Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components

Visual Method for Evaluation of Surface Irregularities
This MSS Standard Practice was developed under the consensus of the MSS Technical Committee 304 and the MSS Coordinating Committee. The content of this Standard Practice is the result of the efforts of competent and concerned volunteers to provide an effective, clear, and non-exclusive specification that will benefit the industry as a whole. This MSS Standard Practice is intended as a basis for common practice by the manufacturer, the user, and the general public. The existence of an MSS Standard Practice does not in itself preclude the manufacture, sale, or use of products not conforming to the Standard Practice. Mandatory conformance is established only by reference in a code, specification, sales contract, or public law, as applicable.

Unless otherwise specifically noted in this MSS SP, any standard referred to herein is identified by the date of issue that was applicable to the referenced standard(s) at the date of issue of this MSS SP. (See Annex A).

In this Standard Practice all notes, annexes, tables, and figures are construed to be essential to the understanding of the message of the standard, and are considered part of the text unless noted as "supplemental". All appendices appearing in this document are construed as "supplemental". "Supplemental" information does not include mandatory requirements.

U.S. customary units in this SP are the standard; metric units are for reference only.

Non-toleranced dimensions in this Standard Practice are nominal, and, unless otherwise specified, shall be considered "for reference only".

Any part of this standard may be quoted. Credit lines should read 'Extracted from MSS SP-55, 2001, with permission of the publisher, the Manufacturers Standardization Society.' Reproduction prohibited under copyright convention unless written permission is granted by the Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

Originally Approved April 1961
MSS STANDARD PRACTICE SP-55

FOREWORD

The MSS SP-55, Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities, was originally adopted in 1961. It was developed for the purpose of providing the industry with a uniform means for identifying various types of casting surface irregularities.

A set of 60 reference photographs illustrating these casting surface irregularities is included in the standard to permit a visual comparison of an actual casting surface with the reference photographs for the purpose of establishing acceptable/unacceptable casting surface irregularities.

The format of this standard was revised in 1996 to be consistent with other MSS Standards.

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERMS AND CONDITIONS</td>
<td>i</td>
</tr>
<tr>
<td>FOREWORD</td>
<td>ii</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>ii</td>
</tr>
<tr>
<td>1 SCOPE</td>
<td>1</td>
</tr>
<tr>
<td>2 DEFINITION OF SURFACE QUALITY BY VISUAL INSPECTION</td>
<td>1</td>
</tr>
<tr>
<td>3 REFERENCE PHOTOGRAPHS</td>
<td>1</td>
</tr>
<tr>
<td>4 TERMINOLOGY FOR REFERENCE PHOTOGRAPHS</td>
<td>1</td>
</tr>
<tr>
<td>5 COMPARISON OF MSS SP-55 ACCEPTANCE CRITERIA WITH SCRATA STANDARD COVERING SURFACE TEXTURE QUALITY STANDARDS</td>
<td>2</td>
</tr>
<tr>
<td>TABLE 1 Acceptance Levels in the Scrata Comparators Considered Equivalent to the Acceptance Criteria of MSS SP-55</td>
<td>3</td>
</tr>
<tr>
<td>ANNEX A Referenced Standards and Applicable Dates</td>
<td>4</td>
</tr>
<tr>
<td>PHOTOGRAPHS Type I through XII</td>
<td></td>
</tr>
</tbody>
</table>
1. SCOPE

1.1 This standard is intended to supplement the requirements of ASTM Specifications A 216/A 216M, A 217/A 217M, A 351/A 351M, A 352/A 352M, A 389/A 389M, A 487/A 487M, and A 744/A 744M and to provide a series of reference photographs typical of the various surface irregularities common to steel pressure castings and illustrations of generally acceptable and generally rejectable quality. Table 1 of Section 5 is provided to show MSS interpretation as to the relationship between this standard practice and the levels of surface quality illustrated by the comparators and photographs of the SCRATNA Comparators for the Definition of Surface Quality of Steel Castings.

1.2 For additional nondestructive examinations defining quality of steel castings, this standard may be supplemented by MSS Standard Practices SP-53 for magnetic particle examination method, SP-54 for radiographic examination method, SP-93 for liquid penetrant examination method, SP-94 for ultrasonic examination method and SP-112 for visual and tactile method.

2. DEFINITION OF SURFACE QUALITY BY VISUAL INSPECTION

2.1 Twelve general types of surface irregularities are characterized in the collection, five examples being included of each type. The two examples in each case shown to the left illustrate acceptable degrees of the particular type of irregularity. The three examples to the right are characterized as containing unacceptable defects.

2.2 It is recognized that problems may be encountered in evaluating surfaces of castings over a wide range of size and section thickness using the same set of standards. This guide attempts to minimize the size effect and is intended for general use for any 4" x 5" (100mm x 125mm) area.

3. REFERENCE PHOTOGRAPHS

3.1 A set of 60 reference photographs illustrating various casting surface irregularities which can be observed by visual inspection, is included herewith. These photographs are actual-size examples of gradations in acceptable and non-acceptable irregularities. It is intended that irregularities less pronounced than those shown as non-acceptable shall be accepted under this guide.

3.2 Photographs included are of actual castings and may exhibit surface irregularities other than the type characterized in the heading. Each type of surface irregularity shall be judged only against the series of photographs identified with the type.

4. TERMINOLOGY FOR REFERENCE PHOTOGRAPHS

4.1 It should be noted that all definitions and discussions of terminologies apply only to surface irregularities and not to internal defects. The types of surface irregularities illustrated in the reference photographs are as follows:

a) *Type 1 - Hot Tears and Cracks.*
Linear surface discontinuities or fractures caused by either internal or external stresses or a combination of both acting on the casting. They may occur during or subsequent to solidification. In general, visible surface cracks and/or hot tears are not acceptable.
b) Type II - Shrinkage.
A void left in cast metals as a result of solidification shrinkage and the progressive freezing of metal, which is exposed upon cutting off risers and gates.

c) Type III - Sand Inclusions.
Sand that becomes entrapped in the molten metal and shows on the surface of the casting.

d) Type IV - Gas Porosity.
Voids in cast metal caused by entrapment of gas during solidification.

e) Type V - Veining.
Features on the surface of castings appearing as a ridge and associated with movement or cracking of sand.

f) Type VI - Rat Tails.
Features on the surface of castings appearing as a depression resulting from faulting or buckling of the mold surfaces.

g) Type VII - Wrinkles, Laps, Folds, and Coldshuts.
Surface irregularities caused by incomplete fusing or by folding of molten metal surfaces.

h) Type VIII - Cutting Marks.
Irregularities in casting surfaces resulting from burning or mechanical means used in the cleaning of castings.

i) Type IX - Scabs.
Slightly raised surface blemishes that are usually sand crusted over by a thin porous layer of metal.

j) Type X - Chaplets.
Evidence of chaplets on surface of casting disclosing incomplete fusion, which likewise can apply to internal chills.

k) Type XI - Weld Repair Areas.
Evidence of improper surface preparation after welding.

l) Type XII - Surface Roughness.
Surface texture due to design, pattern, gating, and sand conditions.

5. COMPARISON OF MSS SP-55 ACCEPTANCE CRITERIA WITH SCRATA STANDARD COV-ERING TEXTURE QUALITY STANDARDS

5.1 MSS and other societies have published standards illustrating various levels of surface texture and irregularities classified by type. The SCRATA standard discussed in this section does not identify specific levels as being acceptable, leaving the issue to the product specification or contract.

5.2 Table 1 has been included for the purpose of showing MSS interpretation as to the levels of discontinuity by type which would be met by castings conforming to SP-55.

5.3 The SCRATA comparators are plastic replicas of actual casting surfaces, each of which is also represented by photograph. The standard suggests designating acceptance criteria on drawings.

5.4 MSS SP-55 acceptance criteria have been reviewed against the SCRATA standard to designate the acceptance criteria of each type, which are equivalent to SP-55 acceptance criteria. Comparisons published in Table 1 represent the MSS interpretation. They are intended to be of assistance to those interpreting the SCRATA standard.
## TABLE 1 - Acceptance Levels in the Scrata Comparators Considered Equivalent to the Acceptance Criteria of MSS SP-55.

<table>
<thead>
<tr>
<th>MSS SP-55 CLASSIFICATION</th>
<th>SCRATA COMPARATORS EQUIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TYPE I</strong></td>
<td></td>
</tr>
<tr>
<td>Hot tears and cracks</td>
<td>None acceptable</td>
</tr>
<tr>
<td>(None acceptable)</td>
<td></td>
</tr>
<tr>
<td><strong>TYPE II</strong></td>
<td></td>
</tr>
<tr>
<td>Shrinkage</td>
<td>NO EXAMPLES Use MSS SP-55</td>
</tr>
<tr>
<td><strong>TYPE III</strong></td>
<td></td>
</tr>
<tr>
<td>Sand Inclusions</td>
<td>COMPARATOR B2 or better</td>
</tr>
<tr>
<td><strong>TYPE IV</strong></td>
<td></td>
</tr>
<tr>
<td>Gas Porosity</td>
<td>COMPARATOR C2 or better</td>
</tr>
<tr>
<td><strong>TYPE V</strong></td>
<td></td>
</tr>
<tr>
<td>Veining</td>
<td>NO EXAMPLES Use MSS SP-55</td>
</tr>
<tr>
<td><strong>TYPE VI</strong></td>
<td></td>
</tr>
<tr>
<td>Rat Tails</td>
<td>NO EXAMPLES Use MSS SP-55</td>
</tr>
<tr>
<td><strong>TYPE VII</strong></td>
<td></td>
</tr>
<tr>
<td>Wrinkles, Laps, Folds, and Cold Shuts</td>
<td>COMPARATOR D2 or better</td>
</tr>
<tr>
<td><strong>TYPE VIII</strong></td>
<td></td>
</tr>
<tr>
<td>Cutting Marks</td>
<td>COMPARATOR G2 or better</td>
</tr>
<tr>
<td></td>
<td>COMPARATOR H4 or better</td>
</tr>
<tr>
<td><strong>TYPE IX</strong></td>
<td></td>
</tr>
<tr>
<td>Scabs</td>
<td>COMPARATOR E1 or better</td>
</tr>
<tr>
<td><strong>TYPE X</strong></td>
<td></td>
</tr>
<tr>
<td>Chaplets</td>
<td>COMPARATOR F2 or better</td>
</tr>
<tr>
<td><strong>TYPE XI</strong></td>
<td></td>
</tr>
<tr>
<td>Weld Repair Areas</td>
<td>COMPARATOR J3 or better</td>
</tr>
<tr>
<td><strong>TYPE XII</strong></td>
<td></td>
</tr>
<tr>
<td>Surface Roughness</td>
<td>COMPARATOR A3 or better</td>
</tr>
</tbody>
</table>
ANNEX A
Referenced Standards and Applicable Dates

This Annex is an integral part of this Standard Practice and is placed after the main text for convenience.

Standard Name or Designation

**ASTM**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 216/A 216M-93 (R98)</td>
<td>Steel Castings, Carbon, Suitable for Fusion Welding for High Temperature Service</td>
</tr>
<tr>
<td>A 217/A 217M-99</td>
<td>Steel Castings, Martensitic Stainless and Alloy for Pressure Containing Parts, Suitable for High Temperature Service</td>
</tr>
<tr>
<td>A 351/A 351M-94A (R99)</td>
<td>Steel Castings, Austeritic, for High Temperature Service</td>
</tr>
<tr>
<td>A 352/A 352M-93 (R98)</td>
<td>Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts, Suitable for Low Temperature Service</td>
</tr>
<tr>
<td>A 389/A 389M-93 (R 98)</td>
<td>Steel Castings, Alloy, Specially Heat Treated, for Pressure Containing Parts, Suitable for High Temperature Service</td>
</tr>
<tr>
<td>A 487/A 487M-93 (R 98)</td>
<td>Steel Castings, Suitable for Pressure Service</td>
</tr>
<tr>
<td>A 744/A 744M-98A</td>
<td>Castings, Iron-Chromium-Nickel Base, Corrosion Resistant, for Severe Service</td>
</tr>
</tbody>
</table>

**MSS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-53-1999</td>
<td>Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method</td>
</tr>
<tr>
<td>SP-54-1999</td>
<td>Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Radiographic Examination Method</td>
</tr>
<tr>
<td>SP-93-1999</td>
<td>Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Liquid Penetrant Examination Method</td>
</tr>
<tr>
<td>SP-94-1999</td>
<td>Quality Standard for Ferritic and Martensitic Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Ultrasonic Examination Method</td>
</tr>
</tbody>
</table>

**SCRATA**

Comparators for the Definition of Surface Quality of Steel Castings
Publications of the following organizations appear on the above lists:

ASTM
American Society for Testing and Materials
100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

MSS
Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
127 Park Street, N.E., Vienna, VA 22180

SCRATA
Steel Castings Research and Trade Association
5 East Bank Road, Sheffield S2 3PT, England

or

Steel Founders Society of America
205 Park Avenue, Barrington, IL 60010

5
NOTE: The two acceptable examples of this type do not show hot tears or cracks. No irregularities of this type are acceptable under this standard.

TYPE I
HOT TEARS AND CRACKS
ACCEPTABLE

NON ACCEPTABLE

TYPE II
SHRINK
The images illustrate examples of acceptability and non-acceptability in the context of Type V veining.

- **Acceptable (a, b)**: These images show areas where veining is present but within acceptable limits.
- **Non-Acceptable (c, e)**: These images depict areas with veining that exceed the acceptability criteria.

The images are labeled to demonstrate the differentiation between acceptable and non-acceptable veining conditions.
ACCEPTABLE

NON ACCEPTABLE

TYPE VI
RAT TAILS
TYPE VII
WRINKLES, LAPS, FOLDS
AND COLDSHUTS
ACCEPTABLE

NON ACCEPTABLE

TYPE XII
SURFACE ROUGHNESS
List of MSS Standard Practices
(Price List Available Upon Request)


Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings
Foot Peeling for Bronze, Iron and Steel Flanges
Standard Marking System For Valves, Fittings, Flanges and Unions
Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
(R 01) Wrought Stainless Steel Butt-Welding Fittings
Steel Pipeline Flanges
Bypass and Drain Connections
Class 150UL Corrosion Resistant Cast Flanges and Flanged Fittings
Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method
Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Radiographic Examination Method
Pipe Hangers and Supports - Materials, Design and Manufacture
Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
Pressure Testing of Steel Valves
High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Les Gaskets
Butterfly Valves
High Pressure Butterfly Valves with Offset Design
Pipe Hangers and Supports - Selection and Application
Cast Iron Gate Valves, Flanged and Threaded Ends
Gray Iron Swing Check Valves, Flanged and Threaded Ends
Ball Valves with Flanged or Butt Welding Ends for General Service
(R 96) Brazing Joints for Wrought and Cast Copper Alloy Solder Joint Pressure Fittings
Specification for High Test Wrought Butt Weld Fittings
(R 00) Guidelines for Pipe Support Contractual Relationships
Cast Iron Plug Valves, Flanged and Threaded Ends
Socket-Welding Reducer Inserts
Bronze Gate, Globe, Angle and Check Valves
Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
Valve Pressure Testing Methods
Class 2000 Steel Pipe Unions, Socket-Welding and Threaded
Cast Iron Globe & Angle Valves, Flanged and Threaded Ends
Guidelines for Metric Data in Standards for Valves, Fittings, and Actuators
(F 96) Factory-Made Butt-Welding Fittings for Class 1 Nuclear Piping Applications
(0 01) Diaphragm Valves
Pipe Hangers and Supports - Fabrication and Installation Practices
Guidelines on Terminology for Pipe Hangers and Supports
(R 56) Guidelines for Manual Operations of Valves
MSS Valve User Guide
Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components-Liquid Penetrant Examination Method
Quality Std for Famiolo and Martensitic Steel Castings for Valves, Flanges, and Fittings and Other Piping Components-Ultrasonic Examination Method
Swaged(0) Nipples and Bull Plugs
Guidelines on Terminology for Valves and Fittings
Integrity Reinforced Forged Branch Outlet Fittings-Socket Welding, Threaded and Butt welding Ends
Protective Coatings for the Interior of Valves, Hydrants, and Fittings
Instrument Valves
Qualification Requirements for Elastomer Diaphragms for Nuclear Diaphragm Type Valves
Fast-Turn Valve Actuator Attachment-Flange and Driving Component Dimensions and Performance Characteristics
Multi-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
(W 05) Wrought Copper and Copper Alloy Insert Fittings for Polybutylene Systems
Wrought Copper Solder Joint Pressure Fittings
Instrument Valves for Code Applications
(R 06) Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300
(R 00) Transition Union Fittings for Joining Metal and Plastic Products
Resistant-Sealed Cast Iron-Eccentric Plug Valves
Weaved Fabricated Copper Solder Joint Pressure Fittings
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
Gray-iron and Ductile-Iron Tapping Sleeves
Quality Standard for Evaluation of Cast Surface Finishes - Visual and Tactile Method. This SP must be sold with a 10-surface, three dimensional Cast Surface Comparator, which is a necessary part of the Standard. Additional Comparators may be sold separately at $25.00 each. Same quantity discounts apply on total order.
Connecting Joint between Tapping Machines and Tapping Valves
Corrosion Resistant Pipe Fittings Threaded and Socket Welding, Class 150 and 1000
Excess Flow Valves for Natural Gas Service
Service Line Valves and Fittings for Drinking Water Systems
Bellows Seals for Globe and Gate Valves
Compact Steel Globe & Check Valves - Flanged, Flangeless, Threaded & Welding Ends (Chemical & Petroleum Refinery Service)
Bell End Socket Welding Fittings, Stainless Steel and Copper Nickel
Flexible Graphite Packing System for Rising Stem Steel Valves (Design Requirements)
Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves
Plastic Industrial Ball Valves
Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube
Fabricated Tapping Sleeves
Gray Iron and Ductile Iron-In-Line, Spring-Loaded, Center-Guided Check Valves
Steel In-Line Spring-Assisted Center-Guided Check Valves
Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
(R YE$) Indicates year standard reaffirmed without substantive changes

A large number of former MSS Practices have been approved by the ANSI or ANSI Standards, published by others. In order to maintain a single source of authoritative information, the MSS withdraws its Standard Practice in such cases.

Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. 127 Park Street, N.E., Vienna, VA 22180-4620 • (703) 281-6613 Fax # (703) 281-6671

Copyright by the Manufacturers Standardization Society Of The Valve And Fittings Industry Inc
Wed May 19 11:43:29 2004