

Category 1 Standard

S1056 Civil Engineering - Pump Drainage Systems

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1 Purpose

- 1.1 The purpose of this Standard is to define the life cycle requirements for pump drainage system assets in performance terms.
- 1.2 Standards for gravity drainage systems are given in London Underground (LU) Category 1 Standard S1052 Civil Engineering – Gravity Drainage Systems.
- 1.3 In defining requirements specifically applicable to pump drainage system assets, this Standard complements LU Standard S1050 (formerly 1-050) that defines mandatory requirements generally applicable to all Civil Engineering assets including pump drainage system assets.
- 1.4 A supporting Manual of Good Practice G056 gives guidance and information specific to LU pump drainage system assets.
- 1.5 There are references within this document to LU Technical Specifications (T-series documents) and within LU they shall be complied with. However, it is not mandatory for other companies within the TfL family to follow them; they may refer to their own company's equivalent specifications.

2 Scope

- 2.1 This standard applies to *new* and *rehabilitated* pump drainage system assets (*foul, grey and surface water*) owned by LU as part of the following drainage systems:
 - a) Track and off-track pump drainage systems (*surface water only*).
 - b) Stations, depots and other operational buildings pump drainage systems (*foul, grey and surface water*).

Rehabilitation works are proposals that constitute *major change* to an existing pump drainage system. It therefore generally excludes simple *like-for-like* replacements of individual assets within the pump drainage system. The exception to this rule is the renewal of a control panel, when this is planned it constitutes *major change*.

- 2.2 This Standard defines the responsibilities involved during the life cycle of the assets and sets out the requirements for:
 - a) Design
 - b) Construction
 - c) Maintenance (*including Inspection and Assessment*)
 - d) Decommissioning
- 2.3 This standard covers the design of pump drainage systems, which includes the following principle elements:
 - a) Hydraulic and structural design of internal and external pump drainage systems (*foul, grey and surface water*). It should be noted that both buried and non-buried pump drainage assets are designated as Civil assets.
 - b) Power and control system requirements associated with pump drainage systems.
- 2.4 This Standard should be read in conjunction with the following LU and Non-LU technical specifications:
 - a) T0002 Civil Engineering – Pump Drainage Systems



- b) T0003 Critical Pump Sites – Control Panel Specification
- c) T0004 Non-Critical Pump Sites – Control Panel Specification
- d) Site-specific application of the National Building Specification (NBS) (*in relation to Stations, Depots and other operational buildings pump drainage systems*) by the Premises team

The aforementioned specifications state the generic and site-specific materials and workmanship LU requirements.

3 Requirements

3.1 Design

3.1.1 General

3.1.1.1 Required Duty

- 3.1.1.1.1 The inception and design of works to pump drainage system assets shall ensure that the assets meet their *Required Duty*.

Note: The *Required Duty* for Pump Drainage System assets is as follows:

- 1 Meet railway operating requirements (*within the performance specification at system installation or at the most recent system upgrade*).**
 - 1.1 Maintain inherent structural integrity (*support itself so as not to suffer complete or partial collapse*).
 - 1.2 Maintain the ability to carry any permitted applied static and dynamic design loads without restriction.
 - 1.3 Allow adequate clearance to ensure the safe passage of rail vehicles.
 - 1.4 Operate without risk of blockage or failure to minimise the risk of flooding or disruption to railway operations.
 - 1.5 Provide sufficient hydraulic capacity to convey the flow requirements.
 - 1.6 Provide appropriate access and egress for all planned uses, and for reasonably anticipated emergency uses (*including Maintenance*).
 - 1.7 Sustain a Condition and state so as not to cause unplanned interruption to, or restriction of, any aspect of the operating railway.
- 2 Ensure support at asset interfaces without undue wear and tear.**
 - 2.1 Minimise the degradation of all interfacing assets (*e.g. as evidenced through Maintenance cycles*). This includes interfaces with the railway and adjacent infrastructure, e.g. track, structures, stations and premises.
- 3 Match LU policy in respect of realistic user perceptions.**
 - 3.1 Ensure pumping and gravity drainage systems collect, convey and discharge their content without undue degradation to interfacing assets, disruption to railway operations, unacceptable environmental nuisance, or risk to the health and safety of passengers, employees, contractors and members of the general public.
- 4 Provide resistance against external interference and events.**

4.1	Provide a drainage system which minimises the likelihood and consequence of asset abuse. Asset abuse encompasses vandalism, damage due to external events, etc.
5	Present acceptable environmental impact.
5.1	Provide an acceptable societal environmental impact (<i>including adverse weather management, outfalls, toxicity, public health, odours, etc.</i>).
5.2	Protect receiving waters from pollution (<i>within statutory limits</i>).
6	Minimise environmental impact throughout lifecycle.
6.1	Minimise environmental impact and demands at all stages in the asset lifecycle; this includes effects now and in the future, including successive refurbishment, final decommissioning, and disposal routes.
7	Function within the legal and standards framework.
7.1	Ensure the asset functions within the framework defined by legislation (<i>including environmental legislation</i>), regulatory guidance, standards (<i>including LU and applicable National, European & International standards</i>), and LU policies.
8	Ensure safe operation as defined by LU.
8.1	Ensure safe operation and Condition as specified by LU requirements; this includes passengers, employees, contractors and members of the general public.
8.2	Ensure safe access/egress by passengers, employees, general public and emergency services (<i>in planned and reasonably anticipated emergency scenarios</i>). Appropriate access/egress shall be provided for Maintenance purposes.
8.3	Safeguard the health and safety of passengers, employees, contractors and members of the general public.
9	Provide above within reliability and availability targets.
9.1	Meet all aspects of the <i>Required Duty</i> within the defined LU requirements.
10	Ensure Required Duty is performed without incurring excessive or prohibitive costs.

3.1.1.2 Pump drainage systems – general design principles

3.1.1.2.1 For each pump site being designed (*whether new or rehabilitation*), the designer shall refer to the *Professional Head (Pumps & Drainage)* for an estimate of the time between pump drainage system failure (*structural or serviceability*) and its impact in terms of restrictions to the operational railway (*e.g. by track or station closure*). This design parameter shall be known as the *Pump Failure Impact Time (PFIT)*.

Note: The *Professional Head (Pumps & Drainage)* is responsible for consulting with the maintenance department (*where appropriate*) to understand the historic failure data for the site; and more specifically, to ensure he has information on the proximity *and* potential failure impact of relevant adjacent assets.

3.1.1.2.2 A *Critical Pump Site* is defined as a site where the PFIT is less than 4 hours. The designation as a *Critical Pump Site* shall be recorded against the pump site in the Asset Register.

3.1.1.2.2.1 *Critical Pump Sites* shall meet the following requirements:



- a) They shall be equipped with a critical control panel compliant with LU Technical Specification T0003.
- b) They shall be equipped with a minimum of two pumps.

3.1.1.2.3 A *Priority Pump Site* is defined as a site where the PFIT is between 4 hours and 24 hours. The designation as a *Priority Pump Site* shall be recorded against the pump site in the Asset Register.

3.1.1.2.3.1 *Priority Pump Sites* shall meet the following requirements:

- a) They shall be equipped with a non-critical control panel compliant with LU Technical Specification T0004.
- b) The design shall ensure there is sufficient redundancy provision within the pump drainage system to facilitate a timely maintenance intervention in the event of pump failure. Such redundancy shall take *one* of the following forms (*in order of LU preference*):
 - I. A minimum of 8 hours storage following pump failure shall be provided.
 - II. Spare pumpsets (*quantity equal to the total number of installed duty and assist permanent pumps*) shall be provided and stored on site in a suitable secure location.

3.1.1.2.4 A *Non-critical Pump Site* is defined as a site where the PFIT is more than 24 hours. The designation as a *Non-critical Pump Site* shall be recorded against the pump site in the Asset Register.

3.1.1.2.4.1 *Non-critical Pump Sites* shall meet the following requirements:

- a) They shall be equipped with a non-critical control panel compliant with LU Technical Specification T0004.

3.1.1.2.5 Wherever pump drainage systems are designed to accept the discharge from fire suppression systems (*e.g. sprinkler discharges*) a minimum of two pumps shall always be provided.

3.1.1.2.6 New and rehabilitated pump drainage systems shall have provision for emergency pumping. This shall be achieved by compliance with the following requirements:

- a) The connection for the emergency pump discharge pipe shall be 2" (50mm) BSP female parallel thread x 2½" (63mm) male instantaneous aluminium fixed head connectors for quick-fit couplings.
- b) If there is no local gravity drainage system to allow a connection to be made with lay-flat hoses then consideration should be given to installing a pressure pipeline as part of the initial build, with a quick-fit coupling to accept the temporary pump discharge.
- c) A 415V or 240V (*depending on the operating voltage of the permanent pump*) Lewden-type socket shall be provided to enable temporary pumps to be installed quickly and easily.
- d) A 110V Lewden-type socket shall be provided to enable use of portable tools, etc.

3.1.1.2.7 For all pump drainage systems, the size of solids capable of passing through pumpsets shall be capable of passing down pressure pipelines to the ultimate point of discharge.

3.1.1.2.8 Appropriate pollution control measures shall be designed within pump drainage systems, if they are required. They shall comply with current statutory requirements *and* best practice. In particular, reference shall be made to the CIRIA publication C643 *The potential for water pollution from railways*.

3.1.1.2.9 Human factors issues shall be considered in the design process for new and rehabilitated pump drainage systems. The requirements of LU Category 1 Standard S1217 (*formerly 1-217*) shall be complied with.

3.1.1.2.10 Systems engineering issues may arise in connection with all aspects of new and rehabilitated pump drainage systems. The requirements of LU Category 1 Standard S1209 (*formerly 1-209*) shall be complied with.

3.1.1.2.11 An application for an allocation of space on operational property may be required in connection with the design of new and rehabilitated pump drainage systems. The requirements of LU Category 1 Standard S1472 (*formerly 1-472*) shall be complied with.

3.1.1.3 Supervisory Control and Data Acquisition (SCADA)

3.1.1.3.1 TfL/LU have a standard pumps SCADA system (*currently Flygt Aquaview*) serving all their pump drainage systems. All new and rehabilitated pump drainage systems shall be connected into the pumps SCADA system using specific software (*for further information refer to LU Technical Specifications T0003 Critical Pump Sites – Control Panel Specification; and, T0004 Non-Critical Pump Sites – Control Panel Specification*).

3.1.1.3.2 Pump drainage systems shall only employ *Duty* and *Assist* pumps. This is due to the potential for the introduction of reliability problems and conflicts within the pump control philosophy. This is a function of a parallel control philosophy, which relies on a pumps SCADA system for primary control and stand-alone local control rods/floats for secondary control in the event of primary control malfunction.

3.1.1.3.3 Pump drainage system Control Panels shall be designed and manufactured in accordance with LU Technical Specifications T0003 Critical Pump Sites – Control Panel Specification; and, T0004 Non-Critical Pump Sites – Control Panel Specification.

3.1.1.4 Chambers, sumps, tanks and interceptors

3.1.1.4.1 Each chamber, sump, tank and interceptor shall be equipped with a Radio Frequency Identification (RFID) tag and a plate displaying its unique identification number. Refer to LU Technical Specification T0002 for materials and workmanship requirements associated with these items. Fixings must be appropriate for the substrate concerned.

3.1.1.4.2 Drainage system access points shall have internal plan dimensions, clear opening plan dimensions and depths that are appropriate for the maintenance regime applied to the drainage system concerned and that are consistent with industry good practice.

3.1.1.4.3 Permanent access provision within pump drainage system chambers (*i.e. step irons and/or ladders*) is required (*except for effluent storage chambers*) unless the designer has sound engineering reasons for adopting a contrary arrangement (*which must be detailed within the CDS for the work in accordance with the relevant assurance process*).

3.1.1.4.4 The position of level-sensing equipment in pump drainage system chambers shall ensure the following.

- a) The equipment shall be accessible for inspection, cleansing and maintenance without the need for staff to enter the chamber.
- b) The risk of damage to the equipment during inspection, cleansing, maintenance and during pump operation is minimised.



- c) Turbulent conditions in the chamber (*regardless of chamber water levels*) shall not compromise the level sensing operations.
- d) Equipment placement shall be discussed in the CDS or DDR in accordance with the relevant assurance process.

3.1.1.5 Pipework

3.1.1.5.1 Pipelines passing beneath tracks (*'under-track crossings' (UTX's)*) shall cross perpendicular to the tracks, but where this is not possible the length of the UTX shall be minimised.

3.1.1.5.2 Unless there is a sound engineering reason for adopting a contrary arrangement (*which must be detailed within the CDS for the work in accordance with the relevant assurance process*) pressure pipelines shall be sleeved (*ducted*) wherever they pass under or through structures (*including under tracks*) to allow the pressure pipeline to be replaced/maintained without the need for the fabric of the host/bridged structure to be interfered with. Appropriate pipe skids/braces shall be employed to bridge the annulus between the sleeve and the pressure pipe in order to prevent significant movement of the pressure pipeline under normal working conditions.

Where pressure pipelines are sleeved under or through structures, the structural design of the pressure pipeline shall take into consideration the impact of the particular sleeving and bracing arrangement upon the structural performance of the pipeline.

3.1.1.6 Electrical

3.1.1.6.1 Pump drainage system designs shall be compliant with the relevant parts of BS 7671 Requirements for Electrical Installations – IEE Wiring Regulations [*current edition*] and with LU Category 1 Standard S1069 (*formerly 1-069*) Low Voltage Electrical Systems. In the event of conflict between these two standards, the decision of the *Professional Head (Mechanical & Electrical)* shall prevail.

3.1.1.6.2 A Load Change Application may be required in relation to connection and/or disconnection of electrical loads and other services. The requirements of LU Category 1 Standard 1-100 shall be complied with.

3.1.1.6.3 The power and control systems associated with pump drainage systems have the potential to be sources of Electromagnetic Interference (EMI). All new and rehabilitated assets shall meet the relevant requirements for Electromagnetic Compatibility (EMC) set out in LU Category 1 Standards S1222 (*formerly 1-222*) and S1193 (*formerly 1-193*).

3.1.1.7 Fire protection

3.1.1.7.1 Only materials which meet the requirements of the current version of LU Category 1 Standard S1085 (*formerly 1-085*) Fire Safety Performance of Materials, in respect of flammability, smoke emission and toxic fume emission shall be used in Sub-surface Railway areas, shafts and tunnels (*both bored tunnel and cut & cover tunnel forms*).

Note: LU Technical Specification T0002 Civil Engineering – Pump Drainage Systems gives requirements and guidance related to pipe materials.

3.1.1.8 Design life and product registration

3.1.1.8.1 The Design Life of drainage assets shall be in accordance with Table 3.1.1.1



Drainage asset	Design life
Pumps and valves	15 years
Pump control panels (<i>critical and non-critical</i>)	25 years
Cables (<i>electrical and communication</i>)	25 years
Chambers made from hydrocarbon-based materials e.g. High Performance Polyethylene (HPPE)	40 years
Chambers made from non hydrocarbon-based materials e.g. concrete, masonry, etc.	100 years
Pipes and fittings made from metallic materials: <i>Galvanised mild steel</i> <i>Stainless steel</i> <i>Copper and copper alloys</i> <i>Ductile cast iron (spheroidal graphite iron)</i> <i>Grey cast iron</i>	40 years 60 years 60 years 100 years 100 years
Pipes and fittings made from hydrocarbon-based materials, e.g. High Performance Polyethylene (HPPE); and CIPP lining systems	40 years
Chamber covers and gratings	20 years

Table 3.1.1.1 – Design Life of Pump Drainage System Assets

3.1.1.8.2 LU maintains a Products Register (<http://www.lu-apr.co.uk>); only products appearing on that register may be incorporated into the works. Should a supplier or contractor wish to use a product not on the register then special approval from the LU *Professional Head (Pumps & Drainage)* will need to be sought and granted before it can be incorporated in to the works. The product shall then be submitted for formal approval and entry on to the Products Register as soon as practicable thereafter.

3.1.1.9 Whole life asset management

3.1.1.9.1 A holistic approach to the design and construction of new and rehabilitated pump drainage systems shall be adopted. Designs shall conform to the principles of *Whole Life Asset Management*.

3.1.1.9.2 The pump drainage systems maintenance strategy shall follow the principles of *Reliability Centred Maintenance* (RCM).

Note: In this context, it is LU policy to normally prioritise the selection of low maintenance pump drainage system assets even if they are not the cheapest in terms of capital cost. This is because, the costs of carrying out on-site maintenance within the LU environment are relatively high and experience has demonstrated that the lowest whole life cost is generally a function of the minimisation of maintenance expenditure rather than capital expenditure.

3.1.1.9.3 Wherever practicable the design of pump drainage systems shall be such that routine maintenance activities like inspection and cleansing can be carried out without requiring track access.

3.1.1.9.4 The *Operation and Maintenance Manual* for a new or rehabilitated pump drainage system shall detail the anticipated inspection, cleansing, maintenance and decommissioning regimes.

3.1.1.10 Consents and approvals

3.1.1.10.1 New discharges to Public Sewers require the agreement of the Sewerage Undertaker and (*in the case of surface water and groundwater discharges*) can only be made subject to approval of the drainage system by the SuDS (*Sustainable Drainage Systems*) Approving Body under the Flood and Water Management Act 2010.



Note: Existing surface water and groundwater discharges to Public Sewers should either be the subject of an existing agreement with the Sewerage Undertaker under the Water Industry Act 1991, or be covered by existing 'prescribed' rights under the relevant Railway Act (*these are sometimes colloquially referred to as 'Grandfather Rights'*).

LU sewers and lateral drains are exempt from adoption (*by relevant sewerage undertakers*) under The Water Industry (Schemes for Adoption of Private Sewers) Regulations 2011 regardless of whether such sewers and drains are within railway land or not.

3.1.1.11 Assurance

3.1.1.11.1 Pump drainage system designs shall be approved by the *Professional Head (Pumps & Drainage)* through the relevant assurance process, in accordance with LU Category 1 Standard S1538 (*formerly 1-538*) Assurance.

3.1.1.11.2 Conceptual Design Statements (CDS) shall be produced and approved in accordance with the requirements of LU Standard S1538 and the relevant specific requirements for drainage CDS's set out in LU Manual of Good Practice G056.

3.1.2 Clean Water (*Non-potable*) Pump Drainage Systems

(*Clean Water (Non-potable) as defined in LU Technical Specification T0002.*)

3.1.2.1 Location of drainage systems

3.1.2.1.1 The need for a pump drainage system at a given location is determined following consideration and elimination of gravity drainage system options.

Note: This may be the result of unavoidable physical constraints such as the downstream end of a contributing gravity drainage system having an elevation lower than the identified discharge point (*whether that be another gravity drainage system, surface watercourse or other body of surface water*); or it may be the result of a *whole-life costing* exercise that unequivocally demonstrates the pumping solution to be more cost beneficial to LU.

Whatever the rationale is for the proposal to employ a pump drainage system, it shall be clearly articulated in the CDS for the work in accordance with the relevant assurance process.

3.1.2.1.2 Location of drainage system access points

3.1.2.1.2.1 Pump drainage system access points shall be located in accordance with industry good practice.

Access points shall be provided on pump chambers (*wet-wells and dry-wells*), valve chambers, pressure pipelines (*at wash-out and air-intake/release valve locations*) and discharge chambers, etc.

3.1.2.2 Hydraulic design criteria

3.1.2.2.1 General

3.1.2.2.1.1 The hydraulic design of pump drainage systems shall follow the principles outlined in BS EN 752, *industry good practice* and be progressed from first principles in accordance with recognised methodologies by a competent Civil or Mechanical & Electrical Engineer. The use of hydraulic design software is acceptable if the software package has been agreed as *fit-for-purpose* by the *Professional Head (Pumps & Drainage)*.