

Guidance

G2107

Pressure systems

Issue no.:	A1	Issue date:	June 2016
		Review date:	June 2019

Contents

1	Purpose	2
2	Scope	2
3	Guidance	2
4	Responsibilities	2
5	Supporting information	2
6	Person accountable for the document	3
7	Document history	3
8	References	3
9	Attachments	3

Printed copies of this document are uncontrolled.

Page 1 of 3

1 Purpose

- 1.1 This guidance provides good practice solutions for the use of pressure systems.
- 1.2 This guidance was produced for the construction of Crossrail.

2 Scope

- 2.1 This guidance may be used for projects that require pressure systems.

3 Guidance

- 3.1 The unedited Crossrail good practice guide begins on the next page.

4 Responsibilities

The Deep Tube Tunnels Engineer is responsible for this guidance.

5 Supporting information

- 5.1.1 This guidance is one of a set that provide overall guidance on the life cycle requirements for Civil Engineering assets.
- 5.1.2 The complete set is as follows:

Document no.	Title or URL
G050	Civil Engineering – Common Requirements
G0051	Civil Engineering – Bridge Structures
G0052	Civil Engineering – Gravity Drainage Systems
G0053	Civil Engineering – Building and Station Structures
G0054A	Civil Engineering – Earth Structures
G0054B	Earth Structures – Guide for Slope Stability Analysis
G055	Civil Engineering – Deep Tube Tunnels and Shafts
G0056	Civil Engineering – Pumping Systems
G0057	Civil Engineering – Miscellaneous Assets
G0058	Civil Engineering – Technical Advice Notes
G1299	Guidance on Civil Engineering Asset Strategic and Tactical Risk Models
G1417	Grouting to control seepage in tunnels and structures
G2105	Construction Railway Operations
G2106	Sprayed concrete lining exclusion zone management
G2107	Pressure Systems
G2108	Occupational Exposure to Respirable Dust

Printed copies of this document are uncontrolled.

Page 2 of 3

5.1.3 The above give guidance and explanation in support of the following standards:

Document no.	Title or URL
S1050	Civil Engineering – Common Requirements
S1051	Civil Engineering – Bridge Structures
S1052	Civil Engineering – Gravity Drainage Systems
S1053	Civil Engineering – Building and Station Structures
S1054	Civil Engineering – Earth Structures
S1055	Civil Engineering – Deep Tube Tunnels and Shafts
S1056	Civil Engineering – Pumping Systems
S1057	Civil Engineering – Miscellaneous Assets
S1060	Civil Engineering – Bridges and Structures inspection standard
S1061	Civil Engineering – Bridges and Structures Assessment
S1062	Temporary Works
S1063	Civil Engineering - Cutting, grinding, drilling, fixing to and supporting from existing structures
S1064	Civil Engineering - Waterproofing
S1800	Cable Runs
S1801	Competence requirements for undertaking Civil Engineering Safety Critical Work

6 Person accountable for the document

Name	Job title
Keith Bowers	Principal Tunnel Engineer

7 Document history

Issue no.	Date	Changes	Author
A1	June 2016	Incorporation of Crossrail best practice guide into LU Standards suite	Mohammed Gajia

8 References

Document no.	Title or URL
	Best Practice Guide: Pressure Systems

9 Attachments

Contents

Section A

Introduction

Section B

Planning

Section C

Competency / Training

Section D

Execution and Control

Section E

Inspection and Maintenance

Appendices

- A. Concrete Pumping Operation Check Sheet
- B. Concrete pipe Blow Out Check Sheet
- C. Cleaning Concrete Lines with Compressed Air
- D. Jet Washing Operation Check Sheet
- E. Examination Checklist for Concrete Pumps
- F. References

Preface

The Crossrail project consists of multiple work sites and contractors where exposure to pressurised systems and stored energy release is significant. This guide brings together information collected in response risks identified on Crossrail construction sites to ensure pressurised systems are operated equally safely across the Crossrail project.

This document has been produced by consolidating the specialist knowledge from the Crossrail Contractors, JVs, supply chain and industry partners identified on Page 2 of this document.

Purpose

Pressure Systems are defined as 1) a system comprising of one a system comprising one or more pressure vessels of rigid construction, any associated pipework and protective devices, 2) the pipework with its protective devices to which a transportable pressure receptacle is, or is intended to be, connected, or 3) a pipeline and its protective devices which contains or is liable to contain a "relevant fluid".

The principal causes of pressure-related incidents are poor design, installation and/or maintenance of equipment, inadequate repairs or modifications, an unsafe system of work and operator error and poor training/supervision.

The main hazards from pressure are impact from the blast of an explosion or release of compressed liquid or gas, impact from parts of equipment that fail or any flying debris, contact with the released liquid or gas, such as steam and fire resulting from the escape of flammable liquids or gases.

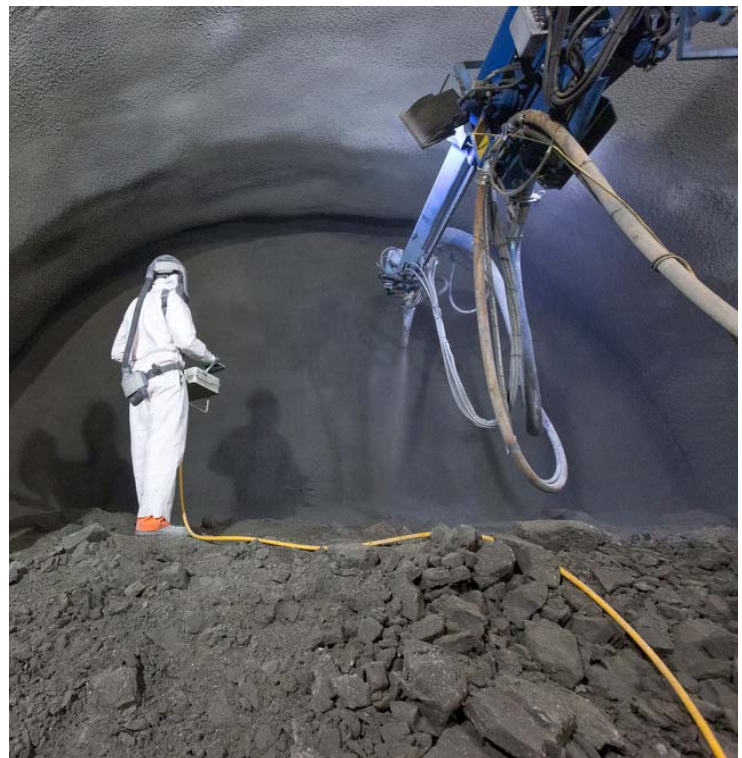
This Best Practice Guide suggests minimum requirements for the safe use of pressure systems, provides Best Practice, competency and training guidance.

This Best Practice Guide applies to all personnel with an involvement with the procurement, operation and supervision of pressurised working systems and stored energy release and specifically covers the following types of Pressurised Systems: Concrete Pumping, Spray Concrete Lining (SCL), Grouting, Compressed Air and Jet/Pressure Washing.

The aim of this document is to raise awareness of the consequences of working with pressurised and storage energy release systems and promote a safer working environment for all operatives working on Crossrail.

This Best Practice Guide should be used alongside:

- Pressure Equipment Regulations 1999 (PER)
- Pressure Systems Safety Regulations 2000 (PSSR)
- Provision and use of Work Equipment Regulations 1998 (PUWER)



Section B: Planning

Concrete Pumping and Spray Concrete Lining (SCL)

Planning and preparation is the first step in ensuring that work is done safely. In order to maintain awareness and ensure sufficient resources are made available, it is recommended that regular planning meetings are held where consideration needs to be given to:

- whether enough operatives are available, including a competent person being present at all times
- events or circumstances that would require the operation to be stopped
- sequence of steps needed to ensure complete and safe stoppage
- impact of stoppages on other operations
- impact of other operations on the pressure system
- an assessment of any manual tasks that may cause any muscle/ligament strains or other injuries
- the provision of personal protective equipment and other safety equipment
- the provision of safe access including elimination of trip, slip and fall hazards
- electrical safety, and systems of work which comply with electrical safety legislation

If applicable:

- the location of the pump and access/egress requirements for delivery trucks
- appropriate instruction manuals accompany the pump unit, giving sufficient instructions for operation,
- the pump operator is trained and competent with the use of the appropriate manuals and the equipment
- maintenance and repair manuals are kept in a safe place at the registered premises, including a parts catalogue, and are kept up to date with any additional information from the manufacturer,

- maintenance and repair to be performed only by authorised personnel, and
- maintenance log books are to be kept on the pump, maintained and up to date, and are to be made available on request at the workplace.

Pump Operators

Pump operators should assess:

- whether enough workers are available to complete the pump concrete safely. This should include having a competent operator present at the pump at all times.
- the capacity and type of pump to be used to complete the job within the required time frame;
- whether the pump location is suitable with regards to access for concrete delivery trucks;
- Personal Protective Equipment (PPE) requirements as well as other safety equipment;
- safe access to the pump and pour site, including elimination of trip, slip and fall hazards;
- whether there are appropriate instruction manuals for the pump unit and/or boom, giving sufficient instructions for operation, maintenance and repairs.



Section B: Planning

Jet Wash Operations

Jet Wash operations have the potential to affect a large number of surrounding operations if not properly controlled. The following considerations during planning will result in a safer working environment for the operator and others in the area:

- Implement an exclusion zone around the operation with sufficient safety signage to warn other operators
- The work area around the equipment should be clean and free of debris. Oil spillage results in slippery floors and must be removed immediately, whilst other items cause trip hazards.
- Shield and bundle equipment hoses and cables so they do not obstruct the operator's freedom of movement. Refer to Section D for further suggested control measures.

Personal Protective Equipment (PPE) Requirements:

PPE should always be regarded as the 'last resort', as it protects the operator without changing the level of hazard. Always consider that other control measures may be needed in addition to PPE which could reduce the level of protection needed from PPE. Standard PPE for operators should include:

- **Waterproof Clothing**

Waterproof garments only protect the operator from spray and flying debris. They do **NOT** deflect direct jet impact.



- **Eye/Face Protection.** Safety Glasses/Goggles/Face shield (EN 166 Class A or B). Goggles and face shields should be suitable to use with other PPE (helmets, hearing protection etc.)



What do operators do when visibility is reduced by splashes, mist or fog?

Systems of work should consider how this will be addressed.

Anti fogging goggles/glasses are available, but try different models first to find which performs best for



- **Waterproof safety boots** (EN 345 or EN ISO 20345)
- **Waterproof gloves.** Operators need to ensure gloves are maintained and in good condition to ensure proper grip and personal hygiene.
- **Warm Clothing:** The risk of finger blanching (due to reduced circulation of blood) increases at low temperatures. Operators working outdoors in cold weather should have adequate protection.
- **Safety helmet** (EN 397) or of higher standard if specified through risk assessment
- **Hearing protection** (as identified by the Risk Assessment) to be worn at all times. Ear defenders should not be worn over clothing or PPE likely to interfere with the effectiveness of the defenders.
- **Respiratory Protection** if identified in the Risk Assessment for the activity, which must consider the possibility that the activity may generate a water mist / aerosol that contains harmful material.

Single Sourcing Components

Single sourcing offers multiple benefits for an organisation, these benefits include:

- Reductions in product variation,
- Streamlined training is possible due to consistent product,
- Reduced downtime and inefficiencies caused by interoperability issues.

With regards to safety of pressurised systems components, the procurement of complete product/component ranges from a single, reputable manufacturer/supplier is highly recommended.

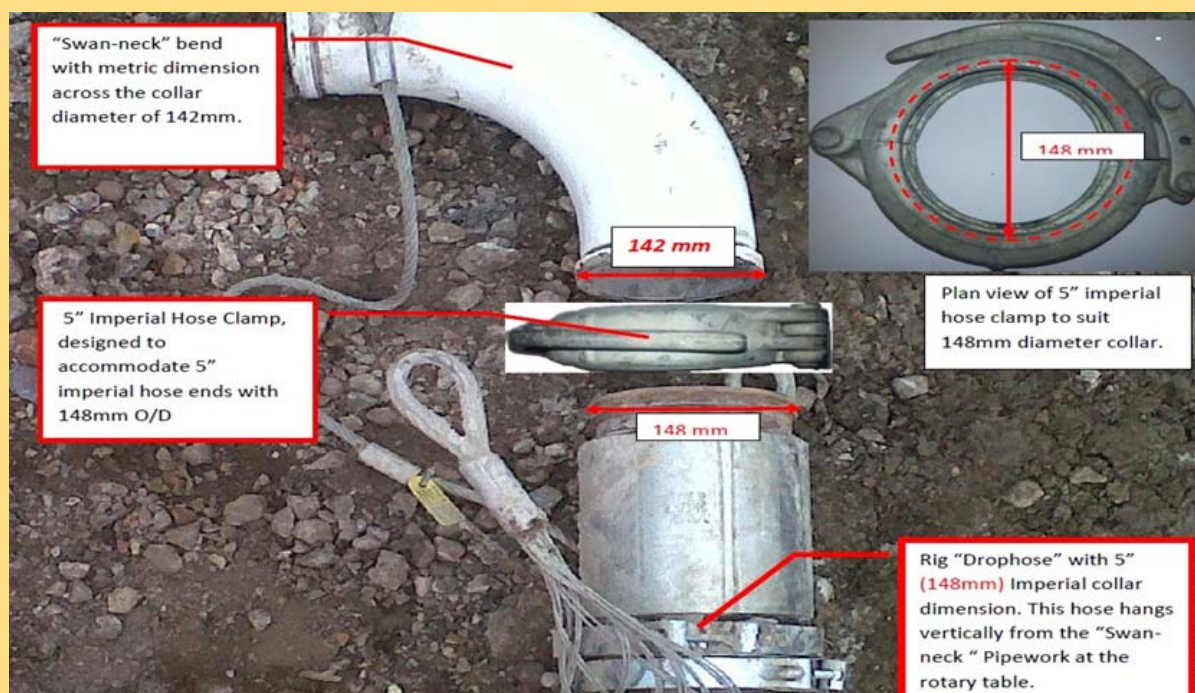
The hazards inherent in pressurised systems necessitates that all components of the system are compatible and securely fitted.

To ensure that single sourcing of components provide adequate risk control, the following additional checks are recommended:

- Ensure that detailed and complete product requirements are defined and included in any purchase agreement.
- The requirements must address form, fit, and function.
- It should also define delivery time and packaging, including clear and consistent labelling.
- Periodically inspect and test the product to ensure continuous compliance with the requirements.



Always confirm specifications of supplied components. Be aware that equipment could be supplied with metric connections when it is expected to have imperial – even when imperial sizes are specified.



The safe operation of pressurised systems is heavily reliant on the selection and training of operators to ensure they are competent to not only carry out their respective operations, but also to identify and react safely to any abnormalities in the standard operation of equipment

Selection

When selecting operators to work with pressurised systems, ensure they are:

- Competent and over 18 years of age. In some cases a higher standard is required eg. for lorry-mounted concrete pumps the recommended age is over 21 years if driving on the highway
- Physically and mentally fit, with particular regard to eyesight, hearing and reflexes. Medical reviews to be held at regular intervals and not exceeding 5 years between intervals
- Able to judge distances, heights and clearances
- Adequately trained and certified for the class of equipment being operated with sufficient knowledge of any relevant machinery and safety devices
- Fully conversant with the duties of the signaller and should understand the signals code

Periodic assessments of each operator should be carried out by a competent person to verify the maintenance of safe standards and to assess any further training needs.

Specific training and assessment must be carried out whenever an operator is transferred to a different machine.

As with all other training, personnel undergoing training should always be adequately supervised. Supervision should be extended to include site-based activities during a familiarisation period.



Training needs to be specific to the equipment and task being undertaken.

Everyone must be familiar with who is authorised to operate various equipment.

Training

In accordance with the Health and Safety At Work Act 1974, the employer must ensure, so far as is reasonably practicable, that employees receive “such information, instruction, training and supervision as is necessary to ensure” their health and safety at work. It is essential that formal training is given and can be shown to have been given.

Section C: Competency / Training

This Section lists training resources available through Crossrail as well training available from outside sources. Most equipment hire companies provide specialist training for their equipment and can be contacted directly for arrangements, examples provided here.

Title:	Sprayed Concrete Lining (SCL) Training and Assessment	
Location:	TUCA Ilford, London E12 5LN	
Content:	Training with regards to Health and Safety, Equipment and Spraying, assessments will be done through practical assessments, observation, discussion and questions.	
Who is the training for:	Training is intended for experienced and semi-experienced nozzlemen, who require up-skilling on the use and application of spray concrete equipment.	
Entry Requirements	SCL experience is mandatory for this programme. Delegates need to hold a current CSCS card	
Duration	5 days	
Contact	0300 456 7424	

Title:	Trailer Mounted Concrete Pump/Pressurised Systems	
Location:	TUCA Ilford, London E12 5LN	
Content:	Concrete pumping accidents, concrete pump operational safety checks, communication, pumping concrete-priming the line, key issues pumping concrete, problem solving, blockage essential actions, pump maintenance, safety reminders, Control of Substances Hazardous to Health.	
Who is the training for:	Training for those who hold a CPCS Blue Card but have not used pressurised systems in the last six months, or other operatives deemed to need refresher training by their employer.	
Entry Requirements	Must be able to demonstrate a background knowledge of pressurised concrete pump systems.	
Duration	2 days refresher + 1 day test	
Contact	Steve Howard 07825 377 036 steven.howard@citb.co.uk or	

Section C: Competency / Training

Title:	Safe Use of Low Pressure Washers	
Location:	Arranged on site	
Content:	Pressure Washer Description, Legal requirements and responsibilities, nature of hazards and identification of causes, identifying the risks, safe and correct use, Selection of correct machinery and PPE, Wash down bays, essential maintenance, Practical assessment.	
Who is the training for:	This programme is designed for any person who may be required to use any low pressure jet washer with a pressure rating below 5000 psi in the workplace or requires familiarisation with the associated regulations.	
Entry Requirements	Delegates attending this course should be 18+ years and be physically and mentally fit to withstand the rigours of training.	
Duration	2 days refresher + 1 day test	
Contact	0845 604 6682 / speedy.training@speedyservices.com / www.speedyservices.com/training	

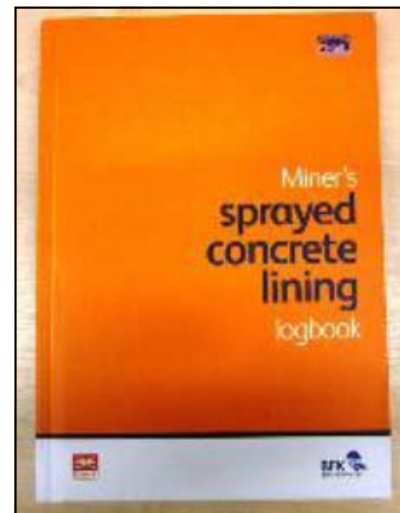
Title:	Water Jetting Safety Awareness (WJ Association Approved Course)	
Location:	Arranged on site or various training centres (eg. Dartford)	
Content:	To provide practical training in the safe, effective use of jetting equipment and the supervision of jetting equipment and operations. • Identification of potential hazards • Setting up equipment with regard to the safety of operators, other staff and the public • Hands on experience using equipment effectively and safely • Immediate procedures to adopt in the event of injury by the impact of a water jet • Nozzle selection with regard to the correct application • Precautions to be taken when using a mains water supply • How to identify and set up a safe system of work when jetting as required by the Health and Safety at Work Act 1974 • Selection of the appropriate Personal Protective Equipment with regard to the P.P.E. Regulations 1992 • Knowledge of the Sewer Jetting Code of Practice as published by the WRc, June 1997 • Knowledge of the Code of Practice as published by the Water Jetting Association. • The content of this course is approved by the Water Jetting Association	
Who is the training for:	Those involved in, or about to become involved in, the use and supervision of high pressure water jetting equipment for cleaning drains, sewers, pipes, culverts, tanks and manholes.	
Entry Requirements	Participants should bring with them a safety helmet, face visor to BS2092 Grade 1, ear defenders, a waterproof suit, safety wellingtons and waterproof gloves	
Duration	1 day	
Contact	Total Protection (UK) Limited / Tel: 0844 567 7423 / info@totalprotectionuk.com / www.totalprotectionuk.com	

Best Practice

Sprayed Concrete Lining

A logbook has been designed to record and monitor the progress of trainees during their formative / initial tenure on the project. The logbook will provide documented evidence of progress and achievement and includes:

- Personal Details
- Training & Qualifications
- Medicals and Occupational Health Monitoring
- SCL Operations
- Major Projects information



On completion of SCL works the logbooks will be issued to the operatives as diverse evidence of competence and experience. The Logbook will undoubtedly provide future employers with credible details of competence and performance. The logbook can also be used in the pursuit of construction NVQ's

CRL1-XRL-Z7-AAG-CR001-50001

Section D: Execution and Control

Concrete Pumping and Spray Concrete Lining

Concrete in pump pipelines is often under considerable pressure and failure of pipeline can result in significant damage or injury. This is especially true during blowout operations when additional stresses on pipelines can expose any weakness in design and installation.

Pump Set-up

The concrete pumping area should be reasonably level, solid and free of obstructions, with careful attention paid to the positioning of the pumping equipment and any stabilising devices. In particular, the area should be:

- clear of excavations, trenches or holes in the ground
- clear of inadequately compacted or soft ground
- clear of cellars, basements, pits or back-filled ground, unless stability is approved in writing by a qualified engineer
- clear of overhead power lines and fixed electrical equipment
- of a size enough to allow for safe operation
- of a size enough to allow for the safe discharge from the concrete delivery trucks.

Receiving hopper and hopper guarding

The concrete pump should be positioned so the receiving hopper is at a height that allows a gravity flow of concrete from the pre-mix delivery trucks into the hopper.

The concrete pump should not be operated unless the hopper opening is fitted with a grille-type safety guard:

- upon which no-one is allowed to stand
- which prevents access to dangerous moving parts
- is constructed of parallel or mesh bars
- which requires a tool to be removed
- is connected to an interlocked cut-out switch designed to stop all moving parts if the guard is lifted.

A correctly fitted hopper guard reduces the risk of body entrapment within the moving parts of the hopper, but due to its design, it cannot protect against all possible contact with the moving parts. Equipment manufacturers use a range of additional measures to limit the likelihood of entrapment, including:

- separating the operator's controls away from the moving parts
- raising the height of the hopper lid from the ground.

When working in the vicinity of the hopper, the manufacturer's operating and safety instructions should be strictly observed.

Operational safety zone

Access to areas around the concrete pump and delivery pipeline should be restricted - the most appropriate method of isolating the area should be used. The use of one or more of the following controls is recommended:

- covered walkways
- barricades
- posts and safety mesh
- posts and danger tape or flags.

Where the pumping or pipeline set-up is for a longer duration project, the isolation methods should be made more permanent. No person, other than those workers directly involved in the concrete pumping operation, should be in the operational safety zone during concrete pumping.