

Test Procedure	Sulzer Pumps Technical Quality	
Non-destructive testing – Visual examination of castings		

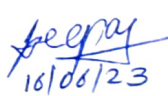
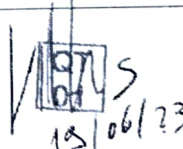
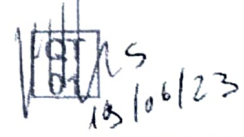
**Document control sheet for the issuing of Test Procedures (NDE) by Level III**  
The signatures below indicate review and approval of this NDE procedure by NDE Level 3.

检测程序 (无损检测) 由NDE 3级 发布文件控制单  
以下的签字表示本NDE程序已由NDE 3级人员审核及批准。

**Dokumentkontrollblatt zur Erstellung von Testverfahren (ZfP) nach Level III**  
Die folgenden Unterschriften zeigen die Überprüfung und Genehmigung dieses ZfP-Verfahrens nach ZfP Level 3.

**Hoja de control de documentos para la emisión de Procedimientos de prueba (ECM) por Nivel III**  
Las firmas a continuación indican la revisión y aprobación de este procedimiento de ECM por NDE Nivel 3.

**Folha de controle de documentos para a emissão de Procedimentos de Teste (END) pelo Nivel III**  
As assinaturas abaixo indicam a revisão e aprovação deste procedimento de END pelo Inspetor END Nivel 3.

	Name (printed letters) 姓名 (打印) Name (Druckbuchstaben) Name (Letra de molde) Nome (Letra de forma)	Function / Qualification 职务/资质 Funktion / Qualifikation Función / Calificación Função / Qualificação	Date & Signature 日期&签名 Datum & Unterschrift Fecha y Firma Data & Assinatura
<b>Created</b> 编制 Erstellt Creado Criado	Deepak Rajurkar	Quality Engineer	 16/06/23
<b>Reviewed</b> 审核 Überprüft Revisado Revisado	Marcel Willems, on behalf Qualitech AG.	NDT Expert (VT Level 3)	 15/06/23
<b>Approved</b> 批准 Genehmigt Aprobado Aprovado	Marcel Willems, on behalf Qualitech AG.	NDT Expert (VT Level 3)	 15/06/23
<b>Remarks / 备注 / Bemerkungen / Comentarios / Comentário:</b>			

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## 1.0 Scope

This procedure details the method and acceptance standards for the visual examination of castings for NDE purposes, (surface roughness and surface discontinuities) unless otherwise specified in the Sulzer Purchase Order.

## 2.0 Reference documents

The following documents are referenced in this specification. All documents shall be current issue unless specified otherwise. In case of any conflict between the current specification and the referred documents, the current document shall take precedence.

ASME Section V Article 9 - Visual Examination

ASTM A802 Standard Practice for Steel Castings – Surface Acceptance Standards – Visual Examination

ISO 11971 Steel and Iron Casting – Visual testing of surface quality

SCRATA Comparators Standard; plastic replicas of actual casting surfaces

MSS SP-55 Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities

ASNT SNT-TC-1A Personnel Qualification and Certification in Non-destructive Testing

EN ISO 9712 Non-destructive Testing - Qualification and Certification of NDT Personnel

## 3.0 Qualification of testing personnel

The personnel performing official visual examination required in the Project Quality Plan (Inspection & Test Plan) for NDE purposes shall be qualified and certified according to EN ISO 9712, SNT-TC-1A or equivalent national standard (e.g. CAN/CGSB 48.9712).

An operator with VT-level I can perform an examination only under the supervision of personnel qualified and certified VT-level II or higher.

Interpretation and evaluation of results shall only be carried out by personnel qualified and certified VT-level II or higher, who is supervising the examination of VT-level I and evaluates the results. Both have to sign the records.

All qualifications and certification must comply, in full, with at least one of the standards referenced in Paragraph 2.0 of this document and, where applicable, should be in full compliance with the Project Quality Plan (Inspection & Test Plan).

Sulzer internal visual examination during the manufacturing processes may be carried out by a competent person familiar with the:

- relevant standards, rules and applicable specifications,
- manufacturing processes used to produce the casting,
- equipment, if remote visual testing,

but not being qualified and certified according to a standard named above under paragraph 2.0.

## 4.0 Examination conditions

### 4.1 Timing of examination

Testing shall be carried out in the manner defined in the project Quality Plan (Inspection & Test Plan), both in chronological order and material condition.

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**4.2 Extent of examination**

The extent or scope of the examination shall be as defined in the project Quality Plan (Inspection & Test Plan).

**5.0 Test procedure**

**5.1 Surface preparation**

The surface to be examined shall be degreased using a suitable solvent.

The surface condition shall be adequate to allow accurate interpretation of indications commensurate with the acceptance criteria specified.

**5.2 Examination procedure**

Direct visual examination may usually be made when access is sufficient to allow surface examination:

- within 600 mm (24 in.) to the surface to be tested.
- at an angle of not less than 30° to the surface to be tested.

Mirrors may be used to improve the angle of vision, aids such as a magnifying lens may be used to assist examination.

The specific part of the casting under examination shall be illuminated by floodlights or other light sources if necessary to attain a minimum of 100 fc = 1'076 lux.

When direct visual examination cannot be utilized, remote visual testing may have to be substituted using suitable visual aids such as endoscopes, borescope and fibre optics etc.

These auxiliaries must have at least the same resolution capability which is required in direct visual examination, too.

**5.2.1 Resolution capability**

It is required that a fine line with a width of  $\leq 0,8$  mm (1/32 in.) can be detected on the surface or on a similar surface in the most unfavourable area to be examined.

Examinations shall be carried out on completion of the heat treatment.

**6.0 Assessment of indications**

Due to the diversity of project requirements, defect acceptance will be as specified in the project Quality Plan (Inspection & Test Plan) or Sulzer Purchase order. In the absence of a stated acceptance criteria, MSS-SP-55 shall be used.

Unacceptable surface discontinuities shall be removed and their removal verified by visual examination of the resultant cavities. Cosmetic repairs may be made prior to the visual examination.

The surface of the casting shall be free from adhering sand, scale, cracks, hot tears, fins or other foreign protrusions.

Hydraulic surfaces are to be clean and free from obtrusions and abrupt changes (convex or concave) with a surface finish in the order of 25  $\mu$ m (1000  $\mu$ inch or Rugotest N11).

Where there is doubt as to the relevance of an indication, the surface in that area shall be cleaned and re-examined.

Alternatively other nondestructive testing methods can be applied, to determine if an indication is due to a defect. Such additional tests have to be reported to Sulzer Pumps.

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**6.1 SCRATA Comparators**

The durable plastic comparator plates, actual replicas of relevant characteristics of surface finish, provide a basis for acceptance of the castings.

The comparators form the basis of ASTM A802/A802M Standard Practice for Steel Castings, Surface Acceptance Standards, Visual Examination. This standard comprises 31 comparators that define features such as:

- Surface Roughness (A)
- Surface Inclusions (B)
- Gas Porosity (C)
- Laps and Cold Shuts (D)
- Scabs (E)
- Chaplets (F)
- Surface Finish – Thermal Dressing (G)
- Surface Finish – Mechanical Dressing (H)
- Welds (J)
- Hot Tears
- Mechanical Dressing – Chipping

**6.2 ASTM A-802 Acceptance Standard**

Surface Feature	Level I	Level II	Level III	Level IV
	Scrata Comparators			
Surface texture	A1	A2	A3	A4
Non-metallic inclusions	B1	B2	B4	B5
Gas porosity	C2	C1	C3	C4
Fusion discontinuities, Cold shut	--	D1	D2	D5
Expansion discontinuities, Scabs	--	--	E3	E5
Inserts, Chaplets	--	--	F1	F3
Metal removal marks				
Thermal	G1	G2	G3	G5
Mechanical	H1	H3	H4	H5
Welds	J1	J2	J3	J5

Table 1

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**6.3 ISO 11971 Acceptance Standard**

Discontinuity	Class 00	Class 0	Class 1	Class 2	Class 3	Class 4
Surface Comparator – Classification (Scrata)						
Inclusions	--	--	B1	B2	B4	B5
Gas porosity	--	--	C2	C1	C3	C4
Fusion discontinuities, Cold shut	--	--	--	D1	D2	D5
Expansion discontinuities, Scabs	--	--	--	--	E3	E5
Chaplet, Inserts	--	--	--	--	F1	F3
Metal removal marks						
Thermal	--	--	G1	G2	G3	G5
Mechanical	--	--	H1	H3	H4	H5
Welds	--	--	J1	J2	J3	J5

Table 2

**MSS SP-55** Acceptance levels in ASTM A802 Scrata Comparators considered equivalent to the Acceptance Criteria of MSS SP-55.

**6.4**

<b>MSS SP-55 Classification</b>	<b>SCRATA Comparators Equivalent</b>
Type I Hot tears and cracks	None acceptable
Type II Shrinkage	<i>No Examples Use MSS SP-55</i>
Type III Sand Inclusions	Comparator B2 or better
Type IV Gas Porosity	Comparator C2 or better
Type V Veining	<i>No Examples Use MSS SP-55</i>
Type VI Rat Tails	<i>No Examples Use MSS SP-55</i>
Type VII Wrinkles, Laps, and Cold Shuts	Comparator D2 or better
Type VIII Cutting Marks	Comparator G2 or better Comparator H4 or better
Type IX Scabs	Comparator E1 or better
Type X Chaplets	Comparator F2 or better
Type XI Weld Repair Areas	Comparator J3 or better
Type XII Surface Roughness	Comparator A3 or better

Table 3

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## 7.0 Repairs

- 7.1 All repair work that involves welding shall fulfil PO / ITP requirements. Any deviation requires an approved concession request prior to execution by Sulzer.
- 7.2 All relevant indication shall be marked on the components themselves, or where this is not possible on an NDE defect map. All relevant indications shall be removed completely.
- 7.3 Whenever an imperfection is to be weld repaired, the excavation shall be examined by one of following method before welding to ensure complete removal of defect
- 7.3.1 Visual inspection, if the imperfection was found by visual inspection
- 7.3.2 Penetrant testing, if the imperfection was found by PT,MT,UT or RT.
- 7.4 On completion of welding, repaired areas shall be blended into their surrounding surfaces to avoid any sharp contours and be examined by the same quality standards that are used to inspect the castings. When subsequent heat treatment is required, examination shall be conducted after heat treatment.

## 8.0 Reporting

For each official visual examination required in the Project Quality Plan (Inspection & Test Plan) for NDE purposes and for each item tested a report shall be completed. This report has to include at least the following information:

- Job and part identification
- Surface condition and material
- Test procedure reference and method used
- Equipment used
- Extent of examination
- Restrictions which limit the effectiveness of the examination
- Acceptance criteria
- Results (of the recording indications: size, depth, position and classification of defects, eventually with drawing)
- Date of examination
- Date of reporting
- The name, qualification and the signature of the person(s) carrying out the test respectively having made the interpretation and evaluation of indications

Components shall be clearly identified as being either acceptable or rejectable. Non-conforming areas on components shall be marked on the components themselves, or where this is not possible on an NDE defect map.

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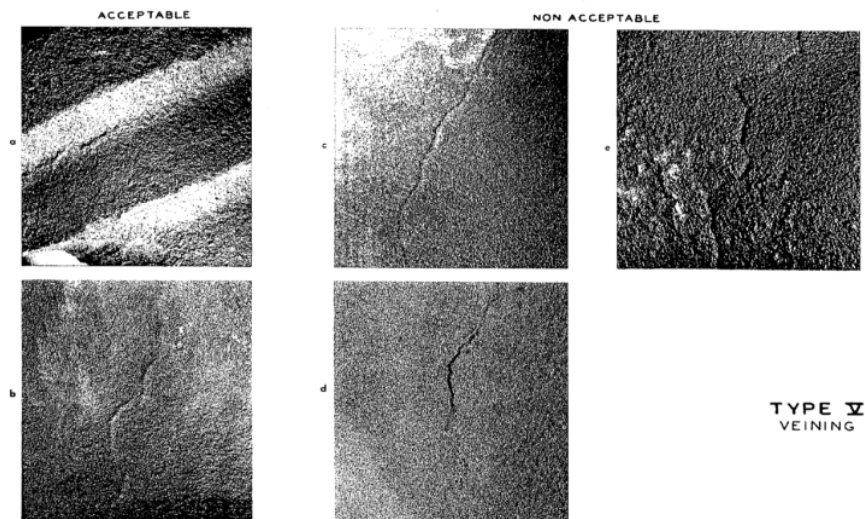
**Enclosure**

The figures below picture examples of acceptance criteria used for visual examination as described in this procedure. These are provided for information only.

SCRATA Comparators for the Definition of Surface Quality of Iron and Steel Casting



MSS SP-55 Photographs Type I - XII (example of Type V defect – Veining)



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