MSS SP-55-2006

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

Visual Method for Evaluation of Surface Irregularities

Standard Practice
Developed and Approved by the
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MSS

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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.)

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

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; the metric (SI) units are for reference only.

Originally Approved April, 1961

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 this Standard Practice to permit a visual comparison of an actual casting surface with the reference photographs for the purpose of the establishing acceptable/unacceptable casting surface irregularities.

The format of this Standard Practice was revised in 1996 to be consistent with other MSS Standard Practices.

This 2006 revised edition includes updates in the referenced standards, Annex A, to reflect current applicable dates and the updated addresses of the referenced publications organizations.

TABLE OF CONTENTS

QUALITY STANDARD FOR STEEL CASTINGS FOR VALVES, FLANGES, FITTINGS, AND OTHER PIPING COMPONENTS – VISUAL METHOD FOR EVALUATION OF SURFACE IRREGULARITIES

1. SCOPE

1.1 This Standard Practice 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 the photographs of the Steel Casting Research and Trade Association (SCRATA) Comparators for the Definition of Surface Quality of Steel Castings.

1.2 For additional nondestructive examinations defining quality of steel castings, this Standard Practice may be supplemented by the following Standard Practices; SP-53 "Magnetic Particle Examination Method", SP-54 "Radiographic Examination Method", SP-93 "Liquid Penetrant Examination Method", SP-94 "Ultrasonic Examination Method" and SP-112 "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 with 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 in. x 5 in. (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 I – 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 or hot tears, or both, are not acceptable.

b) ***Type II – Shrinkage***
A void left in cast metal 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 Cold Shuts***
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 SP-55 ACCEPTANCE CRITERIA WITH SCRATA STANDARD COVERING 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 identity 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 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 SP-55

SP-55 CLASSIFICATION	SCRATA COMPARATORS EQUIVALENT
TYPE I Hot tears and cracks (None acceptable)	None Acceptable
TYPE II Shrinkage	NO EXAMPLES Use MSS SP-55
TYPE III Sand Inclusions	B2 or better
TYPE IV Gas Porosity	C2 or better
TYPE V Veining	NO EXAMPLES Use MSS SP-55
TYPE VI Rat Tails	NO EXAMPLES Use MSS SP-55
TYPE VII Wrinkles, Laps, Folds, and Cold Shuts	D2 or better
TYPE VIII Cutting Marks	G2 or better H4 or better
TYPE IX Scabs	E1 or better
TYPE X Chaplets	F2 or better
TYPE XI Weld Repair Areas	J3 or better
TYPE XII Surface Roughness	A3 or better

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 Description

ASTM	Standard Specification for:
A 216/A 216M – 2004	Steel Castings, Carbon, Suitable for Fusion Welding for High Temperature Service
A 217/A 217M – 2004	Steel Castings, Martensitic Stainless and Alloy for Pressure Containing Parts, Suitable for High Temperature Service
A 351/A 351M – 2006	Steel Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts
A 352/A 352M – 2006	Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts, Suitable for Low-Temperature Service
A 389/A 389M – 2003	Steel Castings, Alloy, Specially Heat Treated, for Pressure Containing Parts, Suitable for High Temperature Service
A 487/A 487M – 1993(R03)	Steel Castings, Suitable for Pressure Service
A 744/A 744M – 2000(R06)	Castings, Iron-Chromium-Nickel Base, Corrosion Resistant, for Severe Service

MSS	
SP-53-1999 (R 2002)	Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components – Magnetic Particle Examination Method
SP-54-1999 (R 2002)	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components – Radiographic Examination Method
SP-93-1999 (R 2004)	Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components – Liquid Penetrant Examination Method
SP-94-1999 (R 2004)	Quality Standard for Ferritic and Martensitic Steel Castings for Valves, Flanges and Fittings and Other Piping Components – Ultrasonic Examination Method
SP-112-1999 (R 2004)	Quality Standard for Evaluation of Cast Surface Finishes – Visual and Tactile Method

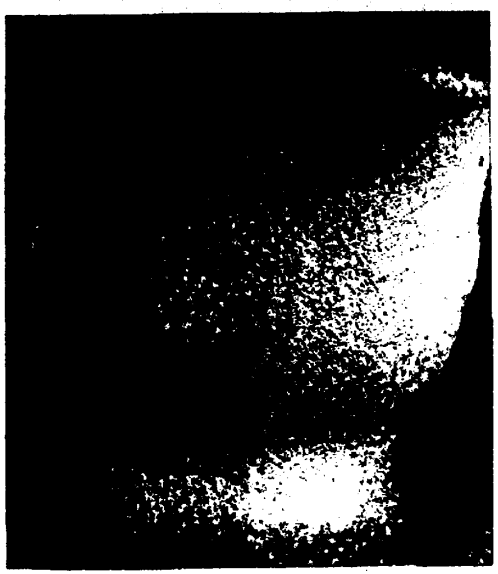
SCRATA

Comparators for the Definition of Surface Quality of Steel Castings

ACCEPTABLE

NON ACCEPTABLE

a



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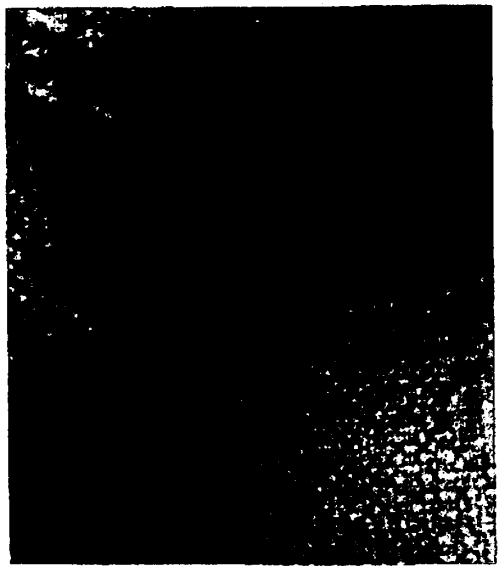

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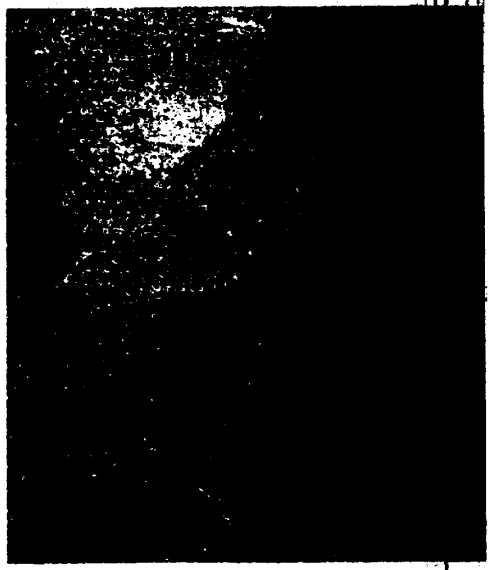
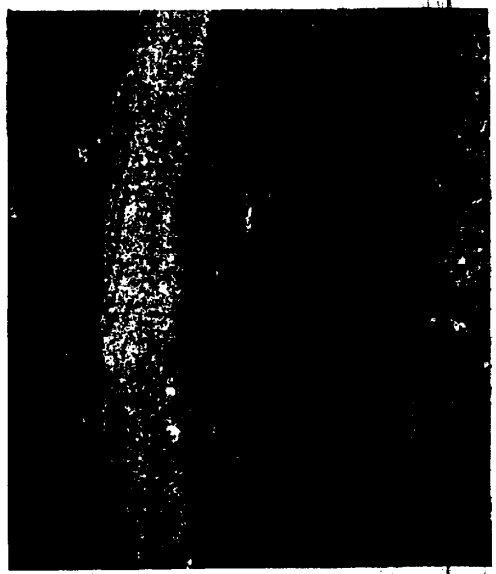


d



e

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.

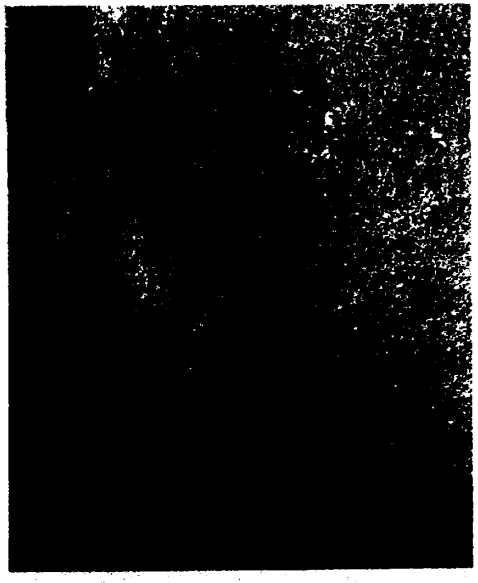
TYPE I
HOT TEARS AND CRACKS

ACCEPTABLE

NOT ACCEPTABLE

a

b



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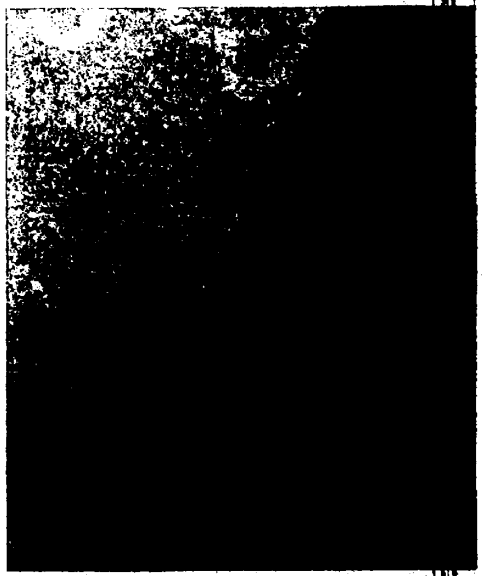

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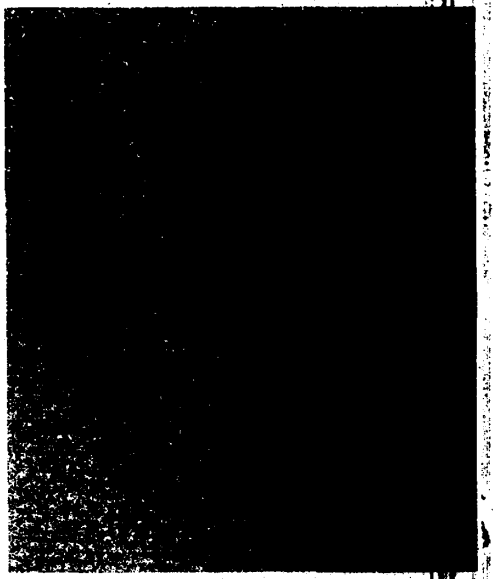

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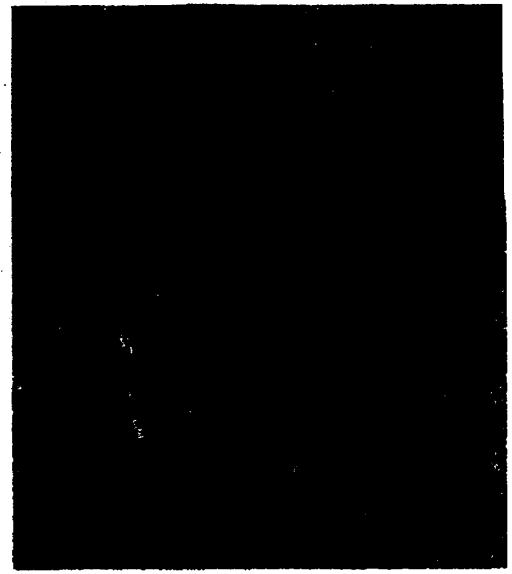


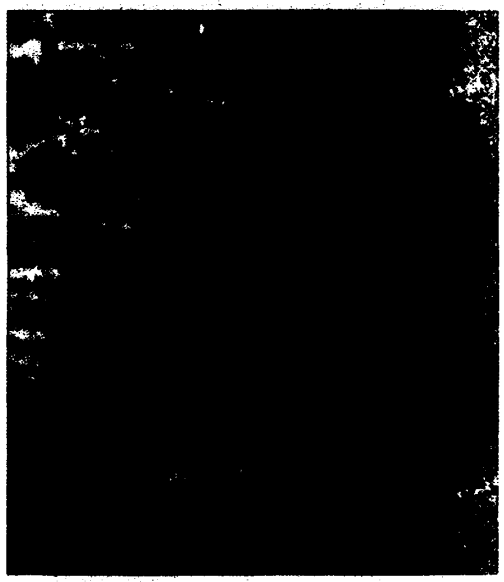
TYPE V
VEINING

PRTD. IN U.S.A.

ACCEPTABLE

NOT ACCEPTABLE

a



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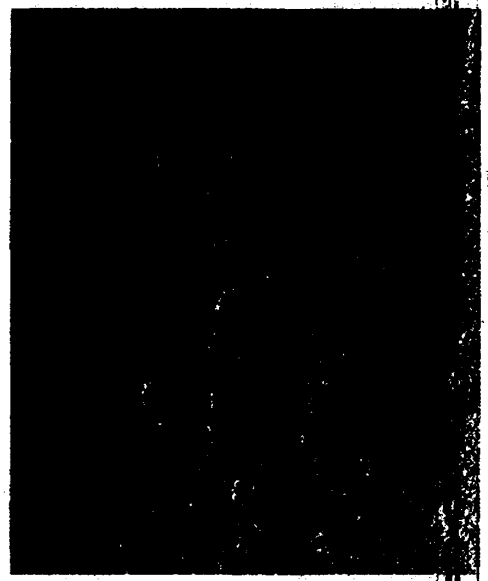

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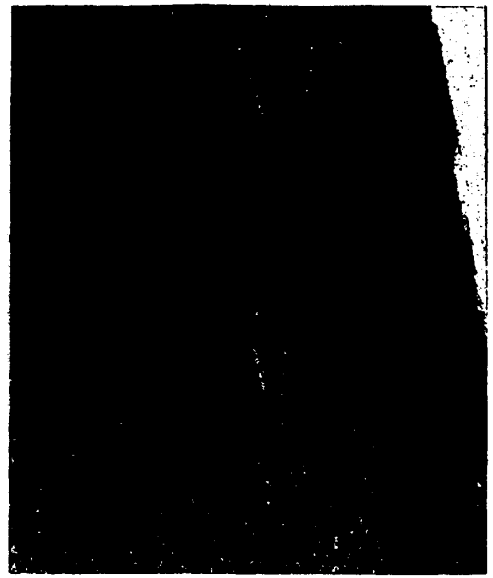

TYPE VI
RAT TAILS

PRTD. IN U.S.A.

ACCEPTABLE

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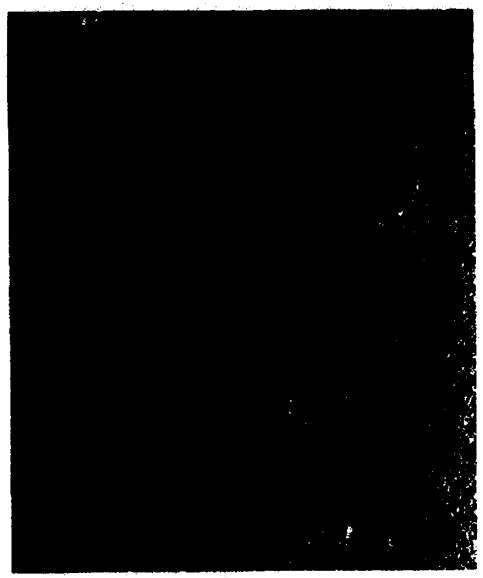

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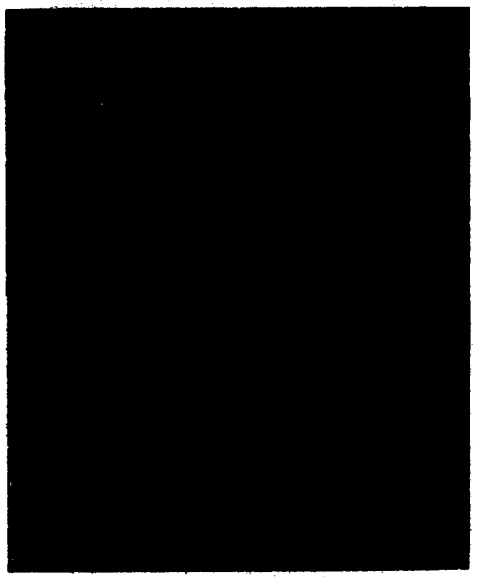
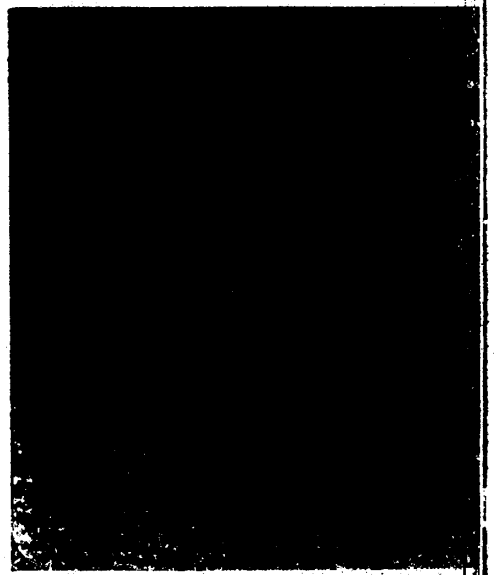


NON ACCEPTABLE

c

d



e

TYPE VII

WRINKLES, LAPS, FOLDS AND COLDSHUTS

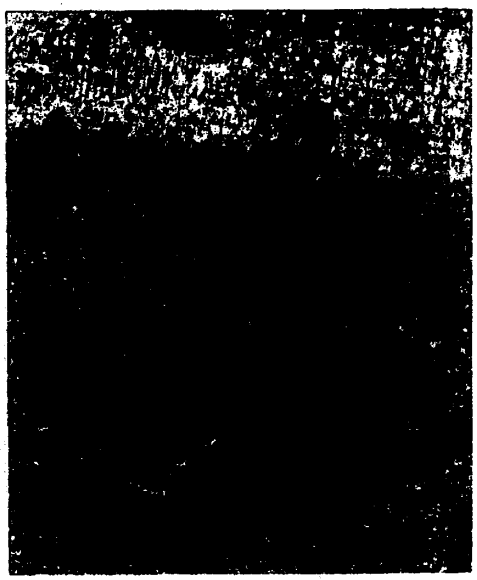
PRTD. IN U.S.A.

ACCEPTABLE

NON ACCEPTABLE

a

b



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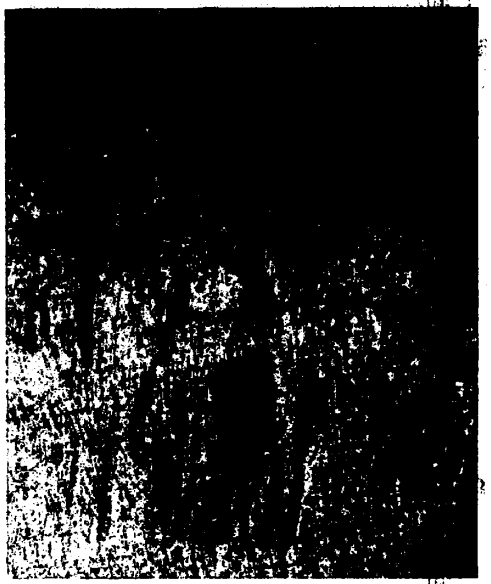

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e

TYPE VIII
CUTTING MARKS

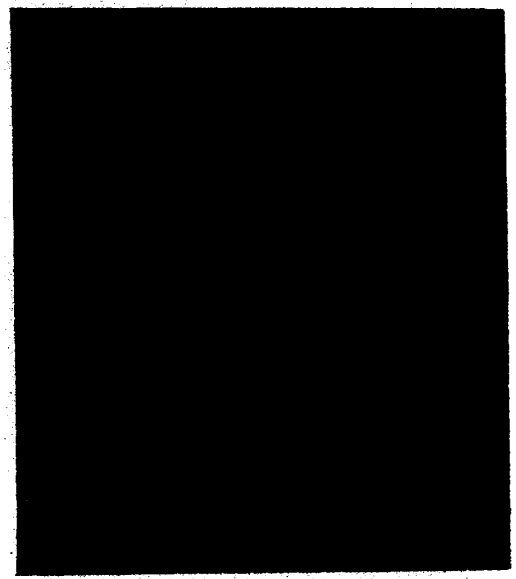
PRTD. IN U.S.A.

ACCEPTABLE

NON ACCEPTABLE

a

b



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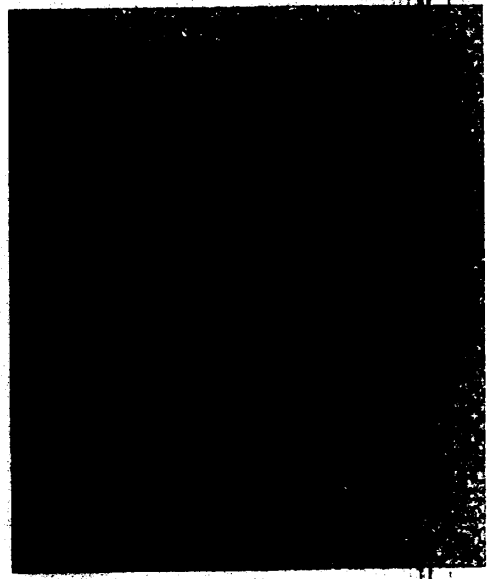

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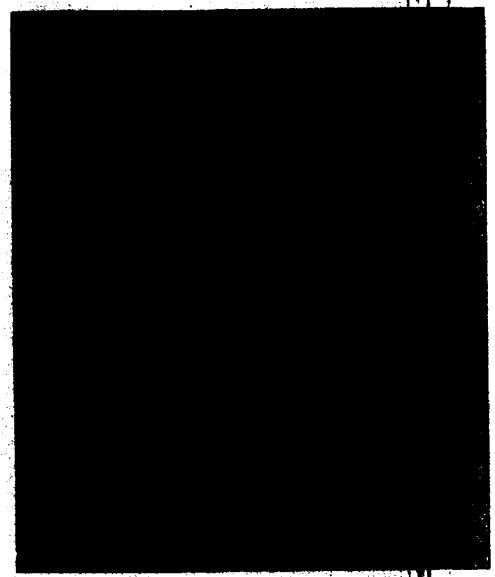

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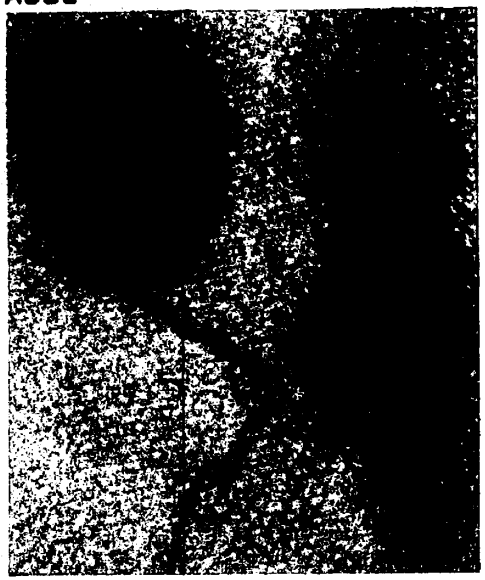


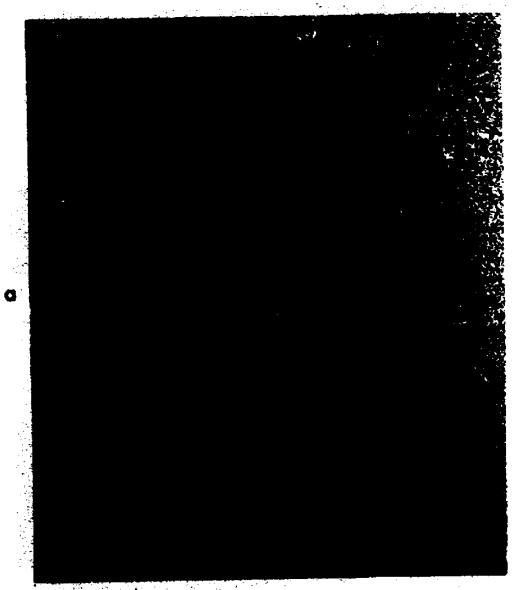
TYPE IX
SCABS

PRTD. IN U.S.A.

ACCEPTABLE

NON ACCEPTABLE

a



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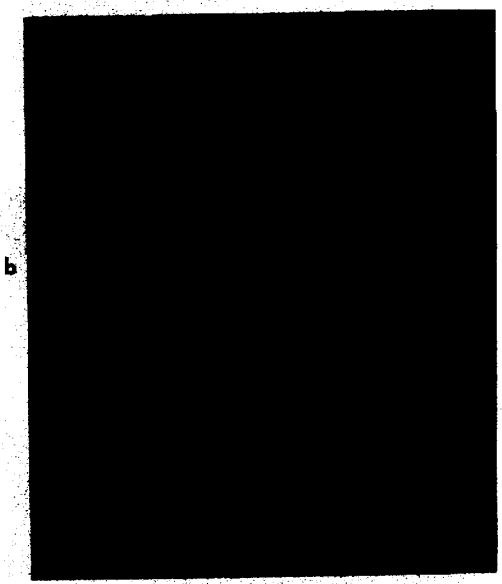

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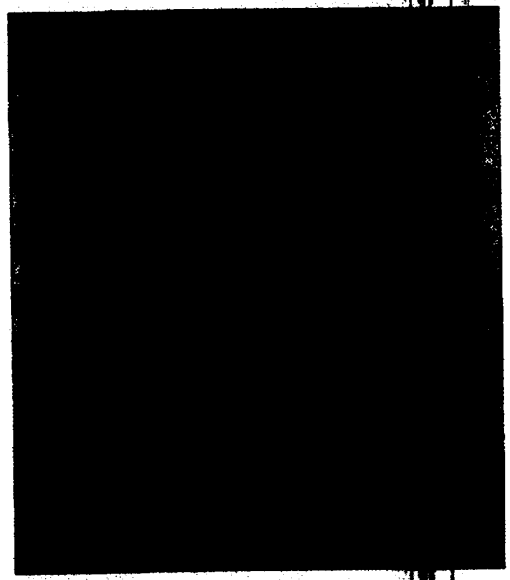

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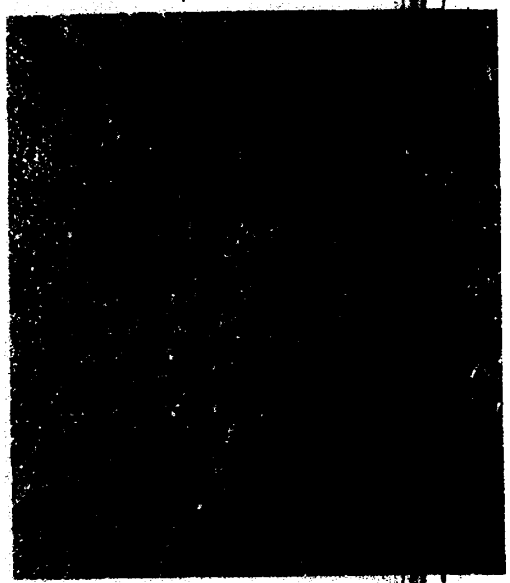

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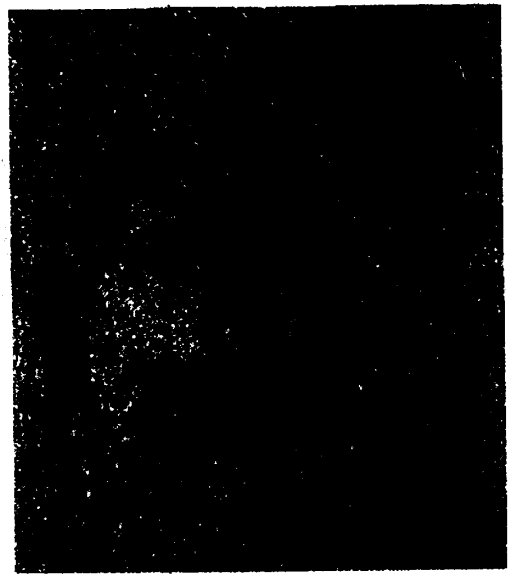

TYPE X
CHAPLETS

PRTD. IN U.S.A.

ACCEPTABLE

NOT ACCEPTABLE

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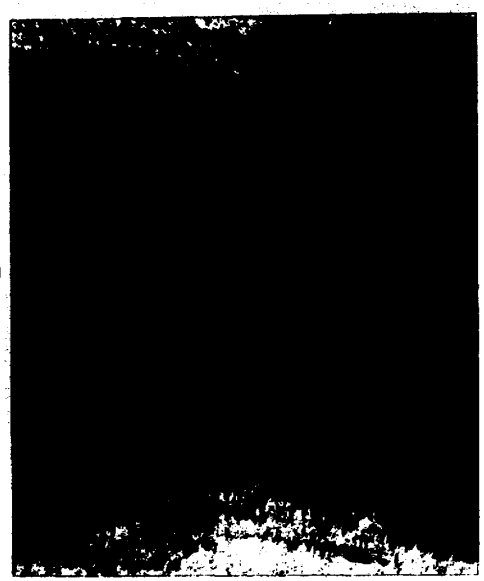

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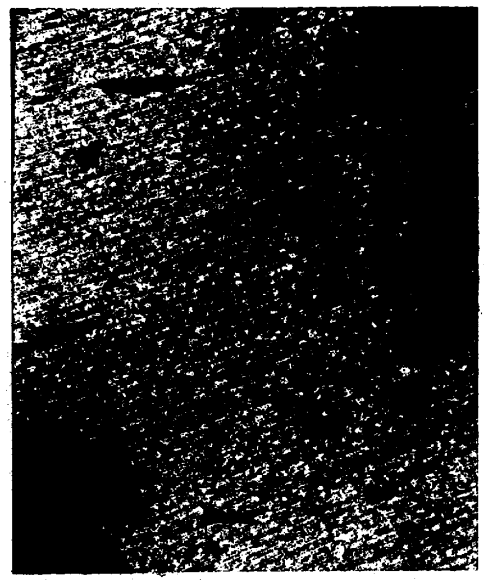

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TYPE XI
WELD REPAIR AREAS

PRTD. IN U.S.A.

ACCEPTABLE

NON ACCEPTABLE

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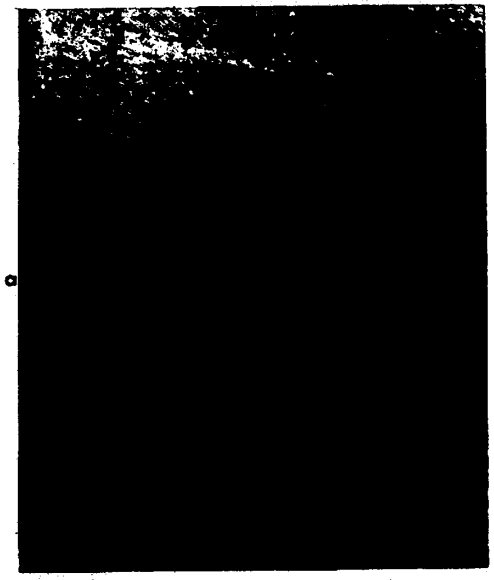

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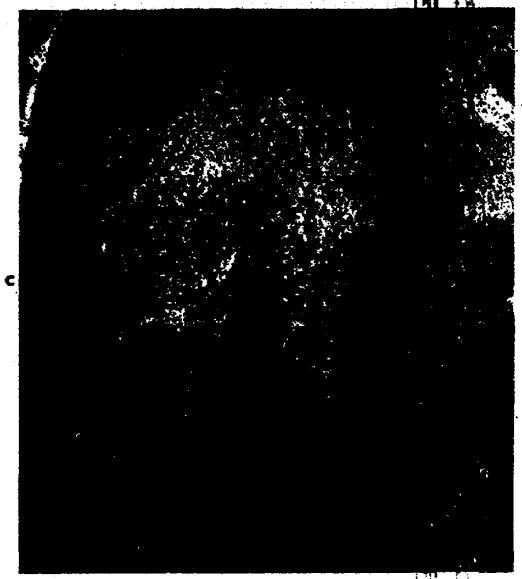

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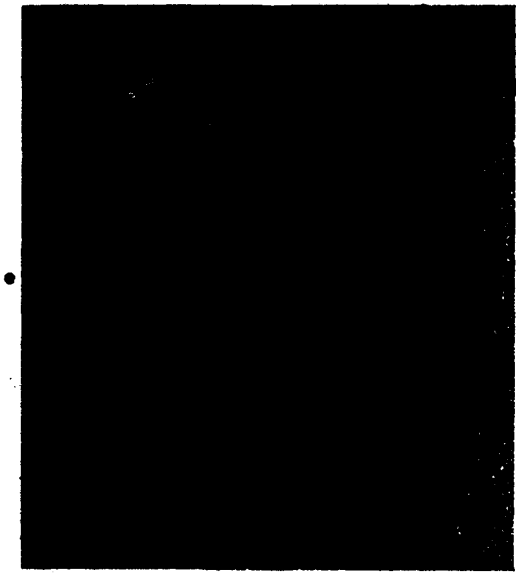

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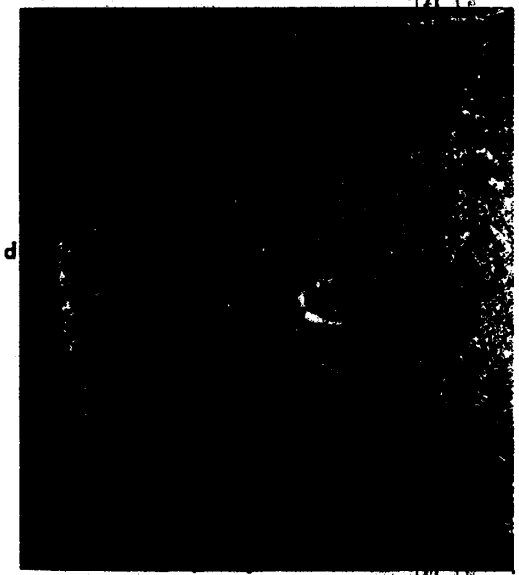

TYPE XII
SURFACE ROUGHNESS

List of MSS Standard Practices
(Price List Available Upon Request)

Number	
SP-6-2001	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
SP-9-2001	(R 05) Spot Facing for Bronze, Iron and Steel Flanges
SP-25-1998	Standard Marking System for Valves, Fittings, Flanges and Unions
SP-42-2004	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
SP-43-1991	(R 01) Wrought Stainless Steel Butt-Welding Fittings
SP-44-2006	Steel Pipeline Flanges
SP-45-2003	Bypass and Drain Connections
SP-51-2007	Class 150LW Corrosion Resistant Flanges and Cast Flanged Fittings
SP-53-1999	(R 07) Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and Other Piping Components - Magnetic Particle Examination Method
SP-54-1999	(R 07) Quality Standard for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Radiographic Examination Method
SP-55-2006	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
SP-58-2002	Pipe Hangers and Supports - Materials, Design and Manufacture
SP-60-2004	Connecting Flange Joint Between Tapping Sleeves and Tapping Valves
SP-61-2003	Pressure Testing of Steel Valves
SP-65-2004	High Pressure Chemical Industry Flanges and Threaded Stubs for Use with Lens Gaskets
SP-67-2002a	Butterfly Valves
SP-68-1997	(R 04) High Pressure Butterfly Valves with Offset Design
SP-69-2003	Pipe Hangers and Supports - Selection and Application (ANSI/MSS Edition)
SP-70-2006	Gray Iron Gate Valves, Flanged and Threaded Ends
SP-71-2005	Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-1999	Ball Valves with Flanged or Butt-welding Ends for General Service
SP-75-2004	Specification for High Test Wrought Butt Welding Fittings
SP-77-1995	(R 00) Guidelines for Pipe Support Contractual Relationships
SP-78-2005a	Gray Iron Plug Valves, Flanged and Threaded Ends
SP-79-2004	Socket-Welding Reducer Inserts
SP-80-2003	Bronze Gate, Globe, Angle and Check Valves
SP-81-2006	Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
SP-83-2006	Class 3000 Steel Pipe Unions, Socket-Welding and Threaded
SP-85-2002	Gray Iron Globe & Angle Valves, Flanged and Threaded Ends
SP-86-2002	Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators
SP-88-1993	(R 01) Diaphragm Valves
SP-89-2003	Pipe Hangers and Supports - Fabrication and Installation Practices
SP-90-2000	Guidelines on Terminology for Pipe Hangers and Supports
SP-91-1992	(R 96) Guidelines for Manual Operation of Valves
SP-92-1999	MSS Valve User Guide
SP-93-1999	(R 04) Quality Standard for Steel Castings and Forgings for Valves, Flanges, and Fittings and Other Piping Components - Liquid Penetrant Examination Method
SP-94-1999	(R 04) Quality Std for Ferritic and Martensitic Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Ultrasonic Examination Method
SP-95-2006	Swage(d) Nipples and Bull Plugs
SP-96-2001	(R 05) Guidelines on Terminology for Valves and Fittings
SP-97-2006	Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded and Buttwelding Ends
SP-98-2001	(R 05) Protective Coatings for the Interior of Valves, Hydrants, and Fittings
SP-99-1994	(R 05) Instrument Valves
SP-100-2002	Qualification Requirements for Elastomer Diaphragms for Nuclear Service Diaphragm Valves
SP-101-1989	(R 01) Part-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
SP-102-1989	(R 01) Multi-Turn Valve Actuator Attachment - Flange and Driving Component Dimensions and Performance Characteristics
SP-104-2003	Wrought Copper Solder Joint Pressure Fittings
SP-105-1996	(R 05) Instrument Valves for Code Applications
SP-106-2003	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300
SP-108-2002	Resilient-Seated Cast-Iron Eccentric Plug Valves
SP-109-1997	(R 06) Welded Fabricated Copper Solder Joint Pressure Fittings
SP-110-1996	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
SP-111-2001	(R 05) Gray-Iron and Ductile-Iron Tapping Sleeves
SP-112-1999	(R 04) 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.
SP-113-2001	Connecting Joint between Tapping Machines and Tapping Valves
SP-114-2001	Corrosion Resistant Pipe Fittings Threaded and Socket Welding, Class 150 and 1000
SP-115-2006	Excess Flow Valves, 1 1/4 NPS and Smaller, for Fuel Gas Service
SP-116-2003	Service Line Valves and Fittings for Drinking Water Systems
SP-117-2006	Bellows Seals for Globe and Gate Valves
SP-118-2007	Compact Steel Globe & Check Valves - Flanged, Flangeless, Threaded & Welding Ends (Chemical & Petroleum Refinery Service)
SP-119-2003	Factory-Made Belled End Socket Welding Fittings
SP-120-2006	Flexible Graphite Packing System for Rising Stem Steel Valves (Design Requirements)
SP-121-2006	Qualification Testing Methods for Stem Packing for Rising Stem Steel Valves
SP-122-2005	Plastic Industrial Ball Valves
SP-123-1998	(R 06) Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube
SP-124-2001	Fabricated Tapping Sleeves
SP-125-2000	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
SP-126-2000	Steel In-Line Spring-Assisted Center Guided Check Valves
SP-127-2001	Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
SP-128-2006	Ductile Iron Gate Valves
SP-129-2003	Copper-Nickel Socket-Welding Fittings and Unions
SP-130-2003	Bellows Seals for Instrument Valves
SP-131-2004	Metallic Manually Operated Gas Distribution Valves
SP-132-2004	Compression Packing Systems for Instrument Valves
SP-133-2005	Excess Flow Valves for Low Pressure Fuel Gas Appliances
SP-134-2006a	Valves for Cryogenic Service Including Requirements for Body/Bonnet Extensions
SP-135-2006	High Pressure Steel Knife Gate Valves

(R-YEAR) 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 Practices in such cases.

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