JB.

13.6 Two all-insulated JBs shall be installed within the valve chamber for pump motor cable connection purposes. The size and arrangement of the JB shall permit bottom cable entry for all cables; top entry arrangements are not acceptable. JBs shall provide ingress protection to IP65 and shall be mounted in an accessible position, where they will not be exposed to mechanical damage or used as a foothold.

13.7 Each pump motor JB shall incorporate four or seven power terminals, as appropriate to starting method, for phase and earth connections. Additionally, four terminals, segregated from the power terminals, are to be provided for the termination of any unused connections in the motor flexible cable (e.g. thermostat, seal fail). Power terminals shall be shrouded to IP2X minimum.

13.8 The removable cover of each motor JB shall be equipped with a '400 V' self-adhesive warning label. Each JB shall be identified with a screw fixed white on black on white flexible 1.5mm thick label fixed to the wall directly above the JB.

13.9 All connections within a JB shall be identified according to the drawings using cable numbers, and shall be fitted with suitable compression connectors or terminal lugs.

13.10 Cable glands shall be of the brass connection pattern, incorporate seals to IP65 and shall be protected by an overall plastic sleeve. This sleeve shall not be of heat-shrink type. For armoured cables, earth continuity shall be afforded through the use of an armour clamp, brass earthing tag and connector. Within pump motor JBs, cable armour and, where appropriate, cable braid shall be interconnected and connected to the CPC cores of the cable.

14.0 INSPECTION AND TESTING

14.1 The Contractor/Designer shall give one months written notice to NWG of the commencement date, and anticipated duration, of each of the activities listed below:

(a) Commencement of electrical installation work on site.

(b) Inspection and testing of the control panel at the manufacturer's works.

(c) Installation of telemetry/communications equipment, where this equipment is to be installed or commissioned at site by NWG.

(d) Acceptance testing and setting to work of the telemetry and communications system by NWG.

(e) Inspection and testing of the completed electrical installation.

(f) Commissioning of the installation

14.2 NWG will confirm with the Contractor/Designer their intention or otherwise to attend, inspect or witness any or all of the activities listed above. Non-attendance by NWG shall not relieve the Contractor/Designer of any obligation to satisfactorily carry out that inspection, test or commissioning activity.

14.3 The Contractor/Designer shall allow NWG access to the site at all reasonable times for the purpose of ensuring compliance with the specifications.

14.4 Methods and procedures adopted for inspection and testing shall be appropriate for the particular activity and prevailing environmental conditions.

Inspecting and testing shall be carried out by persons having the necessary skills and experience to avoid danger to themselves and others, and to prevent damage to equipment and property.

Test equipment shall be suitable for the particular test activity, have current calibration status, and be maintained in a safe condition.

Inspection, testing and the preparation and issue of the Completion Certificate including Schedule of Test Results, shall conform with the requirements of Part 6 of BS 7671 (IEE Wiring Regulations) and IEE Guidance Note No 3 (as amended) 'Inspection and Testing'.

14.5 The control panel shall be inspected and tested before despatch from the manufacturer's works. Inspection and testing shall include:

(a) inspection of all wiring, connections and security of component mounting arrangements

(b) effectiveness of mechanical actuating elements, interlocks and locking arrangements

(c) visual inspection to ensure the prescribed degree of protection, shrouding arrangements and clearance distances etc

(d) marking and conformity of the assembly to the drawings and schedules

(e) dielectric test(s) between live parts and the assembly frame

(f) protective measures with regard to protection against direct and indirect contact

(g) effectiveness of protective conductors, including continuity

(h) RCD testing, trip current and time

(i) tests to satisfactorily demonstrate the full and correct operation of all components, systems and sequences. Tests shall be performed with the level monitoring system(s) temporarily connected to the system; the relays of the Ultrasonic system shall be configured as specified in the 'Level Monitoring' section. Interfacing with the telemetry facility shall be proved up to the telemetry system terminal rail.

The control panel manufacturer shall provide a certificate of inspection and test which shall detail the activities undertaken and the test results.

14.6 During construction and/or on completion, the complete installation shall be verified through inspection and testing to Part 6 of BS 7671. The relevant sections of the NICEIC Completion and Inspection Certificate including the Schedule of Test Results, plus the P.I.T. test sheets shall all be completed at the time of inspection and test .

Testing activities shall include:

(a) detailed inspection as required by BS 7671. The inspection shall determine that the equipment complies with Section 511 of BS 7671, that the equipment has been correctly selected and installed, and that any equipment which is damaged or otherwise defective is identified and replaced.

(b) testing of the installation including:

(i) Continuity of Conductors
- earthing conductors
- main bonding conductors
- supplementary bonding conductors
- radial circuit protective conductors

(ii) Insulation Resistance

(iii) Polarity

(iv) Earth Electrode Resistance

(v) Earth Fault Loop Impedance

(vi) Operation of RCDs trip current and time

(vii) Testing of pump motor circuits including earthing shall not necessitate the opening of the cable entry/motor terminal box at the pumpset. Earth fault loop impedance (EFLI) testing of a pump motor circuit shall comprise an EFLI test of the pumpset

cable circuit up to the JB within the valve chamber, and an assessment of the R1 + R2 resistance of the integral pumpset cable, based on information provided by the pump supplier. Continuity of the pumpset CPC between the valve chamber JB and the exposed conductive parts of the pumpset shall be confirmed by test; this test shall also be used to validate the assessed R2 value.

14.7 Details of each circuit, its composition and relevant test results shall be entered on the Schedule of Test Results section of the Completion Certificate. The schedule shall include the following circuits:

230/400V ac circuits:

(a) REC supply 'tails'

(b) Incoming supply circuit to control panel Distribution Block 1

(c) Standby generator circuit to control panel Distribution Block 1 including RCD

(d) Pump 1 circuit including RCD and size and composition of integral pumpset cable.

(e) Pump 2, as (d) above

(f) Heating circuit

(g) Lighting circuit

(h) Telemetry section internal socket outlet and RCD

(i) Common controls supply circuit including RCD

(j) Telemetry outstation and communications supply circuit including RCD

110V ac (55V-C-55V) circuit:

(k) BS EN 60309-2 socket outlet including RCD

14.8 Following the configuration of the level monitoring system(s) the complete installation shall be tested to prove the satisfactory operation of all components, systems and sequences. The telemetry signals detailed in F9.37 shall be tested up to the outstation for continuity and functionality.

14.9 Conclusive tests shall be undertaken to prove that:

(a) Starter Pump 1 is connected to Junction Box 'Pump 1' within the valve chamber, and

(b) Pump 1 is connected to Junction Box 'Pump 1'

Tests shall be repeated for the Pump 2 configuration. Labelling and cable numbering etc shall be checked for correctness.

14.10 The direction of rotation of pump impellers shall be checked in conjunction with the pump supplier.

14.11 After completion of the installation, and following receipt by NWG of satisfactory 'as-constructed' record documentation, NWG will formally inspect the installation for adoption or take-over purposes. The electrical Contractor(s) shall be present during this inspection to satisfactorily demonstrate the operation of the complete system and to undertake such additional demonstrations and/or tests as directed by NWG.

Where NWG determines that the BS 7671 Completion and Inspection Certificate or other record documentation is incomplete or incorrect, or where a non-conformance with BS 7671 is identified, the Designer and Contractor will be informed accordingly. Thereafter, a formal inspection will not be undertaken until:

(a) matters are resolved to the satisfaction of NWG who shall be informed of the remedial action(s) taken to resolve those matters, and

(b) correct record documentation has been submitted to NWG

Remedial work to the installation, as determined and directed by NWG, shall be carried out.

14.12 Where the installation is over three years old (from the date of connection to the electricity supply) an additional BS 7671 Periodic Inspection and Test shall be undertaken by a NICEIC - approved contractor. Documentation in the form prescribed in BS 7671 plus NWG P.I.T. test sheets shall be completed and submitted to NWG.

15.0 DRAWINGS AND SCHEDULES

Appendix A8.3 contains the detailed electrical design, including schematics, parts lists, schedules, GA's and panel construction details.

The design shall be only used when all the criteria in the sub-section 'Application of Standard Installation' are satisfied.

a) **Site Specific Designs**

Modifications must be made to the supplied design to make it site specific. There are a number of variations which must be considered and the appropriate drawings selected as detailed in Appendix A.8.3.

15.2 **Drawing Amendment**

The schematics, schedules and parts lists will require amending by the Designer, so as to be site specific.

In particular, for **schematic** drawings, the following require detailing:

- Fuse Sizes
- MCB Values
- RCD Values
- Overload Setting (Range)
- Motor Full Load Current and kW Ratings

- Timer Settings
- Cable Sizes
- Emergency Overflow Float switch (if fitted)

For **Parts Lists and Cable Schedules** all site specific components and cables must be detailed. Items or cables that are not used shall be deleted. A site specific drawing register must also be created.

15.3 **Drawings to be Returned to NWG**

The following "as built" drawings are to be included with the O & M Manuals along with an AutoCAD release 14 disk copy:

- All schematic drawings, with the exception of those that are not applicable, as detailed above
- All constant and variable parts lists
- Site specific drawing register
- Control panel General Arrangement
- Cable block diagram
- Site specific kiosk details
- Cable schedule

15.4 **Format**

Each drawing must detail the following:

- Site name
- Contractor name
- Amendment record
- Title
- Approvals box
- Drawing number -**the three figure suffix (e.g. 305) must be retained.** The Contractor may alter the prefix.
- A reference to note that the design is based on Northumbrian Water standard E0702 drawings.

The box to the left of the Amendment box on the drawings may be used for the above purposes. It is not necessary to retain the 'Northumbrian Water' title.

APPENDICES

A1 TWO PUMP SUBMERSIBLE PUMPING STATION DRAWINGS

Drawing Number	Title	Issue
E0702/501	Diagrammatic Site Layout	P3 7/6/95
E0702/502	Plan of Valve Chamber and Wet Well	P1 5/5/95
E0702/503	Elevation of Valve Chamber and Wet Well	P1 5/5/95
E0702/504	Valve Chamber Alternative Arrangement	P1 5/5/95
E0702/505	Inlet Baffle and Emergency Overflow Details	P1 5/5/95
E0702/506	Ultrasonic Sensor Mounting Arrangement	P2 17/5/95

A2 NWG STANDARD DETAIL DRAWINGS

Drawing Number	Title	Issue
E0702/600	Air Valve Chamber Type A	April 1995
E0702/601	Washout Chamber Type C	April 1995
E0702/602	Fencing Type F	April 1995
E0702/603	Gate Type 2	April 1995
E0702/604	Typical Submersible Pumping Station Access Cover	April 1995

A3 WATER INDUSTRY MECHANICAL AND ELECTRICAL SPECIFICATION WIMES 1.02

(a) Copies of WIMES 1.02 are available from:

THE PUMP CENTRE
BUILDING RD1
AEA TECHNOLOGY
BIRCHWOOD SCIENCE PARK
WARRINGTON
WA3 6AT

TELEPHONE: (01925) 252 185
FAX: (01925) 253 576

(b) This document is the industry standard and shall be used to specify all Submersible Sewage Pumps.

(c) The data sheet must be **fully** completed, as indicated therein, by the pump purchaser and the pump supplier.

A4 LIFTING DAVITS AND SOCKETS

The preferred method of lifting submersible pumps is to use a lorry mounted jib crane. Suitable provision must be made to allow vehicular access.

Standard davit sockets must be provided to guard against the non-availability of a crane. These can be obtained from NWG Stores at Pity Me. They must be installed at a radius such as to allow the lifting equipment a vertical pull on the pump lifting attachment.

Details of NWG's standard davits and sockets are given on the following drawings:

500 kg SWL Portable Lifting Davit and Socket	Drawing No: HSP 100/CE0002
1000 kg SWL Portable Lifting Davit and Socket	Drawing No: HSP 100/CE0003
Brass Marker Plate for Lifting Davit Sockets	Drawing No: HSP 100/CE0004

NWG will provide an identification number for the socket on request. This number shall be used on the lifting plant test certificates and inspection records, and shall be indicated on the brass marker plate to be installed adjacent to the davit socket.

All lifting plant must be designed and tested in accordance with prevailing legislation, including the Factories Act and the Construction (Design and Management) Regulations 1994 [CDM Regulations].

The Designer must ensure that the supporting structure is designed to support the davit and any loads transmitted.

When selecting davit sockets, the SWL must be greater than twice the mass of the pump unit.

NWG use chain blocks suspended from the davits to lift pumps. Proprietary, lightweight, winches are not acceptable.

Non standard davit sockets are not acceptable to NWG.

A5 ULTRASONICS PARAMETER SETTINGS

P1		P7		P13		P19	
P2		P8		P14		P20	
P3		P9		P15		P21	
P4		P10		P16		P22	
P5		P11		P17		P23	
P6		P12		P18		P24	

Relay 1& 3: Set at Duty Level

Relay 2 : Set at Standby Level

Relay 1 & 2 : Programmed for Sequential Loop control (DE9)

Relay 3 : Programmed for pump control (DE8)

Relay 4 : Programmed for Wet Well High Level to Telemetry

Relay 5 : Programmed for Ultrasonics System Healthy

P25		HRS RUN 1
P26		HRS RUN 2
P27		HRS RUN 3
P28		HRS RUN 4
P29		HRS RUN 5
P30		SECS
P99	**Reset All**	

HEAD	Metres	FLOW	l/sec	HEAD	Metres	FLOW	l/sec
H1		F1		H7		F7	
H2		F2		H8		F8	
H3		F3		H9		F9	
H4		F4		H10		F10	
H5		F5		H11		F11	
H6		F6		H12		F12	

COMPLETED BY:

DATE: _____

A6 SEWAGE TREATMENT ASSETS SYSTEM

Number *	
Description	
Parent Number *	
Location Lvl 1	
Lvl 2	
Lvl 3	
Commissioned *	
Classification	
Category	
GENERAL	
Terrier Reference *	
Site Address 1	
Site Address 2	
Post Code	
Telephone Number	
OS Grid Reference	
AOD Level	
Adoption Date	
Station Type	
Council Area	
Sewage Work Supplied	
Type of Macerator	
Total Capacity	
Flow Measurement (Y/N)	
Discharge Type	
PSTN Supply	
Level Controller Type	
PLC Type	
Radio	
Telemetry System Equipment	
Building / Kiosk	
Water Supply on Site (Y/N)	
Access Type	
Abloy Key Type *	
PUMPING SYSTEM	
Population Served	
Number of Properties	
Factory Area	
Industry light / Medium / Heavy	
Sewage System Type	
Overflow Type	
Overflow Details (Size)	
Capacity (l/s)-Des/Ms/Calc	
On Line Store Availability	
Capacity Pump Well	
Pump Bypass	
Dry Weather Flow (l/s)	
Store Time Before Overflow	
Trade Effluent (l/s)	
Dry Weather Flow (l/s)	
Store Time Before Overflow	
Trade Effluent (l/s)	
Type of Solid Separation	

RISING MAIN	
Rising Main Discharge Grid Ref	
Rising Main Length (m)	
Rising Main Diameter (mm)	
Rising Main Material	
Total Head (m)	
Average Pumping Head (m)	
Static Head (m)	
Maximum Surge	
Minimum Surge	
Velocity m/s	
Air Valve Type	
PUMPS	
Number of Pumps	
Duty	
Running Current	
Starter Arrangement (DOL etc)	
Type / Make of Pump	
Max Pump Motor Rating (kW)	
Suction / Delivery Size (mm)	
Speed (rpm)	
Impeller Type Number	
Year of Manufacture	
Serial Numbers	
Power	
Panel Manufacture	
Elec Supply O/hd, U/gd, Vlt	
Service Capacity	
Earth Definition/Type	
Test Cert.	
Test Cert. Date	
Phases	
Dual Power Supply (Y/N)	
Plug in Socket for Generator (Y/N)	
Size of Mobile Generator Req'd (kVA)	
Maximum Demand (kW)	
REC Owned HV Equipment (Y/N)	
NWG Owned HV Equipment (Y/N)	
EA Consent Date	
Consent Population	
Storage Capacity	
Sample point Grid Reference	
MISCELLANEOUS	
EA Consent Number	
Discharge Grid Reference	
Water Course	
Hazardous Zone Classification	
Station Manuals	
Telephone Account Number	
Electricity Account Number	
REC Elec Supplier	
Electricity Tariff	
Legal Reference Number *	

Wet Well Size (m dia)			

*** INFORMATION TO BE PROVIDED BY NWG**

A7 LOCATION PLAN EXAMPLE

A8.1 STANDARD ELECTRICAL DESIGN FOR TWO PUMP SUBMERSIBLE PUMPING STATIONS

THE SERCK PROTEUS PS1 "TERMINATION & COMPILE SHEET" SHALL SUPERSEDE ANY REFERENCE TO TELEMETRY INPUT SIGNALS ON DRAWINGS E0702/315-1A & 315-1B

NORTHUMBRIAN WATER LTD
SERCK PROTEUS PS1 OUTSTATION
TERMINATION & COMPILE LIST

These lists will be sent to you electronically, along with a guidance note, by the relevant Engineer in NWG 's Asset Investment Department, at Pity Me.

A8.2 OPERATION PHILOSOPHY (SEPARATE SYSTEM)

1.0 All levels in the pumping station wet well are monitored by an Ultrasonic detector head and control unit. The controlling actions and operation levels are commissioning set by programming the control unit.

The sequence of operation is as follows:

(a) Flow enters the pumping station and accumulates in the wet well. At a pre-set level of liquid, the *Duty Pump Start Level*, the Duty pump will start.

(b) Under normal, healthy, pump operation the Duty pump will pump down the wet well level, and will stop at the *Duty Pump Stop Level*.

(c) If however the level continues to rise after the *Duty Pump Start Level* has been reached, (this may be due to a blockage or other reason whereby the pump is running but is not removing the sewage from the wet well) the level will eventually reach the *Standby Pump Start Level*. At this point the control system will stop and then lock out the Duty pump, which is assumed to be faulty because although rated at 6 x DWF (Dry Weather Flow) it could not cope with the flow into the pumping station. The Standby pump will then be started, a message is then sent *"Pump condition (Failed)"* alarm signal to the NWG Control Room via the telemetry system for the duty pump.

Provided that the Standby pump is healthy, the pump will pump down the wet well and will stop at the *Duty Pump Stop Level*. The Standby pump will then assume the role of Duty pump.

(d) If the level still continues to rise the *Wet Well High Level* will be reached and a further telemetry alarm signal sent to the NWG Control Room. The Standby pump will continue to run, but should be assumed to be faulty or the rising main to be blocked etc.

The *Wet Well High Level* alarm level should be set just above the *Standby Pump Start Level* and as far below the emergency overflow level as possible, so as to give as much notice as possible of an impending overflow operation.

2.0 Notes to the above:

(a) When a pump is locked out it will not be able to be restarted until it is manually reset. This can be done either locally, at the control panel, or remotely via the telemetry system from the NWG Control Room.

(b) When the Duty pump is locked out by the control system, the Standby pump lock out circuit is inhibited, i.e. it is not possible for both pumps to be locked out at the same time.

(c) If the Standby pump is not in the *Auto Available* condition, due to pump failure or the pump Run/Off/Auto selector switch being switched in the OFF or RUN

positions or the starter section being switched in the OFF position, the Duty pump lock out circuit is inhibited.

A8.3 ELECTRICAL DRAWING LIST

Drawing Title	Drawing No	Rev	TN-S	TN-C-S	TT	Low Panel	Std Panel
Document Register	E0702/300-1	01					
General Arrangement Control Panel	E0702/301-1A	01	YES	YES			YES
General Arrangement Control Panel	E0702/301-1B	01	YES	YES		YES	
General Arrangement Control Panel	E0702/301-1C	01			YES		YES
General Arrangement Control Panel	E0702/301-1D	01			YES	YES	
General Arrangement Main Incomer & distribution Section	E0702/302-1A	01	YES	YES			YES
General Arrangement Main Incomer & distribution Section	E0702/302-1B	01			YES		YES
General Arrangement Main Incomer & distribution Section	E0702/302-1C	01	YES	YES		YES	
General Arrangement Main Incomer & distribution Section	E0702/302-1D	01			YES	YES	
General Arrangement Pump No1 (A1) Starter Section	E0702/303-1A	01	YES	YES		YES	YES
General Arrangement Pump No1 (A1) Starter Section	E0702/303-1B	01			YES	YES	YES
General Arrangement Pump No1 (B1) Starter Section	E0702/304-1A	01	YES	YES		YES	YES
General Arrangement Pump No1 (B1) Starter Section	E0702/304-1B	01			YES	YES	YES
General Arrangement common controls & Telemetry Section	E0702/305-1A	01	YES	YES			YES
General Arrangement common controls & Telemetry Section	E0702/305-1B	01		YES	YES	YES	
General Arrangement common controls & Telemetry Section	E0702/305-1C	01			YES		YES
Back Plate Arrangement Main Incomer & Distribution Section	E0702/306-1A	01	YES	YES		YES	YES
Back Plate Arrangement Main Incomer & Distribution Section	E0702/306-1B	01			YES	YES	YES
Back Plate Arrangement Pump No1 (A1) Starter Section	E0702/307-1	01	YES	YES	YES	YES	YES
Back Plate Arrangement Pump No1 (B1) Starter Section	E0702/308-1	01	YES	YES	YES	YES	YES
Back Plate Arrangement Common Controls Section PSTN	E0702/309-1A	01	YES	YES	YES	YES	YES
Back Plate Arrangement Common Controls Section RADIO	E0702/309-1B	01	YES	YES	YES	YES	YES
Main Incomer & Distribution Schematic	E0702/310-1A	01		YES		YES	YES
Main Incomer & Distribution Schematic	E0702/310-1B	01	YES			YES	YES
Main Incomer & Distribution Schematic	E0702/310-1C	01			YES	YES	YES
Main Incomer & Distribution Section Wiring Schematic	E0702/310-2	01	YES	YES	YES	YES	YES
Distribution Section Wiring Schematic (A2)	E0702/311-1A	01	YES	YES		YES	YES
Distribution Section Wiring Schematic (A2)	E0702/311-1B	01			YES	YES	YES
Pump 1 & 2 Starter DOL Circuit	E0702/312-1A	01			YES	YES	YES
Pump 1 & 2 Starter Star / Delta Circuit	E0702/312-1B	01			YES	YES	YES
Pump 1 & 2 Starter DOL Circuit	E0702/312-1C	01	YES	YES		YES	YES
Pump 1 & 2 Starter Star / Delta Circuit	E0702/312-1D	01	YES	YES		YES	YES
Pump 1 (A1) Starter DOL Schematic	E0702/312-2A	01	YES	YES	YES	YES	YES
Pump 2 (B1) Starter DOL Schematic	E0702/312-2B	01	YES	YES	YES	YES	YES
Pump 1 (A1) Starter Star / Delta Schematic	E0702/312-2C	01	YES	YES	YES	YES	YES
Pump 2 (B1) Starter Star / Delta Schematic	E0702/312-2D	01	YES	YES	YES	YES	YES
Pump 1 (A1) Starter Control Indication Schematic	E0702/312-3A	01	YES	YES	YES	YES	YES
Pump 2 (B1) Starter Control Indication Schematic	E0702/312-3B	01	YES	YES	YES	YES	YES
Common Controls Wiring Schematic	E0702/314-1	01	YES	YES	YES	YES	YES
Telemetry Section Wiring Schematic PSTN	E0702/315-1A	01	YES	YES	YES	YES	YES
Telemetry Section Wiring Schematic RADIO	E0702/315-1B	01	YES	YES	YES	YES	YES
Cable Schedule	E0702/320-1	01	YES	YES	YES	YES	YES
Cable Block Diagram (PSTN)	E0702/321-1	01	YES	YES	YES	YES	YES
Cable Block Diagram (RADIO)	E0702/322-1	01	YES	YES	YES	YES	YES
Earthing Arrangement	E0702/323-1	01	YES	YES	YES	YES	YES
Kiosk and Panel Layout Details STD Height	E0702/324-1A	01	YES	YES	YES		YES
Kiosk and Panel Layout Details LOW Height	E0702/324-1B	01	YES	YES	YES	YES	
Main Incomer and Distribution Section Label Schedule	E0702/325-1	01	YES	YES	YES	YES	YES
Pump Starter Cubical A1 and B1 Label Schedule	E0702/325-2	01	YES	YES	YES	YES	YES
Pump Starter Cubical A1 and B1 Label Schedule	E0702/325-3	01	YES	YES	YES	YES	YES
Common Controls and Telemetry Section Label Schedule	E0702/325-4	01	YES	YES	YES	YES	YES
REC Board and Cable Chamber Label Schedule	E0702/325-5	01	YES	YES	YES	YES	YES
Wet Well and Valve Chamber Label Schedule	E0702/325-6	01	YES	YES	YES	YES	YES

Only Vaild on day printed

A.9 CONTACT LIST

Regional Sewerage Manager
Northumbrian Water Limited
New Development/Asset Investment
Abbey Road
Pity Me
Durham
DH1 5FJ

Tel: (0191) 3832222

Fax: (0191) 3846357

Environment Agency (EA)
Northumbria Area Office
Tyneside House
Skinnerburn Road
Newcastle Business Park
Newcastle upon Tyne
Tyne and Wear
NE4 7AR

Tel: (0191) 203 4000

Fax: (0191) 203 4004

A10 PIPES, VALVES AND FITTINGS

1.0 Pipes and Fittings

(a) Where macerating pumps are not fitted, all pipework and fittings shall be sized to allow the free passage of nominal 100 mm spherical solids. Pipework and pumps shall be sized for nominal 1.0 m/s flow (and should be within the range 0.75 m/s to 1.8 m/s).

(b) All wet well, valve chamber and connecting straight pipework shall be ductile iron to BS EN 598, cement mortar lined on the inside and bitumen coated on the outside. Pipe fittings may be ductile iron to BS EN 598. Fittings shall be bitumen or epoxy coated inside and out.

(c) Where a pipe is laid in the ground; exposed Flanges, Couplings and Flange Adaptors shall be additionally protected from corrosion in line with manufacturers recommendations.

.

(d) Joints within the wet well and valve chamber shall be flanged to BS 4504:Section 3.2 PN16 or a higher rating if necessary. Each joint shall contain no more than one joint gasket. All gaskets shall be made from 3 mm rubber and conform to BS4865:Part1.

(e) Flexible joints shall be used where the pipe is laid in the ground. These will normally be of the spigot and socket type with a rubber joint, and shall conform to BS437. Double flexible joints i.e. VJ Couplings or similar, are to be installed on all pipes between the wet well and valve chamber.

(f) Self anchoring flanges may only be used when sufficient care is taken to ensure that pipe linings are not damaged. The use of any device to anchor the flange which imparts a point loading onto the pipe shall be avoided.

(g) Where a pipe passes through a chamber wall, a puddle flange shall be used to secure the pipe rigidly in place. This puddle flange shall be an integral part of the pipe, produced during manufacture and prior to coating or painting. Box outs for the puddle flange shall be a reducing taper to both faces so as to resist movement in either direction.

2.0 ISOLATING VALVES

(a) Isolating valves shall be of a knife gate pattern. These shall generally be in accordance with the requirements of BS 5150 for flanged valves, and shall be of the same nominal size as the pipework.

(b) All valves shall be provided with handwheels and shall be clockwise to close, as indicated by a directional arrow cast onto the rim of the valve handwheel.

3.0 REFLUX VALVES

(a) Reflux valves shall be flanged, swing check single disc to BS 5153, of the same nominal size as the pipework.

4.0 GAUGE COCKS

(a) The outlet main and each pump delivery main shall be drilled and tapped ½" BSPT in the position shown on the drawings. Each tapping shall be fitted with a brass gauge cock, to allow the fitting of a 150mm diameter gauge by others. The spindle in the cock shall be capable of being rotated 360°. These connections may be used during testing of the pipework, suitable brass plugs shall be fitted to protect the gauge cocks when not in use.

5.0 VALVE MATERIALS

A10 Table 1 shows the minimum acceptable materials of construction. However the Contractor may offer alternative materials provided the mechanical properties and resistance to chemical and galvanic corrosion are at least equal to those of the materials listed.

6.0 PENSTOCKS

(a) All penstocks shall comply with BS 7775 or the latest edition of the American Water Works Association, Publication C501-87 for cast iron penstocks. Plastic gate type penstocks shall not be used.

(b) The Penstock shall have cast iron wall mounting frames, having standard inverts, non rising stems, and be suitable for off seating heads. Penstocks shall be supplied with Tee Key operated spindles, clockwise closing. The operating Tee Key is to be provided.

(c) Penstocks shall be constructed and installed to be capable of withstanding the impact of floating debris.

(d) Construction shall be such that effluent cannot readily collect on the penstocks, but any that does can be removed by pressure water jetting.

(e) Penstocks shall normally be designed for use only in the fully open or the fully closed positions and intermediate travel. Where specified penstocks shall be suitable for modulating duties or flow control purposes.

(f) The Contractor shall ensure that all materials used in the construction and installation of Penstocks are selected to prevent galvanic corrosion. Contact between stainless steel and galvanised fittings shall be prevented. Where unavoidable insulating sleeves shall be inserted.

(g) Penstocks shall be capable of sustaining a differential pressure of up to 6m head of water in either the on-seating or off-seating directions subject to a maximum permissible leakage rate of 30 litres per metre of sealing perimeter per hour. The Contractor shall guarantee this maximum leakage rate for one year following commissioning.

(h) The frame and gate shall be made from BS 1452 cast iron and the sealing faces from BS 1400 gunmetal.

(i) The spindle and all fixing bolts, pins and screws shall be made from BS 970 stainless steel except for those retaining the gunmetal faces which shall be non-ferrous.

(j) Operating cams shall be bronze or other approved non-ferrous material.

TABLE 1: VALVE TYPES AND MINIMUM ACCEPTABLE MATERIALS STANDARDS

	Knife Gate Valves	Reflux Valves	Air Relief Valves
Valve body See Note B	Cast iron grade 220 Stainless steel type 304/316	Cast iron grade 220	Cast iron grade 220
Valve bonnet/cover	Cast iron grade 220	Cast iron grade 220	Cast iron grade 220
Body sealing face	Rubber/plastic	Gunmetal LG2	Nitrile rubber/ plastic
Gate disc	Stainless steel type 304/316	Cast iron grade 220	
Gate disc sealing face		Gunmetal LG2	
Gate/disc securing pins	Stainless steel type 304/316	Stainless steel type 304/316	
Hinge pins/shafts/ spindles	Stainless steel type 304/316	Stainless steel type 304/316	Stainless steel type 304/316
Hinge pins/shaft/ spindle bearings	Phosphor bronze BP102	Phosphor bronze BP 102	PTFE/phosphor bronze
Hinge pin/shaft gatebody leak seals	Nitrile rubber/ plastic	Nitrile rubber/ plastic	
Internal fittings and miscellaneous trim	Stainless steel type 304/316 or plastic	See Note A	See Note A

NOTES: A. Manufactured from suitable corrosion resistance materials.

B. Cast iron Grade 220 is only to be used for valves installed inside buildings with no risk of freezing. Where installations could be subject to freezing conditions, valve bodies and bonnets/covers shall be manufactured in ductile iron (spheroidal graphite cast iron 425/12) only.

GENERAL: The Contractor and/or manufacturer will be responsible for ensuring that all materials used in the construction of valves are suitable for the duty and application for which they are intended.

A11 FASTENERS AND FIXINGS

(a) All bolts and fixings are to be metric, complying with BS 4190 and BS 3692 having hexagonal heads and nuts.

(b) Bolts not subject to immersion or splashing shall be manufactured from low carbon steel, unless otherwise stated, and shall be sherradised or hot dipped galvanised.

(c) Bolts subject to immersion or splashing shall be stainless steel A4 quality.

(d) All bolts when fully assembled with a standard washer under the nut, and fully tightened, shall have a maximum of 3 threads protruding from the nut.

(e) No bolts shall be installed without the thread being either flush or protruding up to 3 threads from the nut.

(f) All rag bolts and expanding type anchors for use in concrete shall be as supplied by Rawlplug, Hilti, Leibig or other approved suppliers, and manufactured from A4 stainless steel. Where rag bolts, expanding anchors or resin anchor bolts are used, the manufacturer's recommendations regarding minimum distances from the edge of concrete shall be observed.

(g) All fasteners used shall have an anti-seize component smeared on the thread section.

(h) Materials used shall be selected to prevent galvanic corrosion. Special precautions shall be taken to prevent corrosion at joints, or points of intimate contact, between metals of differing electrochemical potential. Wherever possible electrochemically compatible materials shall be used. Contact between stainless steel fixings and galvanised fittings shall be prevented by plastic sleeves and washers.

A12 HYDRAULIC TESTING

(a) Inspection and testing shall conform to the relevant provisions of *NWG Engineering Standard E0111 Specification for Testing and Commissioning*.

(b) The Designer shall take into account all foreseeable changes to the installation which may affect the maximum working pressure of the system and accommodate these within the design. This shall include:

- Any foreseeable pump changes that would increase the system pressure.
- An allowance for any reduction in pipe bore due to deposition.

(c) In order to prevent leakage, it is essential that the fasteners of all flanged pipework joints are tightened sufficiently to withstand the internal pressures of the pipework.

NWG require all flanged pipework connections to be tightened to the bolting torque specified by the pipework supplier in order to achieve a PN16 pressure rating. An appropriate quality assurance record shall be kept by the installer to confirm the required

torque has been applied and verified. This record shall be made available to NWG on request.

(d) The proposed system test pressure shall not be below the relevant provisions of the Civil Engineering Specification for the Water Industry (CESWI) and will allow for any foreseeable changes to the installation as described in (b) above.

NORTHUMBRIAN WATER

A13.1 NWG P.I.T. SHEET FOR CIRCUIT COMPOSITION AND TEST RESULTS

A CIRCUIT COMPOSITION / DESIGN AND COMMISSIONING DATA :

NORTHUMBRIAN WATER

Characteristics at A: Voltage (max).....V Phases..... Zs.....ohms Ipsc(Ph-N).....kA Ipsc(Ph-Ph).....kA

	Circuit Include designation, number, way phase etc as appropriate	Voltage (V)	FLC (A)	Maximum permitted disconnec-tion time (s)	Overcurrent Protective Device			Motor Overload		RCD		Circuit Impedance		Earth Loop Impedance			Circuit Conductors	
					BS (EN) & Type No	Rating (A)	Break Capac (kA)	Range (A)	Setting (A)	Rated residual operating current $I_{\Delta n}$ (mA)	Time Delay (mS)	R1+R2 (Ω)		Zs (Ω)			mm	
												Design	Comm Test	Max Permitted	Design	Comm Test	Live	CPC
1																		
2																		
3																		
4																		

Continuation Sheet No :

B CIRCUIT TEST RESULTS :

Ref from A above	Circuit Include designation, number, way phase etc as appropriate	Test Results													PIT Report Serial No.	Tested by:	
		Circuit Impedance	Insulation resistance (MΩ) (*Record lower or lowest value)				Polarity (✓)	Maximun measured earth loop impedance Zs (Ω)	RCD Operating times (ms)		RCD Operation (✓)		Ipsc (kA)				
		$R_1 + R_2$ (Ω)	*Phase/ Phase	*Phases/ Neutral	*Phases/ Earth	Neutral/ Earth			at 1x $I_{\Delta n}$	at 5x $I_{\Delta n}$	Test Button	Manual Op	Ph-N	Ph-Ph		Name	Date

Continuation Sheet No :

SCHEDULE OF TEST RESULTS FOR :

LOCATION	SUB-LOCATION	UNIT / CIRCUIT	ASSET REF	

NORTHUMBRIAN WATER

A13.2 NWG P.I..T. SHEET FOR SUPPLY EARTHING AND BONDING TEST RESULTS

INSTALLATION SUPPLY, EARTHING AND BONDING - TEST RESULTS

C SUPPLY CHARACTERISTICS

Type of System: T..... Voltage..... V

Phases..... Ze..... Ω

Ipsc(Ph- N)..... kA Ipsc(Ph-Ph)..... kA

Test Results				PIT Report Serial No.	Tested By :	
Voltage (v)	Supply earth loop Impedance ZeΩ	Ipsc (kA)			Name	Date
		Ph- N	Ph-Ph			

Continuation Sheet No.

D RCD AT ORIGIN OR MAIN SWITCH

COMPLETE RELEVANT PARTS OF SECTIONS A AND B

E MAIN EQUIPOTENTIAL BONDING CONDUCTORS

Test Results CONTINUITY (✓) Identify Extraneous Conductive Part/ Service				PIT Report Serial No.	Tested By :	
.....	.....	.....	.....		Name	Date

Continuation Sheet No :

F EARTH ELECTRODE(S)

Test Results ELECTRODE RESISTANCE (Ω) Identify each Electrode by location				PIT Report Serial No.	Tested By :	
.....	.....	.....	.....		Name	Date

Continuation Sheet No :

NORTHUMBRIAN WATER

A13.3 NWG P.I.T. SHEET FOR INSPECTION AND FUNCTIOAL TESTS

NORTHUMBRIAN WATER LIMITED

SCHEDULE OF INSPECTION AND FUNCTIONAL TESTS

ITEM No.	DESCRIPTION	STATUS * S	U/S	N/A	N/V	ITEM No.	DESCRIPTION	STATUS (TICK BOX) S	U/S	N/A	N/V
	INFORMATION					31	ELECTRODE CONNECTION PROTECTED AGAINST MECHANICAL DAMAGE/CORROSION				
1	DRAWINGS, INSTRUCTIONS ETC. AVAILABLE					32	MAIN BONDING PROVIDED TO STRUCTURAL STEELWORK AND METALLIC SERVICES				
2						33	MAIN BONDING CONDUCTORS LABELLED				
	GENERAL					34					
3	CORRECT IDENTIFICATION					35					
4	LABELS LEGIBLE AND DURABLE						*ASSEMBLIES - GENERAL*				
5	DANGER/WARNING NOTICES					36	ISOLATING DEVICES SECURABLE (LOCKABLE OFF)				
6	ACCESS TO EQUIPMENT					37	COVER PLATES, DOORS, GASKETS ETC				
7	EQUIPMENT AND FIXINGS SUITABLE FOR ENVIRONMENT					38	IDENTIFICATION OF PROTECTIVE DEVICES, SWITCHES & TERMINALS				
8	PROTECTION AGAINST THERMAL EFFECTS					39	DEVICES CORRECT FOR SHOCK PROTECTION DISCONNECTION TIME				
9	FREEDOM FROM PHYSICAL DEFECTS/CORROSION					40	INTERNAL/EXTERNAL CLEANLINESS				
10	COMPLETENESS OF ASSEMBLIES AND INSTALLATION					41	PROTECTIVE BARRIERS/SHIELDS/SHROUDS				
11						42	DAMAGED/MISSING COMPONENTS				
12						43	EXPOSED CONDUCTIVE PARTS EARTHED				
13						44	UNUSED APERTURES SEALED				
	EQUIPMENT AT INSTALLATION ORIGIN					45	OVERCURRENT DEVICE BREAKING CAPACITY SUITABLE FOR FAULT LEVEL				
14	ADEQUATE ACCESS, SPACE AND LIGHTING AT MAIN SWITCHGEAR					46	ACCESS & SPACE				
15	MAIN SWITCHGEAR SUITABLY PLACED FOR READY OPERATION					47					
16	MAIN SWITCHGEAR SUITABLE FOR ISOLATION AND SWITCHING					48					
17	MAIN ISOLATING DEVICE(S) SECURABLE (LOCKABLE OFF)					49					
18	MAIN SWITCH/CB DOUBLE POLE FOR SINGLE PHASE (ANY SYSTEM)						*ASSEMBLIES PROVIDING ACCESS TO UNSKILLED PERSONS EG. DBs*				
19	MAIN SWITCH/CB THREE/FOUR POLE FOR THREE PHASE (TN SYSTEM)					50	INTERNAL NON-ISOLATED PHASE & NEUTRAL SHIELDED BY BARRIERS				
20	NEUTRAL LINK REMOVABLE ONLY BY USE OF TOOL OR HAS RESTRICTED ACCESS					51					
21	MAIN SWITCH /CB FOUR POLE FOR THREE PHASE (TT SYSTEM)						*CABLING AND WIRING*				
22	MAIN CB(S)/FUSE(S) BREAKING CAPACITY ADEQUATE FOR FAULT LEVEL					53	CABLES/CONDUCTORS SECURELY TERMINATED				
23	MAIN RCD CURRENT/TIME-DELAYED FOR DISCRIMINATION					54	PROTECTED AGAINST ABRASION AT ENTRIES				
24	RATING AND CONDITION OF INCOMING SUPPLY TAILS/CABLE(S)					55	CORRECT GLANDS AND GLAND PLATES USED				
25	INCOMING TT TAILS SEGREGATED FROM METAL ENCLOSURES UP TO RCD					56	EARTH TAGS CONNECTED TO EARTH				
26						57	EARTHING CONNECTION NOT VIA NON CONDUCTIVE COATING				
27						58	CONNECTIONS IDENTIFIED				
	SYSTEM EARTHING AND BONDING					59	SUPPORTS/FIXINGS SECURE				
28	MAIN EARTHING TERMINAL PROVIDED / ACCESSIBLE / IDENTIFIED					60	ROUTING OF CABLES/MECHANICAL PROTECTION				
29	PROVISION FOR DISCONNECTING EARTHING CONDUCTOR FOR TESTING					61	CONDUIT/TRUNKING COMPLETE & SECURE				
30	EARTHING CONDUCTOR PROTECTED AGAINST MECHANICAL DAMAGE/CORROSION					62	CONDUIT/TRUNKING CAPACITIES NOT EXCEEDED				

* Tick box as appropriate: S - Satisfactory U/S - Unsatisfactory N/A - Not Applicable N/V - Not Verified

Complete relevant sections only

Checklist continued overleaf

PIT REPORT : * Delete as appropriate

Completed : YES*/NO* Serial No.....

SCHEDULE COMPLETED BY :

Name.....Date.....

SCHEDULE FOR :

LOCATION	SUB-LOCATION	UNIT / CIRCUIT	ASSET REF	

A13.4 NWG P.I.T. SHEET CONTINUATION OF INSPECTION AND FUNCTIONAL TESTS

SCHEDULE OF INSPECTION AND FUNCTIONAL TESTS

ITEM No.	DESCRIPTION	STATUS * S	U/S	N/A	N/V	ITEM No.	DESCRIPTION	STATUS (TICK BOX) S	U/S	N/A	N/V
	CABLING AND WIRING (CONTINUED)					103	- RCD				
63	METALLIC WIRING SYSTEMS EARTHED/ JOINTS SOUND					104	- OVERLOAD				
64	CATEGORY 1,2 AND 3 CIRCUIT SEGREGATED OR EQUIVALENT					105	-				
65	DUCT SEALING					106	-				
66	FIRE BARRIERS					107	-				
67						108	-				
68						109	-				
69						110	FUNCTIONAL- CONTROLS				
	PROTECTIVE CONDUCTORS					111	- START PB				
70	CIRCUIT PROTECTIVE CONDUCTORS					112	- STOP PB				
71	EXPOSED CONDUCTIVE PARTS EARTHED					113	- HOA				
72	EARTHING FIXINGS, BONDS ETC					114	- LOR				
73	SUPPLEMENTARY EQUIPOTENTIAL BONDS					115	- INTERLOCK(S)				
74						116	- REMOTE CONTROL				
75						117	- AUTO CONTROL				
76						118	- DUTY SELECTION				
	MISC SYSTEMS - INSPECTION					119	-				
77	LIGHTING - GENERAL					120	-				
78	EMERGENCY LIGHTING					121	-				
79	SECURITY AND EXTERNAL LIGHTING					122	FUNCTIONAL- FAULT ROUTINES				
80	FIRE DETECTION AND ALARM					123	- FAULT LOCKOUT				
81	SECURITY SYSTEMS INCLUDING INTRUDER ALARM					124	- FAULT RESET				
82	SOCKET OUTLETS					125	- OVERLOAD				
83	CENTRAL BATTERY AND UPS SYSTEMS					126	-				
84	STANDBY GENERATOR					127	-				
85	LIGHTNING PROTECTION SYSTEM					128	-				
86						129	-				
87						130	-				
88						131	FUNCTIONAL- INDICATING DEVICES				
89						132	- LAMPS (INCLUDING COLOURS)				
	FUNCTIONAL TESTS					133	- METERS				
90	MANUAL OPERATION OF SWITCHING AND ISOLATING DEVICES					134	-				
91	RCD TEST BUTTON (WHERE FITTED)					135	TELEMETRY/ SCADA				
92	SAFETY RELATED CONTROL SYSTEMS					136	- STATUS				
93	- TRIP DEVICES					137	- FAULTS				
94	- INTERLOCKS					138	- CONTROLS				
95	- EMERGENCY STOP CIRCUIT(S)					139	-				
96	- EM STOP LATCH/ RESET					140	STARTER FUNCTIONAL TEST				
97	-					141	FUNCTIONAL - MISC ITEMS 77-89				
98	-					142	- ITEM NO.				
99	-					143	- ITEM NO.				
100	-					144	- ITEM NO.				
101	SETTING OF PROTECTION AND MONITORING DEVICES					145	- ITEM NO.				
102	- OVERCURRENT DEVICE					146	- ITEM NO.				

* Tick box as appropriate: S - Satisfactory U/S - Unsatisfactory N/A - Not Applicable N/V - Not Verified Complete relevant sections only