

SOUTH AUSTRALIAN WATER CORPORATION

TECHNICAL STANDARD

MECHANICAL AND HYDRAULIC REQUIREMENTS DURING THE COMMISSIONING AND ON-GOING MONITORING OF PUMPS AND ASSOCIATED EQUIPMENT



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Approval may be granted by the Asset Owner to deviate from the requirements as stipulated in this Standard if the functional requirements (e.g. Asset Life) for the asset differs from those stated in the Standard, but is assessed as still being acceptable by the Asset Owner's nominated representative.

Any approval to deviate from the stated requirements of this Standard will not be seen as creating a precedent for future like project. Any request to deviate from this Standard must be carried out on a project by project basis where each alternate proposal will be individually assessed on its own merit.

CHANGES TO THIS STANDARD

Version	Date	Comment
1 st draft	15/03/2013	Drafted as part of larger TS146
2 nd draft	18/07/2013	Creation of TS146c
3 rd draft	16/09/2013	For review by SA Water Assets, Allwater and PMP
4 th draft	31/01/2014	Issued for review by SA Water Assets, Allwater and PMP

REFERENCED SA WATER STANDARDS AND GUIDELINES

Number	Title
TS146b	Requirements for Pump Specification, Procurement and Testing and the Preparation of Pump Datasheets
TS147	Design and Specification of Surge Mitigating Infrastructure

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1. Scope:

This standard focuses on activities that occur within the overall commissioning process that relate to demonstrating the operational functionality of pumps and associated mechanical and hydraulic infrastructure. This standard is not a prescriptive guide for all commissioning processes. The commissioning activities, relating to mechanical and hydraulic infrastructure only, covered by this standard are:

- Local commissioning
- System commissioning
- Performance acceptance tests

The commissioning process is outlined at a high level in the diagram below.

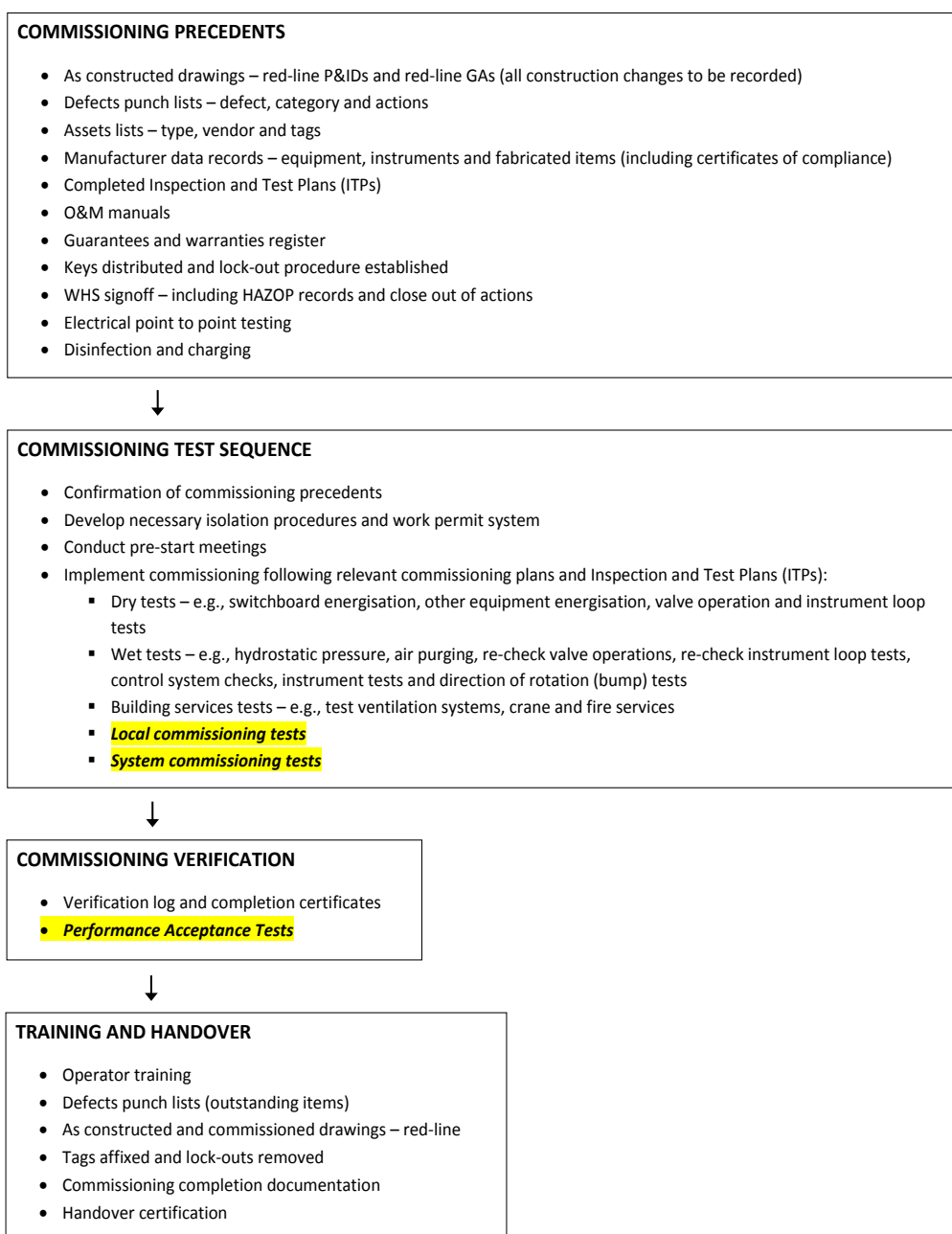


Diagram of commissioning process (high level) with steps relating to TS146c highlighted

Definitions of local commissioning, system commissioning and performance acceptance tests are provided below:

Local commissioning – functional testing of equipment and instruments on local loops without on-going operational impacts

System commissioning – functional testing of equipment and instruments, as well as existing infrastructure, in the ultimate operating system with direct operational impacts

Performance acceptance tests – functional and failure mode testing of equipment and instruments defined and executed by SA Water, or its nominated representative, and which must be satisfactorily completed before operational handover can occur

The requirements of TS 146c apply to designers, contractors and/or their responsible commissioning engineers. It is recognised that the roles of designers and/or contractors, and the engagement of commissioning engineers, varies within different contractual frameworks. All contracts must provide for the requirements of TS 146c to be met by either designers, contractors and/or their responsible commissioning engineers.

This standard must be read and applied in conjunction with TS146b.

2. Commissioning:

All commissioning precedents, as identified in the diagram in section 1, isolation procedures, work permit systems and local and system commissioning plans must be completed, in accordance with this standard, and confirmation of completion provided in writing to SA Water Engineering, 5 working days before any physical commissioning activities commence.

2.1 Local commissioning

One of the objectives of local commissioning includes the testing of all equipment to the maximum extent possible before the introduction of the equipment into SA Water's operating systems. This key objective is to be fulfilled so that the transition from local to system commissioning is completed with minimum risk to system operation and the maximum likelihood of successful operation of the equipment.

Local commissioning involves separate testing of motors and then testing of combined pump and motor equipment on non-system loops (i.e., independently of SA Water's operating systems). Local commissioning loops should be established using:

- Existing or new infrastructure required as part of the ultimate SA Water operating system; and/or
- Dedicated local commissioning infrastructure, in addition to existing or new infrastructure (required as part of the ultimate SA Water operating system), not required for the ultimate SA Water system

2.1.1 Water pump stations < 50kW (all pumps combined)

Local commissioning loops must be established using either permanent existing or new pipework, or temporary pipework, for water pump stations with a combined pump power (from all pumps) of less than 50kW.

If permanently required valves cannot be configured to enable re-circulation of flows from the pumps, through the discharge valves and any installed flowmeter, and back to the suction (upstream) side of the pump station then either:

1. Pipework and valves enabling flow re-circulation must be provided (including suitable control valve); or
2. Direct pumping into SA Water's existing system may be permitted (subject to formal approval from SA Water Operations including acceptance of pre-commissioning documentation covering dry commissioning checks, pressure testing and disinfection)

Any installed flowmeter must be included in the flow re-circulation loop or connection to existing system to enable flow measurement during the commissioning tests.

Water can be re-circulated from the pump discharge to the pump suction provided there is a fixed SA Water tank in the circuit (i.e., pump suction is taken from the tank and discharge delivered back to the tank). Pump cavitation must be avoided during re-circulation.

If there is no tank, as in the case of an in-line booster pump, then a make-up water tank should be provided and connected to the low pressure suction side of the local commissioning loop to ensure:

1. That any water losses do not create air pockets in the commissioning loop; and
2. That the temperature increase in the loop due to the pump heating the water can be dissipated

The size of this make-up water tank will depend on the size of the pumps being commissioned and should be determined by the designer and/or contractor.

A local commissioning plan, prepared by the designer and/or contractor, must be provided to SA Water's superintendent in writing 10 working days before the first start of any equipment. This local commissioning plan shall provide the following information relating to mechanical and hydraulic infrastructure (non-exclusive list):

1. A statement confirming that all dry and wet commissioning tests identified in the diagram in section 1 will be undertaken along with any other dry and wet tests that are required as identified by the designer and/or contractor
2. A statement describing the duty operating points for the pump station and how they will be simulated (using a control valve or otherwise)
3. A statement describing the start and stop procedure for the pumps during local commissioning including the requirements for operating any control valve(s)

4. A statement describing the proposed operation of any variable speed drives including ramp up and down rates, transitions between pumps (if more than one pump installed in parallel) and proposed pump operating speeds
5. A statement describing the operation of the pump control system to demonstrate starting (at low downstream tank level or target control flow/pressure), stopping (at high downstream tank level or target control flow/pressure) and the operation of pumps on variable speed drives to track fixed or dynamic system setpoints (controlling to flow or pressure) including minimum and maximum flows
6. A statement describing the operation of any non-pump infrastructure including cooling systems, priming systems, check valves and air valves to demonstrate opening position, stability and/or times to open and close (and hydraulic sealing in the case of air valves)
7. A statement describing the failure mode tests that can be safely conducted, without risk to the equipment, at the local commissioning stage (see Table 2.1 for a full list of commissioning failure mode tests)
8. A statement describing the proposed measurement of noise and vibration from equipment operating at the maximum power duty point and at any other continuous operating point that results in maximum noise or vibration
9. A description of the proposed equipment used to measure flow, head, noise and vibration
10. A statement of the length of time over which local commissioning will be undertaken (water and pump temperature to be taken into account during recirculation)
11. A statement describing any effects on SA Water's existing operational system including modifications required to established required inflows and outflows from the pump station
12. A schedule of proposed test dates and periods with communication plan for SA Water Operations and SA Water Engineering

Vibration tests are required for pumps once installed in-situ during local commissioning. These tests should be conducted with the pumps restrained in their final positions and when operating at the maximum power duty point and at any other continuous operating point that results in maximum vibration (as simulated in the local commissioning loop). Vibration levels should be measured to obtain root mean square (rms) velocities at the following locations using calibrated instruments (calibration certificates must be made available to SA Water's superintendent on request):

- Non-drive end of motor – axial, horizontal and vertical orientations
- Drive end of motor – axial, horizontal and vertical orientations
- Non-drive end of pump – axial, horizontal and vertical orientations
- Drive end of pump – axial, horizontal and vertical orientations

The vibration tests should be repeated at least once and all measured data checked by the designer and/or contractor to confirm that the measured vibrations are less than the levels stipulated in TS 146b.

Noise tests are required for pumps once installed in-situ during local commissioning (unless otherwise exempted by the SA Water Stakeholder Group). These tests should be conducted with the pump operating at the maximum power duty point and at any other continuous operating point that results in maximum noise (single and all pumps operating). Noise levels

should be measured by a qualified acoustic engineer using calibrated instruments (calibration certificates must be made available to SA Water's superintendent on request).

SA Water Engineering shall be invited to attend the commissioning testing and must be provided with a report, prepared by the designer and/or contractor, covering the results of tests relating to the items identified in this section.

2.1.2 Water pump stations > 50kW (all pumps combined)

The requirements for water pump stations with combined pump power below 50kW apply except that the use of make-up water tanks for on-line booster pump stations must be explicitly approved by SA Water Engineering after submission of a technical justification of the proposed arrangement by the designer and/or contractor.

Failure mode tests may include e-stops of:

1. Single pumps operating at a typical maximum speed duty point and maximum flow (and maximum speed) duty point
2. All duty pumps operating at a typical maximum speed duty point and maximum flow (and maximum speed) duty point

These failure mode tests must only be conducted at the local commissioning stage if it is safe to do so without risk of damage to the equipment and the tests will provide useful information prior to the system commissioning stage.

Dedicated local commissioning infrastructure may include pipework and valves (including control valves) for simulating system operating conditions. Control valve infrastructure must be either powered, hydraulically actuated or manually actuated independently of the operation of the pumps so that pump operation is not required to open, close or otherwise operate the control valves used to simulate system operating conditions.

2.1.3 Wastewater pump stations < 25kW (all pumps combined)

Local commissioning loops must be established using either permanent existing or new pipework, or temporary pipework (including hoses), for wastewater pump stations with a combined pump power (from all pumps) of less than 25kW.

If permanently required valves cannot be configured to enable re-circulation of flows from the pumps, through the discharge valves and any installed flowmeter, and back into the pumping well, then temporary hoses should be used for this purpose.

Wastewater can be re-circulated from the pump wet well to either the control manhole or directly back to the pump wet well for network submersible type pump stations. A valve, either permanent or temporary, must be provided in this loop to enable simulation of system head characteristics. Pump cavitation must be avoided during re-circulation. Any installed flowmeter must be included in this loop to enable flow measurement. Volumetrically calibrated ultrasonic strap-on type flowmeters may be used.

A local commissioning plan, prepared by the designer and/or contractor, must be completed before the first start of any equipment. This local commissioning plan shall provide the following information relating to mechanical and hydraulic infrastructure (non-exclusive list):

1. A statement confirming that all dry and wet commissioning tests identified in the diagram in section 1 will be undertaken along with any other dry and wet tests that are required as identified by the designer and/or contractor
2. A statement describing the duty operating points for the pump station and how they will be simulated (using a control valve or otherwise)
3. A statement describing the start and stop procedure for the pumps during local commissioning including the requirements for operating any control valve(s)
4. A statement describing the proposed operation of any variable speed drives (including ramp up and down rates and proposed pump operating speeds)
5. A statement describing the operation of the pump control system to demonstrate starting (at high wastewater level), stopping (at low wastewater level), operation at minimum flowrate and duty/assist operation of pumps (generally 2 off) at maximum flow rate
6. A statement describing the operation of any non-pump infrastructure including cooling systems, priming systems, check valves and air valves to demonstrate opening position, stability and/or times to open and close (and hydraulic sealing in the case of air valves)
7. A statement describing the failure mode tests that can be safely conducted, without risk to the equipment, at the local commissioning stage (see Table 2.1 for a full list of commissioning failure mode tests)
8. A statement describing the proposed measurement of noise and vibration from equipment operating at the maximum power duty point and at any other continuous operating point that results in maximum noise or vibration. Vibration measurements are not required from submersible pumps where submerged
9. A description of the proposed equipment used to measure flow, head, noise and vibration
10. A statement of the length of time over which local commissioning will be undertaken (wastewater and pump temperature to be taken into account during recirculation)
11. A statement describing any effects on SA Water's existing operational system including modifications required to established required inflows and outflows from the pump station
12. A schedule of proposed test dates and periods with communication plan for SA Water Operations and SA Water Engineering

Noise tests are required for pumps once installed in-situ during local commissioning (unless otherwise exempted by the SA Water Stakeholder Group). These tests should be conducted with the pump operating at the maximum power duty point and at any other continuous operating point that results in maximum noise (single and all pumps operating). Noise levels should be measured under the following conditions, with pumps being operated at the required continuous duty that results in maximum noise, by a qualified acoustic engineer using calibrated instrument(s) (calibration certificates must be available to SA Water's superintendent on request):

1. Pump wet well lid open
2. Pump wet well lid closed
3. Control manhole lid open
4. Control manhole lid closed

SA Water Engineering shall be invited to attend the commissioning testing and must be provided with a report, prepared by the designer and/or contractor, covering the results of tests relating to the items identified in this section.

2.1.4 Wastewater pump station > 25kW (all pumps combined)

The requirements for wastewater pump stations with combined pump power below 25kW apply except that the use of temporary hoses for re-circulation from pump wet wells to control manholes or directly back to pump wet wells must be explicitly approved by SA Water Engineering after submission of a technical justification of the proposed arrangement by the designer and/or contractor.

The following additional information must be included in the local commissioning plan (if the relevant equipment is part of the pump station):

1. A statement of the proposed operation of any variable speed drives including ramp up and down rates, transitions between pumps (if more than one pump installed in parallel) and proposed pump operating speeds
2. A statement describing the operation of the pump control system to demonstrate starting (at low downstream tank level or target control flow/pressure), stopping (at high downstream tank level or target control flow/pressure) and the operation of pumps on variable speed drives to track fixed or dynamic system setpoints (controlling to flow or pressure) including minimum and maximum flows

Failure mode tests may include e-stops of:

1. Single pumps operating at a typical maximum speed duty point and maximum flow (and maximum speed) duty point
2. All duty pumps (including duty and assist pumps) operating at a typical maximum speed duty point and maximum flow (and maximum speed) duty point

These failure mode tests must only be conducted at the local commissioning stage if it is safe to do so without risk of damage to the equipment and/or infrastructure and the tests will provide useful information prior to the system commissioning stage.

Dedicated local commissioning infrastructure may include pipework and valves (including control valves) for simulating system operating conditions. Control valve infrastructure must be either powered, hydraulically actuated or manually actuated independently of the operation of the pumps so that pump operation is not required to open, close or otherwise operate the control valves used to simulate system operating conditions.

2.1.5 Dry well wastewater pump station (all power levels)

SA Water's dry well pump stations typically have combined pump power > 25kW.

The requirements for wastewater pump stations with combined pump power above 25kW apply in addition to those specified in this section.

Vibration tests are required for pumps once installed in-situ during local commissioning. These tests should be conducted with the pumps restrained in their final positions and when operating at the maximum power duty point and at any other continuous operating point that

results in maximum vibration (as simulated in the local commissioning loop). Vibration levels should be measured to obtain root mean square (rms) velocities at the following locations using calibrated instruments (calibration certificates must be made available to SA Water's superintendent on request):

For line shaft pumps:

- Non-drive end of motor – axial, horizontal and vertical orientations
- Drive end of motor – axial, horizontal and vertical orientations
- Non-drive end of pump – axial, horizontal and vertical orientations
- Drive end of pump – axial, horizontal and vertical orientations
- Intermediate shaft bearings – horizontal and vertical orientations

For dry well submersible pumps

- Non-drive end of motor – axial, horizontal and vertical orientations
- Drive end of motor and plane through the coupling to pump impeller – axial, horizontal and vertical orientations

The vibration tests should be repeated at least once and all measured data checked by the designer and/or contractor to confirm that the measured vibrations are less than the levels stipulated in TS 146b.

Noise tests are required for pumps once installed in-situ during local commissioning (unless otherwise exempted by the SA Water Stakeholder Group). These tests should be conducted with the pump operating at the maximum power duty point and at any other continuous operating point that results in maximum noise (single and all pumps operating). Noise levels should be measured by a qualified acoustic engineering using calibrated instruments (calibration certificates must be made available to SA Water's superintendent on request).

SA Water Engineering shall be invited to attend the commissioning testing and must be provided with a report, prepared by the designer and/or contractor, covering the results of tests relating to the items identified in this section.

2.1.6 Miscellaneous

The cost of dedicated once-off local commissioning infrastructure needs to be assessed on a cost benefit and risk basis for pumps stations with a total pump power exceeding 500kW.

Testing loops (facilitating local commissioning) shall be able to be used to replicate ultimate system operating conditions and not result in the operation of equipment under artificial conditions that may be potentially damaging.

All existing SA Water systems shall be hydraulically (and physically) isolated from the local commissioning loops to minimise the potential for any hydraulic, mechanical, water quality or wastewater spill or cross-contamination.

2.2 System commissioning

System commissioning involving testing of the pumps and associated equipment in the final system installation must be conducted before a pump station can be confirmed as having met the requirements of practical completion and be handed over for operation.

A plan for the system commissioning of all pumps and associated infrastructure must be prepared by the designer and/or contractor. The system commissioning plan must contain all technical analysis supporting the required system commissioning activities and written confirmation from SA Water Operations (either metropolitan or regional) that they have been consulted in the preparation of the plan, have approved it and are aware of and can provide the required level of operational support for the system commissioning activities identified in the plan.

The system commissioning plan must be submitted to SA Water Operations and SA Water Engineering for review and acceptance. SA Water Engineering will review the plan within 10 working days. Re-submission of the plan may be required after the initial review by SA Water Engineering.

The system commissioning plan must be based on a SA Water Engineering reviewed control philosophy and/or functional description for the new equipment and its operation in the existing system. The availability of a SA Water Engineering reviewed control philosophy and/or functional description, prepared by the designer and/or contractor, is a pre-requisite to the commencement of any commissioning activities. The control philosophy and/or functional description must be made available at the end of the detailed design phase of a project, or otherwise before equipment procurement, to avoid delays during the commissioning phase.

The requirements for the system commissioning plan will vary with the size of the pump station being commissioned and the complexity of the existing system within which it is to become operational.

The minimum requirements for the system commissioning plan are:

1. Documentation of methods and precautions to be taken so that existing infrastructure is not compromised, by the connection and operation of the new works, in the following ways (non-exclusive list):
 - a. Hydraulic failure of connected pipelines, valves or other infrastructure
 - b. Mechanical failure of interconnected mechanical equipment (including other new or existing pumps, valves or other infrastructure)
 - c. Electrical failure of interconnected electrical equipment (including other new or existing switchboards, variable speed drives or other equipment)
 - d. Control failure of interconnected control, telemetry and SCADA systems (including other new or existing control infrastructure)
 - e. Cross contamination of water or wastewater systems
2. A retraceable step by step approach to system commissioning is to be demonstrated in the system commissioning plan such that the introduction of any new element can be tested with the option of putting the system back into its original condition after the

test (to enable the operational impacts of the test to be determined). This step by step approach should provide for:

- a. The maintenance of the operational requirements of the system (both during and after the system testing) with provision for testing to be halted at the request of SA Water Operations or the responsible commissioning engineer (if operational requirements are compromised)
- b. Confirmation, by the responsible commissioning engineer, that the hydraulic response of the existing system is as expected and matches the anticipated response used as the basis of equipment selection and also matches the results from the local commissioning tests. A process for adjusting the system commissioning and/or operation of equipment should be included in the system commissioning plan to allow for unexpected reactions from the existing system
- c. Making adjustments to new and existing controls, and the operation of equipment, for unexpected reactions that were not anticipated or simulated during local commissioning
- d. Implementing all controls as per the SA Water Engineering reviewed control philosophy and/or functional description
- e. Adjusting parameter dead bands and time averaging (lagging) to achieve satisfactory performance of equipment and the control system
- f. Conducting failure mode tests (see section 2.2.1 below)

2.2.1 Failure mode tests

Failure mode tests must be incorporated in the scope of the commissioning testing including (but not limited to) the tests listed in Table 2.1 below:

Table 2.1

Test	Description	Required Checks
1	No flow (low flow) tests for each installed pump simulating closed control or check valve, air lock or other reason for lack of flow (due to physical or control failure), wastewater choke or no water/wastewater	Check equipment used to monitor flow, check control system time and method for turning off pump, check for mechanical damage to equipment and check for ability of control system to automatically reset
2	Low flow test with each installed pump operating at the pump minimum continuous flow stipulated by the vendor	Check for mechanical damage to equipment and ability of control system to ensure flow is greater than minimum
3	High flow test with each installed pump operating at the pump maximum continuous flow stipulated by the vendor	Check for mechanical damage to equipment and ability of control system to ensure flow is less than maximum
4	Surge test for each installed pump operating at 100% speed duty point with variable speed drive ramp down to 0% speed (if variable speed drive applicable). These tests must take into account the requirements of TS147	Log pressure response in pump station pipework and system and confirm minimum pressure greater than zero (unless otherwise specified in TS147) and maximum pressure less than the minimum rated equipment in the system, check for mechanical damage to equipment and ability of control system to control stop and automatically reset
5	Surge test for all installed pumps operating simultaneously at 100% speed duty point with variable speed drive ramp down to 0% speed (if variable speed drive applicable). Test to only be conducted after examination of the results from	Log pressure response in pump station pipework and system and confirm minimum pressure greater than zero (unless otherwise specified in TS147) and maximum pressure less than the minimum

	test 4 and if deemed safe for personnel and equipment. These tests must take into account the requirements of TS147	rated equipment in the system, check for mechanical damage to equipment and ability of control system to control stop and automatically reset
6	Surge test for each installed pump operating at 100% speed duty point with e-stop and/or power failure simulation. These tests must take into account the requirements of TS147	Log pressure response in pump station pipework and system and confirm minimum pressure greater than zero (unless otherwise specified in TS147) and maximum pressure less than the minimum rated equipment in the system, check for mechanical damage to equipment and ability of control system to control stop and automatically reset
7	Surge test for all installed pumps operating simultaneous at 100% speed duty point with e-stop and/or power failure simulation. Test to only be conducted after examination of the results from test 6 and if deemed safe for personnel and equipment. These tests must take into account the requirements of TS147	Log pressure response in pump station pipework and system and confirm minimum pressure greater than zero (unless otherwise specified in TS147) and maximum pressure less than the minimum rated equipment in the system, check for mechanical damage to equipment and ability of control system to control stop and automatically reset
8	Water or wastewater on floor tests	Check for maximum depth of water in pump station and ability of control system to shutdown electrical equipment if alarm water level exceeded

Checks for physical or other damage to systems and equipment must be carried out after all failure mode tests.

The ability of automatic control systems to reset after failure and automatically resume operation, provided systems and equipment are not damaged, must be confirmed after failure mode tests.

2.2.2 Performance acceptance tests

SA Water Engineering shall be contacted by the designer and/or contractor, or their responsible commissioning engineer, after the completion of local and system commissioning plans and prior to the commencement of any physical commissioning activities, so that SA Water Engineering can confirm which (if any) performance acceptance tests will be required and which (if any) performance acceptance tests will be conducted by either SA Water Engineering or its nominated representative. Such performance acceptance tests would be separate from, and may or may not repeat, the scope of local and system commissioning tests conducted by the designer and/or contractor or their responsible commissioning engineer.

SA Water Engineering will provide notice of, and a scope for, any performance acceptance tests 20 working days after the receipt of the local and system commissioning plans from the designer and/or contractor or their responsible commissioning engineer. SA Water Engineering or a nominated representative will develop a plan for the performance acceptance tests and submit the plan to the designer and/or contractor and their responsible commissioning engineer an additional 15 working days after providing notice of, and a scope for, any performance acceptance tests.

Depending on the scope and characteristics of the identified performance acceptance tests either SA Water Engineering or a nominated representative shall conduct the performance acceptance tests within 20 working days of receiving notification of the completion of commissioning testing by the designer and/or contractor and their responsible commissioning engineer. In some circumstances, SA Water Engineering or its nominated representative will require the designer and/or contractor and their responsible commissioning engineer to assist in conducting the performance acceptance tests. If assistance and resources are required from the designer and/or contractor and their responsible commissioning engineer, then this requirement will be identified in the plan for the performance acceptance tests.

Satisfactory results from performance acceptance tests are a pre-requisite to the handover of the infrastructure to operations. Examples of performance acceptance tests that have occurred in the past include:

- Using specialised logging equipment to confirm the as-commissioned impact of the infrastructure in operating SA Water systems
- Pressure and flow testing at the infrastructure site to confirm as-commissioned equipment control and operational settings during dynamic transitions do not result in operation of equipment outside the warranted ranges specified by vendors
- Vibration testing and monitoring at the infrastructure site to confirm the impact of as-commissioned equipment control and operational settings, particularly under dynamic system conditions, on vibration performance and confirm optimised commissioning settings
- Surge pressure testing and monitoring at the infrastructure site and more generally in SA Water systems
- Efficiency testing to confirm as commissioned equipment is operating within the ranges specified by vendors

2.2.3 Commissioning inputs to operating manual

The completion of a system operating manual, by the designer and/or contractor and their responsible commissioning engineer, describing the results of all local and system commissioning testing and important parameters for operators is a pre-requisite before handover of the infrastructure to operations. Formal training for operators, conducted by equipment vendors and the designer and/or contractor and their responsible commissioning engineer, describing:

- All vendor requirements for the equipment (including the requirements from the equipment Operation and Maintenance Manuals)
- All maintenance requirements and procedures (including the requirements from the equipment Operation and Maintenance Manuals)
- All local and system commissioning tests and results
- All operational set points, commissioned settings and effects of varying from the settings
- All operational alarms and required responses

must be conducted, to the satisfaction of the operators, before handover of the infrastructure.

3. On-going Monitoring:

On-going monitoring systems are required for mechanical and hydraulic infrastructure, in addition to normal operational monitoring, for:

- Bearing temperatures for pumps and any other associated rotating elements with bearings as (and if) required by the vendor supplied Operation and Maintenance Manuals
- Vibration levels, at the same locations nominated for the commissioning testing in this standard, as (and if) required by the vendor supplied Operation and Maintenance Manuals. The installation of vibration monitoring systems is a significant undertaking and includes:
 - Fixed (permanent) accelerometers at the locations described in sections 2.1.1-2.1.5 (single axis type accelerometers)
 - Monitoring software capable of processing alarm signals and providing historical data logging for periodic retrieval

On-going vibration monitoring systems will only be considered for individual pumps with motor power greater than 200kW or pump stations with a total pump motor power greater than 1MW or otherwise critical infrastructure (as identified by SA Water Engineering after consultation with other SA Water Groups). The designer and/or contractor shall contact SA Water Assets before the finalisation of tender submissions for projects which fit the criteria for on-going vibration monitoring systems to confirm whether a monitoring system is required (if any) and the scope of the monitoring system.

Pump performance monitoring is undertaken by SA Water Assets for a range of major pump stations. A number of mechanical devices and fixtures, probes and electrical modifications to switchboards are required to enable the installation and successful use of the portable performance monitoring equipment held by SA Water Assets. The designer and/or contractor shall contact SA Water Engineering before the finalisation of tender submissions for projects to confirm whether provisions are required for the installation and successful use of the portable performance monitoring equipment held by SA Water Assets. SA Water Engineering will consult with SA Water Project Management and SA Water Assets before providing a response to the designer and/or contractor.

4. Australian Standards

AS 2625.1-2003	Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts - General guidelines
AS 2417-2001	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1 and 2