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Loss Prevention Standard

LPS® 1131 : Issue 2.0

Requirements and testing methods for pumps for automatic sprinkler installation pump sets

180319_LPCB

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PARTICIPATING ORGANISATIONS

This standard has been developed in conjunction with Industry Stakeholders and was the subject of public consultation via the BRE Global website.

REVISION OF LOSS PREVENTION STANDARDS

Loss Prevention Standards (LPSs) will be revised by issue of revised editions or amendments. Details will be posted on our website at www.redbooklive.com.

Technical or other changes which affect the requirements for the certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

USERS OF LPSS SHOULD ENSURE THAT THEY POSSESS THE LATEST ISSUE AND ALL AMENDMENTS.

FOREWORD

This Standard identifies the evaluation and / or testing practices undertaken by BRE Global for the purposes of LPCB certification and listing of products and services. LPCB certification and listing and of products and services is based on evidence acceptable to BRE Global:-

- that the product or service meets the standard;
- that the manufacturer or service provider has staff, processes and systems in place to ensure that the product or service delivered meets the standard

and on:-

- periodic audits of the manufacturer or service provider including testing as appropriate;
- compliance with the contract for LPCB certification and listing, including agreement to rectify faults as appropriate;

The responsibility for ensuring compliance with the technical and managerial process and requirements for the product or service lies with the manufacturer, service provider or supplier.

This standard should be read in conjunction with LPCB Scheme Document SD 1131. “Certification requirements for LPCB approval of pumps for automatic sprinkler installation pump sets ”.

The pump shall comply with the relevant regulatory requirements and standards and any other regulatory requirements applicable in the region of use.

NOTES

Compliance with this LPS does not of itself confer immunity from legal obligations. Users of LPSs should ensure that they possess the latest issue and all amendments.

LPCB welcomes comments of a technical or editorial nature and these should be addressed to “the Technical Director” at BREGlobalEnquiries@bregroup.com.

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1 SCOPE

This standard specifies LPCB's certification requirements for single stage and multi-stage centrifugal pumps with mechanical seal or soft packing for use in automatic sprinkler systems conforming to EN 12845:2015 or the LPC Rules for Automatic Sprinkler Installations.

This Standard is only applicable for the following pumps, independent of installed orientation (Vertical, Horizontal or Sloped):

- end suction pumps (close-coupled, split-coupled or long-coupled) of the back pull-out type pump;
- axial horizontal split case pumps;
- ring section pumps;
- inline pumps (vertical line shaft pump with inlet and outlet in line);
- vertical turbine pumps;
- multistage inline pumps;
- multistage-multi outlet pumps;
- submersible motor borehole pumps

This specification does not include requirements for the pump set assembly.

2 DEFINITIONS AND ABBREVIATIONS

2.1.1 Total Head (Absolute)

The absolute total head at any section of a pump is given by:

Static head + atmospheric pressure head + dynamic pressure head + difference in level between reference plane and the section being considered.

2.1.2 Pump Total Head (Generated Head)

The difference between the pump outlet total head and the pump inlet total head.

2.1.3 Closed Valve Condition

The condition under which there is zero flow through the pump.

2.1.4 Maximum Working Pressure

The rating on the pump nameplate, which meets the hydrostatic pressure test requirements of 6.1.

2.1.5 Rated Speed

The speed of rotation at which the pump is certificated.

2.1.6 Pump Power Input

The power required to drive the pump at rated speed and a given total head and flow rate.

2.1.7 Pump Efficiency

The ratio of pump power output to pump power input.

2.1.8 Net Positive Suction Head (NPSH)

The total head (absolute) at the pump inlet centreline minus the vapour pressure head.

2.1.9 Net Positive Suction Head Required (NPSHr)

The minimum Net Positive Suction Head (NPSH) at the pump inlet centreline necessary to maintain a stable flow rate and suppress cavitation through the pump at a given flow rate and speed of rotation.

2.1.10 Net Positive Suction Head Available (NPSHa)

The Net Positive Suction Head (NPSH) provided by the water supply arrangement to the pump inlet.

2.1.11 Pump set

An assembly comprising at least a pump, driver or motor, partial wiring loom, drive coupling and a mounting and/or base, which is intended to supply water to an automatic sprinkler installation.

2.1.12 Close-coupled

Arrangement where the impeller is on the same shaft as the motor that drives the pump.

2.1.13 Split-coupled (or Long-coupled)

Arrangement where the impeller is on a different shaft to the motor that drives the pump.

2.1.14 Suction pipework

Pipework connected to the suction side of the pump.

2.2 Abbreviations

2.2.1 LPCB

Loss Prevention Certification Board.

2.2.2 LPS

Loss Prevention Standard.

2.2.3 BS

British Standard

2.2.4 BRE

Building Research Establishment

2.2.5 EN

European Standard

2.2.6 ISO

International Standard (International Organization for Standardisation)

3 DESIGN REQUIREMENTS

3.1 Materials

Pump shafts where in contact with water shall be made of corrosion resistant materials. Protective sleeves for shafts, and impeller fastenings shall be made from corrosion resistant material.

The pump body shall be made of cast iron, ductile iron, cast steel, stainless steel, bronze or aluminium bronze.

The protective sleeves for shafts (where used), metal parts of mechanical seals, impellers, impeller fastenings (impeller nuts, locking plates or washers and adjusting springs) and wear rings (where used), including their counterparts shall be made of bronze, stainless steel or other suitable materials.

The materials of construction of the pump shall be fully documented and supported documented evidence of the material specifications.

3.2 Pump Total (Generated) Head -v- Flow Rate Curve

Note: For example, curves see Annex C.

Pumps shall have a stable characteristic curve H(Q) within the measurement uncertainty range as specified in EN ISO 9906:2012, Grade 1U or 2U. i.e., all tangents to the curve shall have zero or negative slope.

Zero-flow head instability (i.e., churn) is permitted up to 2.5 % below maximum head.

The criterion for NPSHr is 3 % drop in total differential head for the first stage of multi-stage pumps or for single-stage pumps as specified in EN ISO 9906:2012. The measurement uncertainty as specified in EN ISO 9906:2012, Grade 1U or 2U shall be applied.

The flow, power consumption, NPSHr and the corresponding total differential head of the pump shall be determined in accordance with EN ISO 9906:2012, Grade 1U or 2U.

The curve may be corrected for pump induced pre-swirl using the method described in described in BS EN ISO 9906:2012 Annex A.4.1 pre-swirl test .

The pump total head at the rated speed shall not exceed 12 bar in the closed valve condition.

Note 1: Applications for approval of pumps with higher pressures will be accepted, e.g., for high rise sprinkler systems and special applications.

Note 2: As two ISO 9906 grades are permitted within this LPS, the grade used shall be recorded in the LPCB listing, on the data plate and in pump documentation.

3.3 Operating Range

Pumps will only be approved for use at flow rates at which the NPSHr is below 5.38m. This flow rate shall be clearly marked on the performance curves for the range of impeller diameters or speeds.

3.4 Closed Valve Conditions

A minimum bypass flow rate shall be specified, to minimise the possibility of pump failure in the closed valve condition.

When tested in accordance with 4.2, the declared minimum by-pass flow value shall not lead to a pump failure in the closed valve condition.

3.5 Maximum Working Pressure of Pump

The maximum working pressure of the pump shall be declared by the pump manufacturer and be less than or equal to the pressure which meets the hydrostatic pressure test requirements of 4.1.

3.6 Speed of Rotation

3.6.1 General

The pump shall operate within the rotational speed limits declared by the manufacturer.

When tested in accordance with clause 4.2 and 4.3, the rated speed shall not exceed 3600 1/min and the maximum allowable continuous speed shall be at least 105 % of the rated speed.

3.6.2 Balance and Vibration

The rotating parts of the pump shall be balanced in accordance with BS ISO 21940-14:2012 clause 5.3 . There shall be no undue vibration.

3.7 Mechanical Features

3.7.1 Dismantling

The pump shall be designed to permit dismantling, without disturbing the system pipework.

3.7.2 Casing Gaskets

Casing gaskets shall satisfy the operating conditions and hydrostatic test conditions at ambient temperature. Compliance shall be demonstrated by the test in Clause 4.1.1

3.7.3 External Bolting

Bolts or studs that connect pressure containing parts shall be selected to be adequate for the pump pressures and for normal tightening procedures. Compliance shall be demonstrated by meeting the requirements of the test in Clause 4.1.2.

3.8 Branches and Miscellaneous Connections

3.8.1 Inlet, outlet and threaded connections

Shall be in accordance with appropriate National, European or International Standards.

The type and size of all connections to the pump shall be specified by the manufacturer and shall be of adequate material and thickness for the intended duty.

3.8.2 Connections

Connections for vents, pressure-gauges and drains shall be fitted with removable closures to contain maximum working pressure. Closures shall satisfy the hydrostatic pressure tests described in Clause 4.1.

3.8.3 Branch Flanges

The branch flanges shall conform to BS EN 1092-2:1997 (PN 16) and BS 1560-3.2:1989: Class 150.

3.8.4 Closed Head Relief Valve

The closed head relief valve shall be regarded as part of the pump, and it should be of the non-adjustable differential pressure type.

The valve may have a facility for adjustment for setting up on site but shall be tamper-proof after setting.

3.9 Impellers

Impellers shall be positively and securely attached to the pump shaft by recognised engineering methods. i.e., long-coupled pumps should have an anti-rotating locking mechanism.

3.10 Casing Wear Rings

Where casing wear rings are fitted, they shall be prevented from rotating.

3.11 Running Clearance

When establishing running clearance between stationary and moving parts, consideration shall be given to operating conditions and properties of the material used (such as hardness and gall resistance) for these parts. Clearances shall be sized to prevent contact, and material combinations selected to eliminate seizure and minimize erosion, taking account of the pump application which involves long periods in the stationary condition.

3.12 Shafts and Shaft Sleeves

3.12.1 General

Shafts shall be of ample size and stiffness to:

a) transmit the prime mover rated power;
b) minimize unsatisfactory packing or seal performance;
c) minimize wear and the risk of seizure;
d) take due consideration of method of starting and inertia loading involved.

3.12.2 Axial Movement

Axial movement of the rotor permitted by the bearings shall be limited by design to not adversely affect the performance of the mechanical seal, where fitted.

3.12.3 Shaft Stresses

Stress calculations associated with the functional operation in-line with the performance criteria shall be fully documented and provided. Detailed shaft stress calculations shall be provided which show that the shaft is suitable for the maximum impeller diameter at 105 % the maximum rated speed. Detailed shaft stress calculations shall use a density of water of 1035 kg/m^3 at 20°C.

Shaft stresses shall not exceed:

- 30% Yield stress for torsional and shear stresses, and
- 18% Ultimate tensile strength for principal stresses

in respect of the following conditions:

a) Torsional shear stress at the coupling end of the shaft at maximum power or impeller attachment whichever is the greater (ref. Appendix A).
b) Principal direct stress and maximum shear stress at impeller attachment under closed valve conditions (ref. Appendix A).

For close-coupled pumps, removable shaft extensions shall be securely fitted to the motor shaft to accommodate the most arduous combination of torsional and axial forces.

3.13 Bearings

3.13.1 Rolling Bearings

Pumps shall be fitted with rolling bearings where there is no reliance on associated driver bearings.

For close-coupled pumps the motor bearings shall also conform to the following requirement.

Rolling bearings shall be selected in accordance with BS ISO 76:2006+A1:2017and BS ISO 281:2007. The minimum calculated life rating (L_{10}) shall not be less than 5000 hours at closed valve conditions at maximum impeller diameter and rated speed.

3.13.2 Lubrication

Information on the type of lubrication to be used and the frequency of application shall be stated in the operation instructions.

3.13.3 Bearing Housing Design

The bearing housing shall be designed to minimise the ingress of contaminants and the escape of the lubricant under normal operating conditions.

3.14 Shaft Sealing

3.14.1 General

The pump may use mechanical seals or soft packaging.

3.14.2 Stuffing Box

Ample space shall be provided for repacking without removing or dismantling any part other than gland components or guards.

3.14.3 Mechanical Seals

The mechanical seal shall be suitable to withstand the given operating conditions and water quality to be used.

Material for the seal components shall be chosen to withstand corrosion, erosion, temperature and mechanical stress etc. For mechanical seals metallic parts wetted by the pumped liquid shall have at least the same material quality as the pump casing as far as mechanical properties and corrosion resistance are concerned.

A mechanical seal shall not be subjected to a hydrostatic pressure exceeding the seal pressure limit.

3.15 Orifice Plates

3.15.1 General

Orifice plates shall only be fitted in pump outlets of 50mm nominal bore or greater.

3.15.2 Requirements

Where fitted, orifice plates shall:

a) have an orifice diameter not less than one-half of the internal diameter of the pump outlet into which it is fitted,
b) be of brass or stainless steel with a plain central hole without burrs, and of a thickness complying with Table 1,
c) be integral with or securely attached to the pump outlet; and

d) the orifice plate shall be 3mm minimum thickness

3.15.3 Orifice plate k factor

The k factor of a non-integral orifice plate shall be calculated from:

$$k = \frac{Q}{\sqrt{p}}$$

Where:

Q = flow rate (//min)

p = pressure drop across the orifice plate with flow Q(bar)

4 TESTS

Consideration for LPCB approval will require testing to all clauses is the following section.

Note: The testing of multistage pumps shall include consideration of the minimum and maximum number of stages incorporated in their design.

4.1 Hydrostatic Pressure Tests

Note: Attention is drawn to the need for manufacturers to comply with all applicable regulatory requirements, for example, the Machinery Directive and BS EN 12162.

4.1.1 1.5 x Working Pressure Test

The pump shall be hydrostatically tested at 20°C ± 5°C to 1.5 times the maximum working pressure for 10 minutes. There shall be no visible leakage from the pump.

4.1.2 2 x Working Pressure Test

The pump shall be hydrostatically tested at 20°C ± 5°C to 2 times the maximum working pressure for 10 minutes. There shall be no cracking or rupture of the casing.

4.2 Closed Valve Test

The pump with maximum impeller size shall be run in the closed valve condition, with the manufacturer specified minimum bypass flow. The bypass flow rate and pump temperature shall be recorded using a temperature measuring device with an accuracy of ± 2 °C.

The pump shall be run at the maximum rated speed for two hours. The maximum water temperature rise across the pump shall not exceed 10°C for the duration of the test. Temperature measurements shall be made at the pump suction inlet and at an outlet measuring section normally located at a distance of two diameters from the pump outlet housing.

The pump total head curve (4.3) shall then be verified.

After the test the wear surface and impeller shall be examined, and their condition recorded. There shall be no significant wear.

4.3 Performance Tests

The flow, power consumption, NPSHr and the corresponding delivery head shall be determined in accordance with EN ISO 9906:2012, Grade 1U. The measurement uncertainty as specified in EN ISO 9906:2012, Grade 1U shall be applied.

The test data required for the purpose of evaluation in accordance with EN ISO 9906:2012, shall be established at a minimum of 7 points uniformly distributed between the lowest rate of flow and the highest rate of flow to be measured.

The lowest rate of flow to be measured shall be between zero and the minimum by-pass flow. NPSHr shall be determined for minimum and maximum impeller diameters and speeds at 5 points between 0,3 x peak flow limited by peak power or NPSH 16m, and the highest flow.

A pump model with a range of duties shall be tested with maximum and minimum impeller diameters and also with an intermediate impeller diameter, where deemed necessary (at LPCBs discretion).

If the range of duties is achieved using orifice plates, the pump will be tested using maximum, and minimum orifice plate diameters. Intermediate orifice plate diameters may

require testing (at LPCBs discretion). The approval test speed shall be within ± 4% of the pump rated speed. All test data shall be corrected to rated speed to determine approval performance characteristics.

The following performance characteristics of the pump shall be verified at the rated speed, over a range of flow rates.

4.3.1 Pump Total Head

The Pump Total Head shall be verified after the closed valve test (4.2).

The specified minimum bypass flow rate (determined in 4.2) shall be run to waste when the curve is verified.

The verified curve represents individual duty points that may be guaranteed for the pump.

Where a guaranteed duty point is verified in accordance with BS EN ISO 9906:2012 clause 4.2 , the guaranteed duty point shall be within the test curve (there shall be no negative value of the guaranteed point).

4.3.2 Net Positive Suction Head Required Curve

The NPSHr curve shall be determined using water as specified in BS EN ISO 9906:2000 clause 5.4.5.2 .

The flow rate at which the NPSHr is 5.38m shall be clearly marked on the performance curves for the range of impeller diameters and speeds tested.

4.3.3 Pump Power Input Curve

The maximum pump power input shall be verified to a maximum flow rate corresponding with the following requirements:

a) For pumps with an ever increasing power input, to an NPSHr at the pump suction flange, of 16 metres: An NPSH of 16 metres shall be available.
b) For pumps with a detectable peak power value (at an NPSH required of less than 16 metres), until a peak is determined: It shall be demonstrated that the peak is occurring by design and not cavitation. Values which are minimum 15 % higher than the flow at the maximum power demand shall be taken.

5 MARKING

5.1 Nameplate

The pump shall have securely fitted to it a nameplate which is durable, non-combustible, legible and indelible.

The nameplate shall contain the following information:

a) Supplier's name or trademark.
b) Supplier's address.
c) Model designation.
d) Serial number.
e) Year of manufacture.
f) LPCB Approval Mark and Reference No.
g) Rated flow (L/min).
h) Rated speed. (revs/min).
i) Rated total head (generated head) (bar).
j) ISO 9906 Grade (1U or 2U)
k) Fitted impeller diameter (mm).
l) Maximum working pressure (bar).
m) Maximum absorbed power (kW) at the rated speed and flow conditions.
n) Where an orifice plate is required but is not integral with the pump outlet, a statement that the performance is that of the pump and orifice plate combination and the k factor of the orifice plate.

5.2 Direction of Rotation

The direction of rotation shall be indicated by a prominently located and securely attached durable rotation arrow.

6 DOCUMENTATION

Each pump shall be supplied with the following data and a characteristic curve sheet, for use by the end user. To include the following:

a) Model designation
b) Pump serial numbers
c) Test date (production test dates, see Scheme Document SD1131 table 1)
d) Place of test
e) Pump total head curve (bar) (generated head, at test speed from production testing)
f) Pump NPSHr and power curve (bar) (from approval data; not pump specific)
g) ISO 9906 Grade (1U or 2U)
h) Rated speed (revs/min)
i) Impeller diameter (mm)
j) Minimum bypass flow rate (L/min)
k) Nominal bore of inlet flange (mm)
l) Nominal bore of outlet flange (mm)

Orifice diameter (mm)

7 CLASSIFICATION AND DESIGNATION

LPCB approved products will be listed in the Red Book of approved products and services and published on the product approval certificate supplied to the owner of the approval.

Accompanying the listings & certificates will be any key supporting information in relation to the LPCB approval. Any special limitation to the approval will also be set out in the listing and on the certificate. For details of acceptable use of the mark, see LPCB publication PN103 “Use of the certification marks”.

PUBLICATIONS REFERRED TO:

BS 1560-3.2:1989	Circular flanges for pipes, valves and fittings (Class designated) - Part 3: Steel, cast iron and copper alloy flanges - Section 3.2 Specification for cast iron flanges
BS EN 809	Pumps and Pump Units for Liquids – Safety Requirements
BS EN 1092:1997	Series. Flanges and their joints.
BS EN ISO 9906:2012	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3
BS EN 12162	Liquid Pumps. Safety Requirements. Procedure For Hydrostatic Testing
BS ISO 21940-14:2012	Mechanical vibration - Rotor balancing - Part 14: Procedures for assessing balance errors
BS ISO 76:2006+A1:2017	Rolling bearings. Static load ratings
BS ISO 281:2007	Rolling bearings. Dynamic load ratings and rating life
ISO 7-1	Pipe threads where pressure-tight joints are made on the threads - Part 1: Dimensions, tolerances and designation
ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel -- Part 1: Bolts, screws and studs with specified property classes -- Coarse thread and fine pitch thread

For undated references please refer to the latest published issue.

Annex A – STRESS CALCULATIONS:

Reference Clause 3.12.3

A.1 Torsional shear stress at the coupling end of the shaft and at the impeller attachment at maximum power is calculated from the following.

$$S_{tc} \text{ or } S_{tr} \ (N/m^2) = \frac{16\ T_m}{\pi\ (D_c)^3}$$

$$\text{where } T_m \ (N.mm) = \frac{9.549 \times 10^6\ P_m}{\text{rpm}}$$

A.2 Maximum principal direct stress and maximum shear stress at impeller attachment under closed valve conditions are calculated from the following:

$$S_{pr} \ (MN/m^2) = \frac{16}{\pi\ (D_r)^3} \left[M + \sqrt{(M^2 + (T_{cv})^2)} \right]$$

$$\text{and } S_{sr} \ (MN/m^2) = \frac{16}{\pi\ (D_r)^3} \sqrt{(M^2 + (T_{cv})^2)}$$

where $M = M_{sc}$ or M_{es}

Nomenclature and Units

S_{tc} (MN/m^2)	-	Torsional stress at coupling diameter
S_{tr} (MN/m^2)	-	Torsional stress at diameter under impeller
S_{sr} (MN/m^2)	-	Maximum shear stress at diameter under impeller at closed-valve conditions
S_{pr} (MN/m^2)	-	Maximum principal stress at diameter under impeller at closed-valve conditions

D_c (mm)	-	Shaft diameter at coupling
D_r (mm)	-	Shaft diameter under impeller
P_m (kW)	-	Maximum power
T_m (N.mm)	-	Torque at maximum power conditions
T_{cv} (N.mm)	-	Torque at closed-Valve conditions
rpm	-	Rotational speed in revolutions per minute
M_{sc} (MNm)	-	Bending moment: Split-case
M_{es} (MNm)	-	Bending moment: End-suction

Annex B – NPSH CALCULATIONS:

NPSH – Net Positive Suction Head is used in two ways in sprinkler system design.

$NPSH_R$ – (see 2.1.9) Net Positive Suction Head Required: The minimum pressure required at the suction port of the pump to prevent the pump from cavitating. $NPSH_R$ is a function of the pump performance and data must be provided by the pump manufacturer from testing (see clause 4.3.1 of this document).

$NPSH_A$ – (see 2.1.10) Net Positive Suction Head Available: The absolute pressure at the suction port of the pump. $NPSH_A$ is a function of the hydraulic system of water supply and pipe work and must be calculated (this appendix provides further guidance).

$NPSH_A$ may be calculated as follows:

$NPSH_A = P_s + P_a – P_v - P_f$

Where:

P_s is the suction head measured from the low water level “X” (see BS EN 12845 figure 4) to the pump centre line or impeller eye (in m of H_2O);

P_a is the absolute atmospheric pressure, assumed to be 10.194 at sea level (in m of H_2O)

P_v is the water vapour pressure assumed to be 0.310 in the UK (in m of H_2O)

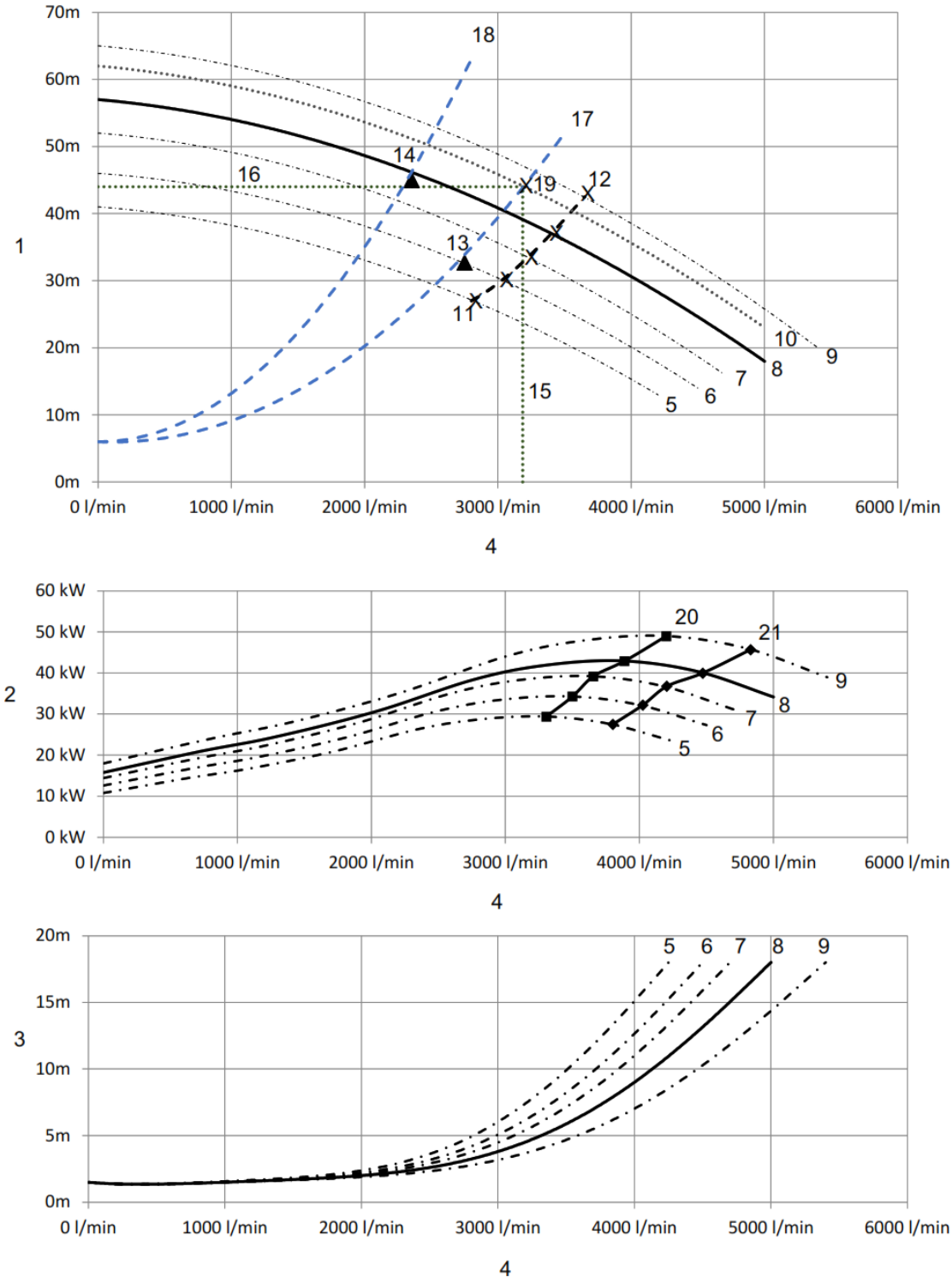
P_f is the friction loss in suction pipework, i.e., pipes, fittings, valves etc. at flow rate Qmax. (in m of H_2O).

Using this data and assumptions, the equation can be simplified to:

$NPSH_A = P_s - P_f + 9.884$

Note: P_s may be negative in some installations, but the specified requirements for $NPSH_A$ must always be met.

Figure A.1 — Typical curves for non-overloading power pumps (Q_{max} method)



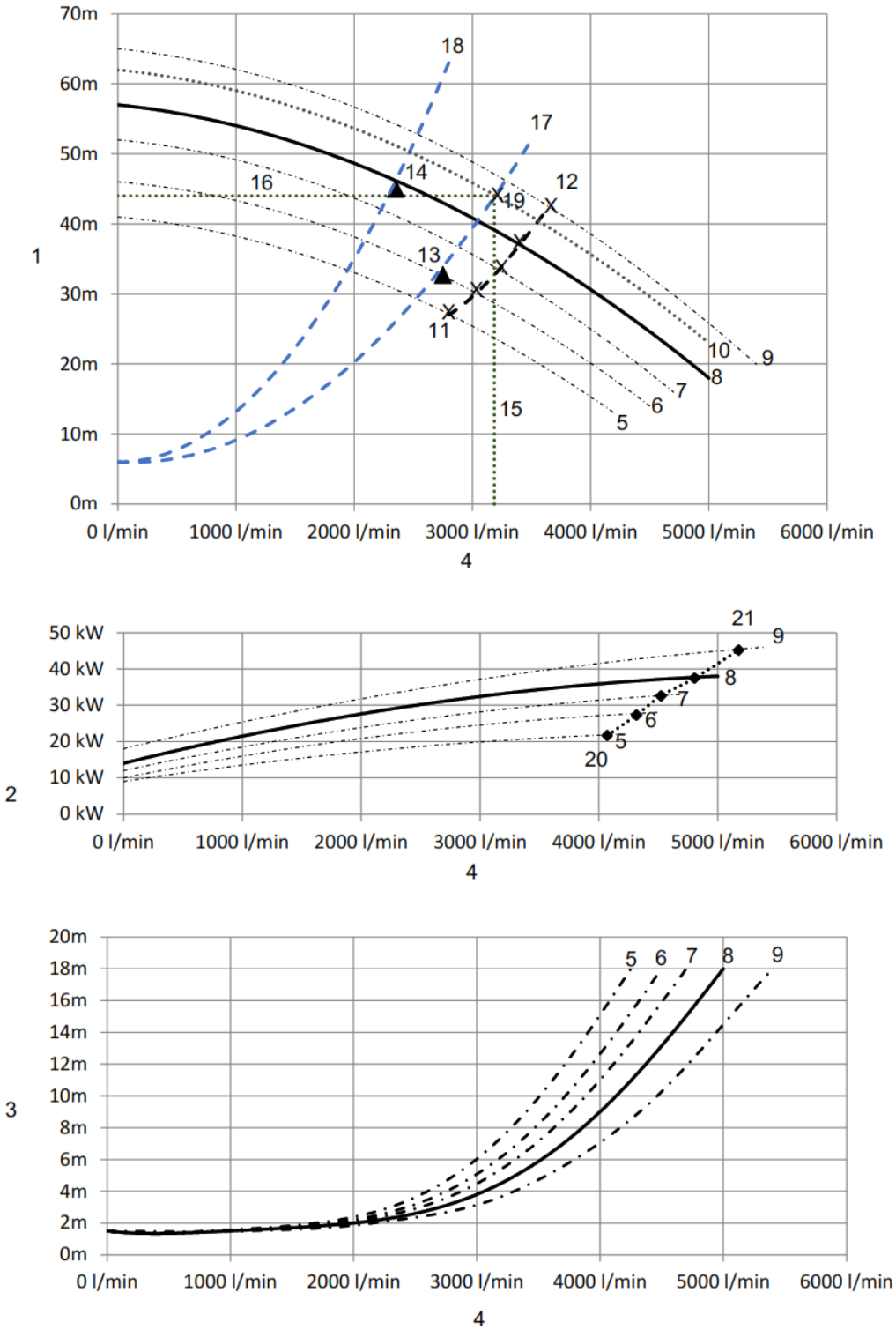
Key

1	H in m	11 to 12	5.38 m NPSHR limitation points for maximum demand flow ≥Q_{max}
2	P in kW	13	Pump flow demand required by hydraulically most favourable location
3	NPSHR in m	14	Pump flow demand required by hydraulically most unfavourable location
	$\mathrm{Q\ in\ l/min}$	15	Flow at Q_{max} (intersection of key 17 with 10)
5	impeller $Ø_1$ in mm (note 2)	16	Pressure at Q_{max} (intersection of key 17 with 10)
6	impeller $Ø_2$ in mm (note 2)	17	System friction curve most favourable location
7	impeller $Ø_3$ in mm (note 2)	18	System friction curve most remote location
8	impeller $Ø_4$ in mm (actual pump performance)	19	Q_{max} point on pump curve
9	impeller $Ø_5$ in mm (note 2)	20	Power at maximum point on overloading power curve
10	Pump performance with tank water level at maximum (relative to key 8)	21	Power at maximum point on 16 m NPSHR

Note 1: Keys 11 and 12 (5.38 m NPSHR limitation points) are given for information and are plotted afterwards in the process of selecting the correct pump.

Note 2: Alternative pump performance curve, using alternative impellor diameters.

Figure A.2 — Typical curves for constant raising power consumption pumps (Q_{max} method)



Key

1	H in m	10	Pump performance with tank water level at maximum (relative to key 8)
2	P in kW	11 to 12	5.38 m NPSHR limitation points for maximum demand flow ≥Q_{max}
3	NPSHR in m	13	Pump flow demand required by hydraulically most favourable location
4	Q in l/min	14	Pump flow demand required by hydraulically most unfavourable location
5	impeller $Ø_1$ in mm (Note 2)	15	Flow at Q_{max} (intersection of key 17 with 10)
6	impeller $Ø_2$ in mm (Note 2)	16	Pressure at Q_{max} (intersection of key 17 with 10)
7	impeller $Ø_3$ in mm (Note 2)	17	System friction curve most favourable location
8	impeller $Ø_4$ in mm (actual pump performance)	18	System friction curve most remote location
9	impeller $Ø_5$ in mm (Note 2)	19	Q_{max} point on pump curve
		20 to 21	Power at maximum point on 16 m NPSHR

Note 1: Keys 11 and 12 (5.38 m NPSHR limitation points) are given for information and are plotted afterwards in the process of selecting the correct pump.

Note 2: Alternative pump performance curve, using alternative impellor diameters.

AMENDMENTS ISSUED SINCE PUBLICATION

DOCUMENT NO.	AMENDMENT DETAILS	SIGNATURE	DATE
LPS 1131-1	Copyright and address change	CJA	Oct 2001
LPS 1131-1	Further copyright changes	CJA	Jul 2002
LPS 1131-1.2	1. New front cover 2. Title added to header 3. Contents page moved to Page 1. 4. 'Revision of Loss Prevention Standards' added on Page 2 5. Notes added on Page 3 6. Updated references to ISO 9001 'Quality management systems, Requirements' in the 'Foreword' and in 'Publications Referred To' 7. All references to ISO 9002 deleted (Standard withdrawn and replaced by ISO 9001) 8. Repagination Update of copyright information	SJP	Jan 2014
LPS 1131-2.0	Major update to align with prEN 12259-12 and current best practice. 1. Updates to references 2. Changes to align (where possible) with EN 12259-12 Detailed review by subject matter expert working group.	SNB	Dec 2022