1.0 Scope

This procedure details the minimum requirements for hydrostatic pressure testing of pressure retaining components of pumps and process piping.

This standard defines hydrostatic testing per category 1, 2 and 3 where 1 is the most stringent and 3 is the least stringent. Typically, category 1 applies to Engineered products (API 610) and category 3 applies to Standard and Configured products (non-API 610). Category 2 may be used when Category 3 items require a hydrotest report. In the case where category 3 is required, testing can be performed to the requirements of category 1 or 2 or parts thereof. Similarly, where category 2 is required, testing can be performed to the requirements of category 1 or parts thereof.

Note: Preferably, the testing is carried out on the complete pressure boundary assembly of the items but may be carried out on a sub-assembly or an individual part.

This test procedure does not address safety aspects. All reasonable safety precautions need to be taken during any pressure testing. Applicable laws and regulations must be followed. All testing at Sulzer facilities shall comply with the safety requirements for PM-PU-5.033 "Safety Regulation for Pressure and Performance Testing."

2.0 Reference documents

All standards, codes and norms refer to the last published edition and addenda, which has to be adopted, if customer is not requiring a former revision.

- EN 12162, Liquid pumps - Safety requirements - Procedure for hydrostatic testing
- ISO 13709, Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
- API 610, Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
- ASME Boiler and Pressure Vessel Code Section VIII Div. 1
- VDMA 24276, (for chemical standard pumps)
- VDMA 24279, (for pump with magnetic coupling)
- EN 13480-5, Metallic industrial piping - Part 5: Inspection and testing
- ASME B31.1, Power Piping
- ASME B31.3, Process Piping
- ASME B73-1, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Processes
- EN 837-1 / -2 / -3, Pressure Gauges
- IEC 60770-1 / -2 / -3, Transmitter for use in industrial-process control systems
- EN ISO 5199, Technical specification for centrifugal pumps- Class II
- Sulzer PM-PU-5.033, Safety Regulation for Pressure and Performance Testing

3.0 Preparation for test

3.1 All pressure containing items (parts) shall be hydrostatically pressure tested as required by the applicable codes and standards. Pump casings are to be hydrostatically pressure tested as assemblies less mechanical seals and seal studs. Fasteners which are part of Sulzer scope of supply shall be used for the pressure test

Exception: API single-stage overhung pumps not exceeding 610mm radial joint diameter (mean gasket diameter) may be exempted from this requirement (see API 610 resp. ISO 13709 Paragraph 8.3.2.14). For these pumps segmental testing and use of stock fasteners is acceptable.

Requirements for hydrostatic pressure test of pipework are defined in Section 5.0

3.2 Prior to the setting up of a pressure test, a visual examination of the items to be tested will be carried out to ensure there are no obvious defects likely to lead to unsatisfactory test results.

3.3 All pressure testing will be carried out by a competent person in designated test/assembly areas (as applicable) and under controlled conditions with the appropriate safety precautions.

A “competent person” should have received on the job training supervised by an experienced co-worker/supervisor. A competent person shall be able to carry out a Hydrotest alone, knowing and understanding this Test Procedure, relevant engineering drawings and interpret test results. They are familiar with pressure testing devices and different pressure scales.

3.4 All open ports and flanges will be plugged or blanked and sealed as necessary, in a manner, which is intended to withstand the designated test pressure.

3.5. For category 1, items subjected to test shall be left un-coated, free from oil (except preservative oil), and other contaminants. All joints and welds shall be visible where practical, for examination during the test.

Parts may only be hydro-tested in the painted condition with the customer’s written agreement.

Protection of raw parts against rust that does not stop capillary action may be applied.

3.5.1 For category 2 and 3, products may be pressure tested where castings are primer coated

3.6 Incorporated into the test arrangement are non-return valves, pipework, connections, pump and pressure gauges or pressure transmitters etc. as required. All of which should be in good condition and free from leaks.

3.7 All pressure indicating devices (pressure gauges/transmitters etc) shall have a valid calibration status. Pressure gauges shall have a graduated dial range of not less than 1½ times or more than 4 times the test pressure. The accuracy class for dial pressure gauges should be ≤ 2.5 (± 2.5% of gauge span). Digital reading pressure gauges may be used provided the reading give the same or greater degree of accuracy as obtained with dial pressure gauges.

3.8 For category 1, gaskets used during hydrostatic pressure testing shall be of the same design as those to be supplied with the item being tested.

3.8.1 For category 2 and 3, test equipment (incl. test flanges) have their own special seal design. Specific pressure test gaskets are used.

3.9 As allowed by API 610, austenitic or duplex stainless steel pressure-casing components may be hydrostatically tested with an additional amount of material on areas where machining to critical dimensions and tolerances is required. The additional amount of material shall not exceed 1 mm (0.040 in) material stock or 5% of minimum allowable wall thickness, whichever is less.

4.0 Test procedure

4.1 Access to the test area is determined based on the risk assessment. In case of high risk (high pressure) the test will be carried out in a confined area without access during the test.

4.2 The system shall be filled with water at mains pressure at ambient temperatures. For ferrous materials the minimum water temperature shall not be less than +7°C (45°F). A wetting agent shall be added to the test water (e.g. CORTEC S-5 or equivalent) if required by API 610 or customer specifications.

The chloride ion content of the test water for austenitic and duplex stainless steel is not to exceed 50ppm.

4.3 Air vents shall be provided at all high points in the system. The system shall be bled to ensure removal of all air pockets before applying the test pressure.

4.4 Visually inspect all around the item being tested to ensure no leaks. Auxiliary light sources may be used to ensure adequate lighting for visual inspection of item being tested.

4.5 The pressure shall be raised gradually at increments appropriate to the item under test and the final test pressure until the test pressure is achieved.

4.6 The pressure raising equipment shall be isolated from the item under test and the pressure held for a sufficient time to permit examination to ensure no leakage at each stage.

4.7 Items intended for stock will be raised to the maximum design test pressure as specified on individual drawings.

4.8 When components are to be pressure tested, the indicating gauges shall be connected to the component, or to the component from a remote location, with the gauges readily visible to the operator controlling the pressure throughout the duration of pressurising, testing and depressurising or venting of the component.

4.9 Pressures in items manufactured for live orders will be raised to:

a) the test pressure stated on approved drawings, in the order or in other order related documents; or

b) where not stated, 1½ times the specified max allowable working pressure at ambient temperature

4.10 For category 1, the test pressure shall be maintained isolated from source and at or above the test pressure for a minimum period of 30 minutes during which time the temperature conditions shall be stable. At regular intervals pressure gauge readings shall be checked and the parts under test shall be visually inspected all around to ensure no leaks.

4.10.1 For category 2 and 3, the test pressure shall be maintained isolated from source and at or above the test pressure for a minimum period of 10 minutes during which time the temperature conditions shall be stable. At regular intervals pressure gauge readings shall be checked and the parts under test shall be visually inspected all around to ensure no leaks.

4.11 Acceptance criteria:

The integrity of the items under test is to be regarded as satisfactory if during the test period there are no visible signs of leakage and the pressure has not dropped below the minimum test pressure at any time during the test.

If this criteria is not met, the cause shall be identified. Suitable and authorized corrections will be made prior to retesting. Records of the failure and corrective measure taken shall be maintained including, if required, design changes. After correction, the test shall be repeated.

After completion of test the pressure shall be relieved, the tested item shall be drained, and preferably will be dried using dry air where equipment/facilities permit.

Note: Drying by the application of heat is not permitted for Stainless Steel materials.

5.0 Category 1 and 2 requirements for piping:

Equipment which is not to be tested shall be either disconnected from the piping or isolated by blank flanges or other means during the test.

Contract bolting shall be used unless use of stock fasteners is allowed by both the customer's specification and the construction code for the pump (such as ASME BPVC, PED, Machinery Directive, etc.). Caution: the risk of using stock fasteners include test failures if the stock fasteners are of lower strength.

No piping shall be subject to any form of shock loading such as hammer testing when undergoing pressure testing.

Piping which has been repaired following the hydrostatic pressure test shall be subjected again to the specified pressure test after completion of the repair and any required post-weld heat treatment, unless otherwise agreed between the parties involved.

The pressure of piping under test shall be increased to a value of approximately 50 % of the specified test pressure. Thereafter, the pressure shall be increased in steps of approximately 10 % of the specified test pressure until it is reached. The piping system shall be held at the test pressure for a period of at least 30 minutes. During this examination, the piping shall show no signs of plastic yielding.

During the hydrostatic test, the external surface of the piping system shall be kept in such a condition that leaks can be detected.

The hydrostatic test shall be passed if no leakage or visible plastic deformation is observed.

When the pressure test setup contains piping that may encounter vacuum conditions, for thin wall piping, venting shall be provided to prevent its collapse.

6.0 Reporting and Marking (Stamping)

6.1 Reporting and marking requirements for Category 1 and 2:

On completion of the test a test report must be produced identifying at least the following:

- Items tested
- Unique Certificate Number
- Project & Customer references
- Date of test
- Outcome of test (pass or fail)
- Test pressure
- Test medium
- Test temperature
- Duration
- Amount of material left on for subsequent machining (if applicable)
- Unique identification of gauge / transmitter
- Gauge / transmitter calibration due date
- Qualified person who conducted the test for Sulzer
- Customer personnel who witnessed the test (if applicable)

Note: Any areas which are machined after hydrostatic testing shall be identified in the test report, as required by API 610.

After completion of the test, the part should be marked (stamped) at least with:

- Hydrotest pressure
- Order-No. or Production-No. or Serial-No. or Tag-No
- The hydrotest report number (which shall be unique to the items tested)

6.2 Reporting and marking requirements for Category 3:

Individual items shall be identified as having passed the appropriate pressure test.

Main pumps components as indicated in the product type specific instructions :

- by stamping “P” on the item concerned (only low stress stamps are to be used)
- by maintaining a “log-book” of pressure tests including the data: Order No/Position, Product Type, Pressure, Name, Accepted/Rejected, and data about possible corrections

If agreed with customer a pressure test report is issued .

6.3 The organizations shall keep on file documentation regarding the quality of the water used in hydrostatic testing which shall be provided to the customer upon request.