SYM	ZONE	DESCRIPTION	DATE	APPROVED
2		**DIRECT DRAWING CHANGE** REVISE TABLE 1 – UNDER COLUMN NOTED GRADE A, REVISED GRADE B TO GRADE C. ADD NEW REQUIREMENTS TO SECTION E, WHICH DELETED RADIOGRAPHIC REQUIREMENTS FOR CERTAIN AUSTENTIC STAINLESS STEEL COMPONENTS. ADD FLAGNOTE 1 TO SHT. 8. REVISED TABLE 2 AND 3, CHANGED LEVELS. CHANGED GRADE FROM B TO A IN PARAGRAPH 3c. SCD REVISED AND REDRAWN IN ITS ENTIRETY PER FSR J1DOGPW311.		
1		**DIRECT DRAWING CHANGE** COMPLETELY REVISED & REWRITTEN IN ITS ENTIRETY, SEE REVISION N/C FOR PREVIOUS INFORMATION. REVISED PER FSR J1DOGPW238 RM 10-5-92	11-24-92	ISSUED/CEF 11-30-92 S.D.M.
		THIS DWG. SUPERSEDES MT SPEC-SC-A.		

REVISIONS

	SIGNATURE	DATE
DRAWN	KARL SWANSON	10-23-87
CHECKED	D.A. CARRECA	10-24-87
ENGINEER	D.A. DECERBO	10-24-87
ISSUED	CEF	1-8-88
SUBMITTED	SWAIN	11-9-87
DATA SHEET		
APPROVED	R.G. SMITH	1-5-88
USED ON	54000-C001 SH G1	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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CASTINGS, STEEL QUALITY AND INSPECTION REQUIREMENTS

SIZE B | DWG. NO. 54000-GC10 | REV. 2

AUTHORITY NASW-410 MODE MSFC-1 AMEND. 90 | SHEET 1 OF 8

CADD CONTROLLED DRAWING
CADD P/N: SCD/54000/GC10R2/SHT1

1. SCOPE

SPECIFIED HEREIN ARE THE QUALITY AND INSPECTION, REQUIREMENTS FOR STEEL CASTINGS FOR VALVES, FITTINGS, AND OTHER PIPING COMPONENTS, WHICH ARE SUPPLEMENTARY TO THE BASIC COMPONENT SPECIFICATION WHEN SO INDICATED BY REFERENCE.

2. REFERENCE DOCUMENTATION

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM E709	MAGNETIC PARTICLE EXAMINATION, PRACTICE FOR
ASTM E446	STANDARD REFERENCE RADIOGRAPHS FOR STEEL CASTINGS UP TO 2 INCHES IN THICKNESS.
ASTM E186	STANDARD REFERENCE RADIOGRAPHS FOR HEAVY WALLED (2 TO 4 1/2 INCH) STEEL CASTINGS
ASTM E165	LIQUID PENETRANT INSPECTION METHOD, STANDARD TEST METHOD FOR
ASTM E94	RADIOGRAPHIC TESTING, STANDARD GUIDE FOR
ASTM E142	CONTROLLING QUALITY OF RADIOGRAPHIC TESTING, STANDARD METHOD FOR

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY, INC.

MSS SP-55	QUALITY STANDARD FOR STEEL CASTINGS FOR VALVE, FLANGES AND FITTING AND OTHER PIPING COMPONENTS, VISUAL METHOD.
MSS SP-54	QUALITY STANDARD FOR STEEL CASTINGS FOR VALVES, FLANGES AND FITTINGS AND OTHER PIPING COMPONENTS, RADIOGRAPHIC EXAMINATION METHOD

THE LATEST REVISION OF THE ABOVE NOTED DOCUMENTATION SHALL APPLY FOR NEW PROCUREMENTS.

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CASTINGS, STEEL QUALITY AND INSPECTION REQUIREMENTS

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CADD CONTROLLED DRAWING
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3. GENERAL REQUIREMENTS

THE QUALITY OF THE STEEL CASTINGS PROVIDED UNDER THIS SPECIFICATION SHALL BE DETERMINED BY VISUAL, MAGNETIC PARTICLE, LIQUID PENETRANT AND RADIOGRAPHIC INSPECTION. THE MINIMUM ACCEPTABLE QUALITY REQUIREMENTS FOR THESE INSPECTION METHODS ARE LISTED BELOW. WHEN THESE METHODS YIELD CONFLICTING OR CONTRARY INDICATIONS AS TO THE SEVERITY OF A DEFECT. THE INDICATION WHICH WILL PROVIDE THE BEST QUALITY CASTING WILL GOVERN THE ACCEPTANCE AND/OR DISPOSITION OF THE CASTING IN QUESTION.

A) INTERNAL SURFACE REQUIREMENTS

THE INTERNAL SURFACES OF THE CASTINGS, THAT CAN BE EXPOSED TO THE SERVICES NOTED BELOW, SHALL HAVE NO TRACES OF VOIDS, PITS OR ANY OTHER SURFACE IRREGULATIES WHICH CAN BE A SOURCE OF TRAPPED CONTAMINATES OR PARTICLES. THESE AREAS SHALL BE REMOVED PER PARAGRAPH F.

THE SERVICES WHICH APPLY ARE:

1) LIQUID & GASEOUS OXYGEN
2) LIQUID & GASEOUS NITROGEN
3) LIQUID & GASEOUS HYDROGEN
4) HELIUM
5) AIR
6) HYDRAULIC

THE SERVICE(S) WHICH APPLY TO A PARTICULAR PROCUREMENT WILL BE NOTED IN THE BASIC COMPONENT SPECIFICATION.

B) VISUAL INSPECTION

ALL EXTERNAL AND INTERNAL SURFACES OF EACH CASTING SHALL BE VISUALLY INSPECTED. THE CASTING SHALL BE ACCEPTABLE ON THE BASIS OF A COMPARISON OF ANY SURFACE DEFECT OR IRREGULARITY WITH THE APPROPRIATE DEFECT OR IRREGULARITY AS SHOWN IN THE REFERENCE PHOTOGRAPHS OF MSS SP-55. THE CASTING SHALL MEET THE ACCEPTANCE CRITERIA OF MSS SP-55. ALL INDICATIONS THAT ARE NOT ACCEPTABLE SHALL BE REMOVED PER PARAGRAPH F.

C) MAGNETIC PARTICLE INSPECTION

ALL SURFACES OF FERRO-MAGNETIC CASTINGS SHALL BE SUBJECTED TO A MAGNETIC PARTICLE EXAMINATION IN ACCORDANCE WITH ASTM E709. INDICATIONS EXCEEDING THOSE INDICATED IN TABLE 1, SHALL BE REMOVED PER, PARAGRAPH F. IF NO GRADE IS NOTED ON THE APPLICABLE PURCHASE ORDER, THEN GRADE A SHALL APPLY.

TABLE 1

MAXIMUM ALLOWABLE DISCONTINUITY SIZES (IN INCHES) AND DISTRIBUTION

TYPE DISCONTINUITY	LOCATION	GRADE A	GRADE B	GRADE C	GRADE D	GRADE E *****
NONMETALIC INCLUSION, ROUNDED:	SURFACE	SEE PARA 3A	0.031 DIA. D-3*	0.047 DIA. D-3*	0.063 DIA. D-3*	0.125 DIA. D-2*
	**** SUBSURFACE	GRADE C	0.047 DIA. D-3*	0.063 DIA. D-3*	0.094 DIA. D-3*	N/A
GAS HOLE POROSITY/DISCRETE SHRINKAGE CAVITIES	SURFACE	SEE PARA 3A	0.031 DIA. D-3**	0.047 DIA. D-3**	0.063 DIA. D-3**	0.125**,*** D-2*
	**** SUBSURFACE	GRADE C	0.047 DIA. D-3**	0.063 DIA. D-3**	0.094 DIA. D-3**	N/A
CRACKS, HOT TEARS, OR COLD SHUTS	SURFACE	0	0	0	0	0.25 LONG ***
	**** SUBSURFACE	0	0	0	0	0.25 LONG ***
SHRINKAGE SPONGE AREAS (MAY INCLUDE SMALL CAVITIES, CAVITY STRINGERS)	SURFACE	SEE PARA 3A	0.250	0.375	0.625	1.25 DIA ***
	**** SUBSURFACE	GRADE C	0.250	0.375	0.625	1.25 DIA ***
MICROSHRINKAGE (MICRO-POROSITY) MAXIMUM CLUSTER DIAMETER	SURFACE	SEE PARA 3A	0.063 D-3*	0.188 D-3*	0.313 D-3*	0.375 D-3*
	**** SUBSURFACE	GRADE C	0.063 D-3*	0.188 D-3*	0.313 D-3*	0.375 D-3*
ALLOY OR METALLIC PHASE SEGREGATION	SURFACE	SEE PARA 3A	0.125	0.375	1.5	1.5
	**** SUBSURFACE	GRADE C	0.25	0.5	1.5	1.5

* DISTRIBUTION DESIGNATIONS SIGNIFY THE FOLLOWING:

D-2 DISCONTINUITIES NO CLOSER TO EACH OTHER THAN TWO TIMES THE MAX. SIZE

D-3 DISCONTINUITIES NO CLOSER TO EACH OTHER THAN THREE TIMES THE MAXIMUM SIZE

** THE LIMITS FOR GAS HOLE POROSITY FOR THE INDIVIDUAL GRADES DO NOT APPLY IF THE VOIDS ARE LESS THAN ONE HALF THE MAXIMUM SIZES SPECIFIED AND ARE WELL DISPERSED.

*** SHRINKAGE DISCONTINUITIES ARE NOT ALLOWED IF WITHIN 0.5 INCH OF AN OUTER EDGE OF A CASTING SECTION.

**** MAGNETIC PARTICLE INSPECTION ONLY.

***** PENETRANT INSPECTION ONLY.

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D) LIQUID PENETRANT INDICATIONS

FOR NON-MAGNETIC MATERIALS, LIQUID PENETRANT METHODS SHALL BE USED TO DETECT SURFACE DISCONTINUTIES. THESE METHODS SHALL BE IN ACCORDANCE WITH ASTM E 165. TABLE I IS TO BE USED TO DETERMINE IF AN INDICATION IS UNACCEPTABLE. ANY INDICATION NOT ACCEPTABLE SHALL BE REMOVED PER PARAGRAPH F. IF NO GRADE IS NOTED ON THE APPLICABLE PURCHASE ORDER, THEN GRADE A SHALL APPLY. LIQUID PENETRANT EXAMINATION IS NOT REQUIRED FOR COMPONENTS MADE UP OF AUSTENTIC STAINLESS STEELS WHICH MEET ASTM STANDARDS.

E) RADIOGRAPHIC INSPECTION 1

RADIOGRAPHIC EXAMINATION IS NOT REQUIRED FOR COMPONENTS WHICH MEET THE FOLLOWING CRITERIA:

1) THE COMPONENT SHALL HAVE AN ASME CODE STAMP (APPLICABLE TO RELIEF VALVES ONLY)
2) MATERIAL OF CONSTRUCTION SHALL BE AUSTENTIC STAINLESS STEEL TO ASTM STANDARDS.
3) THE MANUFACTURER SHALL DEMONSTRATE THAT AN ACCEPTABLE ATTRIBUTE SAMPLING PROCEDURE IS IN PLACE FOR EXAMINING CASTINGS BY RADIOGRAPHIC EXAMINATION. THIS PROCEDURE MUST BE APPROVED BY NASA OR BY NASA'S REPRESENTATIVE.

CASTINGS FABRICATED FROM MATERIAL OTHER THAN AUSTENIC STAINLESS STEEL SHALL BE SUBJECTED TO A RADIOGRAPHIC EXAMINATION IN ACCORDANCE WITH ASTM E 94. AREAS OF THE CASTING TO BE RADIOGRAPHED SHALL BE IN ACCORDANCE WITH MSS SP-54, PARAGRAPH 4.1. THE TYPES AND DEGREES OF DEFECTS SHALL BE DETERMINED BY ASTM E 446 (UP TO 2 INCHES IN THICKNESS) AND ASTM E 186 (2 TO 4 1/2 INCHES). THE BEST PRACTICES AS STIPULATED IN ASTM E142 SHALL BE FOLLOWED TO CONTROL THE QUALITY OF THE RADIOGRAPHIC IMAGES. ACCEPTANCE CRITERIA FOR CASTINGS SHALL BE PER MSS SP-54. INDICATIONS EXCEEDING THOSE GIVEN ON TABLE 2 AND TABLE 3 SHALL BE REMOVED PER PARAGRAPH F.

TABLE 2

WALL THICKNESS LESS THAN 2 IN. (51 MM). THE FOLLOWING COMPARATIVE PLATES OF ASTM E446 DEFINE ACCEPTABLE INDICATIONS:

DISCONTINUITY TYPE	CATEGORY	ACCEPTABLE COMPARATIVE PLATES ASTM E446
GAS	A	LEVEL 2
SAND	B	LEVEL 2
SHRINK	CA	LEVEL 2
SHRINK	CB	LEVEL 3
SHRINK	CC	LEVEL 3
SHRINK	CD	LEVEL 3
HOT TEARS & CRACKS	D & E	NONE
INSERTS (CHILLS, CHAPLETS)	F	NONE
MOTTLING	G	REFERENCE ONLY

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CASTINGS, STEEL QUALITY AND INSPECTION REQUIREMENTS

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TABLE 3

WALL THICKNESS FROM 2 IN. UP TO 4 1/2 IN. (51 MM UP TO 114 MM).

THE FOLLOWING COMPARATIVE PLATES OF ASTM E186 DEFINE ACCEPTABLE INDICATIONS:

DISCONTINUITY TYPE	CATEGORY	ACCEPTABLE COMPARATIVE PLATES ASTM E186
GAS POROSITY	A	LEVEL 3
SAND AND SLAG INCLUSIONS	B	LEVEL 3
SHRINK	CA	LEVEL 3
SHRINK	CB	LEVEL 3
SHRINK	CC	LEVEL 3
CRACKS	D	NONE
HOT TEARS	E	NONE
INSERTS	F	NONE

F) (1) DISCONTINUITIES IN EXCESS OF THOSE REPRESENTED BY ACCEPTABLE INDICATIONS SHALL BE REMOVED BY SUITABLE MEANS. IF REMOVAL OF SURFACE DISCONTINUITIES TO ACCEPTABLE LEVEL DOES NOT RESULT IN REDUCING WALL THICKNESS BELOW ACCEPTABLE MINIMUM, THE AREA SHALL BE BLENDED SMOOTHLY INTO SURROUNDING SURFACE. WHERE REMOVAL OF DISCONTINUITIES RESULTS IN A WALL THICKNESS BELOW ACCEPTABLE MINIMUM, THE RESULTANT CAVITY MAY BE REPAIRED BY WELDING. WELDED AREAS SHALL BE BLENDED SMOOTHLY INTO SURROUNDING SURFACE.

(2) AREAS WHICH HAVE BEEN WELD REPAIRED OR FROM WHICH DISCONTINUTIES HAVE BEEN REMOVED WITHOUT REQUIREMENT FOR WELD REPAIR AS A RESULT OF THE INSPECTION SHALL BE RE-EXAMINED BY THE SAME INSPECTION METHOD WHICH DETECTED THE DEFECT(S). THE SAME ACCEPTANCE STANDARDS SHALL APPLY TO THE RE-EXAMINATION.

(3) ACCEPTANCE STANDARDS FOR POROSITY AND SLAG INCLUSIONS IN WELDS SHALL BE IN ACCORDANCE WITH UW-51, ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII, DIVISION 1.

G) GENERAL

(1) VENDOR'S RESPONSIBILITY. THE VARIOUS INSPECTIONS OF STEEL CASTINGS AS STIPULATED HEREIN SHALL BE THE RESPONSIBILITY OF THE VENDOR. HOWEVER, IT IS NOT THE INTENT OF THIS SPECIFICATION TO EXCLUDE THE USE OR APPLICATION OF ANY OTHER INSPECTION PROCEDURES OR TECHNIQUES, NOT SPECIFIED HEREIN, THAT MAY BE NECESSARY OR DESIRABLE IN ESTABLISHING THE SOUNDNESS AND SERVICABLITY OF ANY CASTING PROVIDED HEREUNDER. ALL COST ASSOCIATED WITH THE INSPECTIONS SHALL BE BORNE BY THE VENDOR AND BE INCLUDED IN THE BID OR CONTRACT PRICE OF THE COMPONENT.

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(2) PURCHASER SURVEILLANCE. THE PURCHASER, OR PURCHASER'S AUTHORIZED REPRESENTATIVE, SHALL HAVE ACCESS TO WITNESS ALL PHASES OF THE INSPECTIONS AND SHALL HAVE A RIGHT TO ALL DATA AND RESULTS OF SUCH INSPECTIONS. THESE DATA AND RESULTS MUST BE MADE AVAILABLE TO THE PURCHASER IMMEDIATELY UPON COMPLETION OR TERMINATION OF ANY INSPECTION PROCEDURE. X-RAY FILMS AND ALL PERTINENT DATA RELATING TO THEIR INTERPRETATION SHALL BE TRANSFERRED TO AND BECOME THE PROPERTY OF THE PURCHASER.

IF THE PURCHASER OR HIS AUTHORIZED REPRESENTATIVE HAS REASON TO BELIEVE THAT THE REQUIREMENTS OF THIS SPECIFICATION ARE NOT BEING MET, HE (THE PURCHASER OR HIS AUTHORIZED REPRESENTATIVE) CAN SUSPEND THE USE OF ANY QUESTIONABLE MATERIAL, EQUIPMENT, PROCEDURES, PERSONNEL, ETC., ON WORK COVERED BY THIS SPECIFICATION UNTIL COMPLIANCE WITH THE REQUIREMENTS OF THIS SPECIFICATION IS JUDGED SATISFACTORY.

(3) POINT OF INSPECTION. THE CASTINGS ARE TO BE SUBJECTED TO THE INSPECTIONS AS OUTLINED HEREIN UPON RECEIPT FROM THE FOUNDRY, OR PRIOR TO ANY FINISHED MACHINING OPERATIONS. INSPECTION OF THE CASTING AT THIS POINT DOES NOT RELIEVE THE VENDOR OF THE RESPONSIBILITY OF PROVIDING A COMPONENT THAT SATIFIES THE INTENT AND REQUIREMENTS OF THE BASIC COMPONENT SPECIFICATION.

H) REPAIR BY WELDING

1) REPAIRS OF DEFECTS BY WELDING SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS STIPULATED IN THE BASIC ASTM CASTING SPECIFICATION, EXCEPT THAT ALL WELDING SHALL BE PERFORMED USING A WELDING PROCEDURE QUALIFIED IN ACCORDANCE WITH SECTION IX, ASME BOILER AND PRESSURE CODE. THE PROCEDURE QUALIFICATION SHALL BE PERFORMED ON TEST SPECIMEN OF CAST MATERIAL OF THE SAME SPECIFICATION AND SUBJECTED TO THE HEAT-TREATMENT BEFORE AND AFTER WELDING AS WILL BE APPLIED TO THE WORK. ALL WELDERS AND OPERATORS PERFORMING THIS WELDING SHALL ALSO BE QUALIFIED IN ACCORDANCE WITH SECTION IX.
2) WHEN REPAIR WELDING IS DONE AFTER HEAT TREATMENT OF THE CASTING. THE CASTING SHALL BE POSTWELD HEAT TREATED.

I) FREQUENCY OF INSPECTION

A) ALL CASTINGS SHALL BE INSPECTED IF GRADE A OR B OF TABLE I APPLIES TO THE COMPONENT'S PROCUREMENT.

B) WHERE MORE THAN ONE CASTING OF A PARTICULAR DESIGN IS PRODUCED, EACH OF THE FIRST FIVE CASTINGS SHALL BE INSPECTED AS OUTLINED HEREIN. WHERE MORE THAN FIVE CASTINGS ARE BEING PRODUCED, THE EXAMINATION SHALL BE PERFORMED ON THE FIRST FIVE, PLUS ONE ADDITIONAL CASTING TO REPRESENT EACH FIVE ADDITIONAL CASTINGS. IF THIS ADDITIONAL CASTING PROVES TO BE UNACCEPTABLE, EACH OF THE REMAINING FOUR CASTINGS IN THE GROUP SHALL BE INSPECTED.

J) IDENTIFICATION AND MARKING

EACH CASTING SHALL BE MARKED WITH THE MANUFACTURER'S NAME AND CASTING IDENTIFICATION, INCLUDING MATERIAL DESIGNATION.

J) RECORDS

THE MANUFACTURER SHALL MAINTAIN A QUALITY CONTROL SYSTEM ADEQUATE TO ASSURE THE PURCHASER OR HIS AUTHORIZED REPRESENTATIVE THAT ALL OF THE REQUIREMENTS OF THIS SPECIFICATION HAVE BEEN AND ARE CONTINUOUSLY BEING MET. THE QUALITY CONTROL SYSTEM SHALL INCLUDE PREPARING AND MAINTAINING WRITTEN RECORDS OF AT LEAST THE FOLLOWING LISTED ITEMS AS REQUIRED BY THIS SPECIFICATION FOR EACH CASTING PRODUCED.

a. CHEMICAL ANALYSIS
b. TENSILE PROPERTIES
c. HEAT TREATMENT
d. VISUAL AND DIMENSIONAL INSPECTION RESULTS
e. RADIOGRAPHIC, MAGNETIC PARTICLE, LIQUID PENETRANT AND INSPECTION RESULTS
f. REPAIR WELDING
g. IMPACT PROPERTIES IF IMPACT TESTING IS REQUIRED
h. RADIOGRAPHIC FILM & RECORD SHEETS ARE TO BE SUBMITTED TO THE PURCHASER PRIOR TO SHIPMENT OR TO BE INCLUDED WITH SHIPMENT OF EQUIPMENT

J) NOTES

1 RADIOGRAPHIC REQUIREMENTS REVISED PER NASA'S LETTER "MEMORANDUM FOR RECORD" ISSUED AS AN ATTACHMENT TO SSC REPORT #4522-93-004.

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CASTINGS, STEEL
QUALITY AND INSPECTION
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