

# INDEX FOR STAMPING DIES CAST MATERIALS

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# GENERAL INFORMATION

GLOBAL STANDARD COMPONENTS



Stamping

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## 1. SCOPE

This specification encompasses criteria for stamping dies cast materials delivered in the rough-cast condition.

### 1.1 TYPES

This specification covers ferrous casting materials used for stamping dies. These materials include: G2500/NAAMS, G25HP/NAAMS, G3500/NAAMS, D4512/NAAMS, D5506/NAAMS, D6510/NAAMS, S0030/NAAMS, S0050A/NAAMS, S7140/NAAMS, S2333/NAAMS, TA2/NAAMS, TD2/NAAMS, and TS7/NAAMS. This specification does not include or cover wrought materials.

### 1.2 PROPERTIES

The properties of all castings are sensitive to section size, particularly the properties of gray and ductile irons. Since the cooling rate varies with thickness, the microstructure and properties will vary with thickness as well. Therefore, all properties must be referenced to specific test methods and test sample locations.

### 1.3 APPLICATIONS

The application of these materials is automotive stamping dies.

### 1.4 MATERIAL DESCRIPTIONS

Brief descriptions are listed below for the materials covered in this specification.

- G2500/NAAMS: Non-Alloyed Gray Cast Iron (not surface hardenable)
- G25HP NAAMS: High Pearlite Low-Alloyed Gray Cast Iron
- G3500/NAAMS: Alloyed Gray Cast Iron (surface hardenable)
- D4512/NAAMS: Non-Alloyed Ferritic Ductile Iron (not surface hardenable)
- D6510/NAAMS: Refined Alloyed Pearlitic Ductile Iron (surface hardenable)
- S0030/NAAMS: Non-Alloyed Steel (not surface hardenable)
- S0050A/NAAMS: Alloyed Steel (surface hardenable)
- S2333/NAAMS: Alloyed Steel (surface or through hardenable)
- S7140/NAAMS: Alloyed Steel (surface hardenable)
- TA2/NAAMS: Medium Shock/Medium Wear Resistant Tool Steel
- TD2/NAAMS: High Wear/Low Shock Resistant Tool Steel
- TS7/NAAMS: High Shock/Low Wear Resistant Tool Steel

The prefix on each alloy designation indicates the type of alloy as listed below.

- G Gray Iron
- D Ductile (Nodular) Iron
- S Steel
- T Tool Steel

### 1.5 SAFETY-HAZARDOUS MATERIALS

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials or procedures, this specification does not address those hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials or process and to take any necessary precautionary measures to ensure the health and safety of all personnel involved.

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## 2. TEST PROCEDURES

### 2.1 COMPOSITION

Chemical analysis of cast iron shall be made from chilled samples only. Cast iron chemical analysis shall be determined according to appropriate Standard Test Methods included in Volumes 03.05 and 03.06 of the Annual Book of ASTM Standards. The preferred method for carbon and sulfur determination is according to ASTM E 1019. If alloys are added by inoculation, after taking the chilled sample, calculated recovery amounts shall be noted and added to the analysis. Chemistry checks for steel shall be determined by emission spectroscopy or wet method for all elements according to ASTM A751.

### 2.2 MICROSTRUCTURE

#### 2.2.1 CAST IRON

The microstructure for cast iron, except for G2500/NAAMS, shall be determined using the casting coupon shown in Figure 1. This coupon may be attached to the casting on or close to a working surface, or may be located on a representative section of the casting.

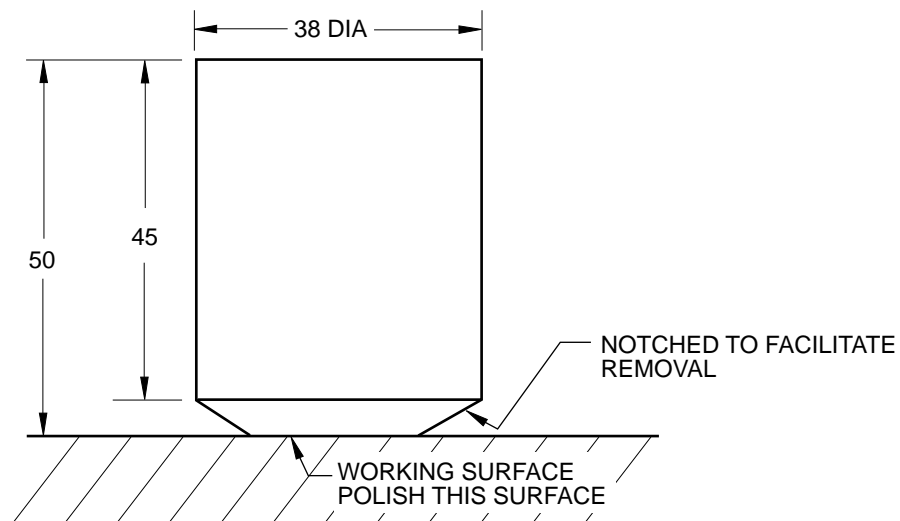


Figure 1 Typical Casting coupon showing location of surface for microstructure analysis.

The microstructure shall be determined in the center of the smaller diameter cross-section.

If required, the microstructure for G2500/NAAMS can be checked using a small representative section from the casting.

Metallographic preparation shall be done according to ASTM E 3. The graphite characteristics shall be determined by ASTM A 247. The matrix microstructure shall be evaluated by quantitative image analysis. If such equipment is unavailable, it is acceptable to use a visual comparison with the Gray Iron or Ductile Iron Microstructures Rating Chart at 100x. These charts are available in poster form from the AFS (American Foundry Society, Inc).

## 2.2.2 CAST STEEL

Microstructures of steel castings may be determined from small samples taken on or close to the working surface of the die.

Grain size is to be determined according to ASTM E 112.

## 2.3 HARDNESS

Hardness shall be measured on the casting or on the working surface of the coupon shown in Figure 1. The surface to be checked shall be flat and free of any porosity, inclusions, and decarburization. A minimum of 3.0 mm is to be ground or machined from the casting surface prior to hardness checking. Care must be taken not to burn the surface and cause hairline crack.

All hardness measuring equipment shall be checked using standard blocks and/or calibrated according to the manufacturer's recommended procedures prior to making any hardness checks.

The Brinell hardness test is the preferred method for as-cast samples, performed according to ASTM specification E 10 or E 110 at a load of 3000 kg.

The Rockwell hardness test is the preferred method for hardened samples, performed according to ASTM specification E 18 or E 118.

Electronic rebound type testers providing a digital readout in Brinell are acceptable. A minimum of three (3) hardness measurements shall be made for each area checked.

If there is any discrepancy or question of conformance, the Brinell or Rockwell test, as described above, shall be the arbiter.

## 2.4 TENSILE TESTING

Standard tensile testing may be done to determine tensile strength, yield strength, and elongation.

Samples for gray iron shall come from a separately cast type C test bar in accordance with ASTM A 48.

Samples for ductile iron shall come from 75 mm Y blocks in accordance with ASTM A 536. As an alternative, samples for ductile iron may come from "cast on" 25 mm keel blocks per Figure 2. Samples for steel shall come from keel blocks in accordance with ASTM A781.

Sample preparation and subsequent testing shall be in accordance with ASTM E8 for Iron and ASTM A370 for Steel.

The presence of porosity, shrink, inclusions, or other discontinuities within the fracture area invalidates the test, and the data must be discarded.

The viewing of such discontinuities shall be done without the use of any magnifying device.

# GENERAL INFORMATION

SPECIAL NOTE:  
BOTH LEGS CAN BE CUT FROM  
THE KEEL BLOCK AND USED  
FOR TENSILE TEST BARS

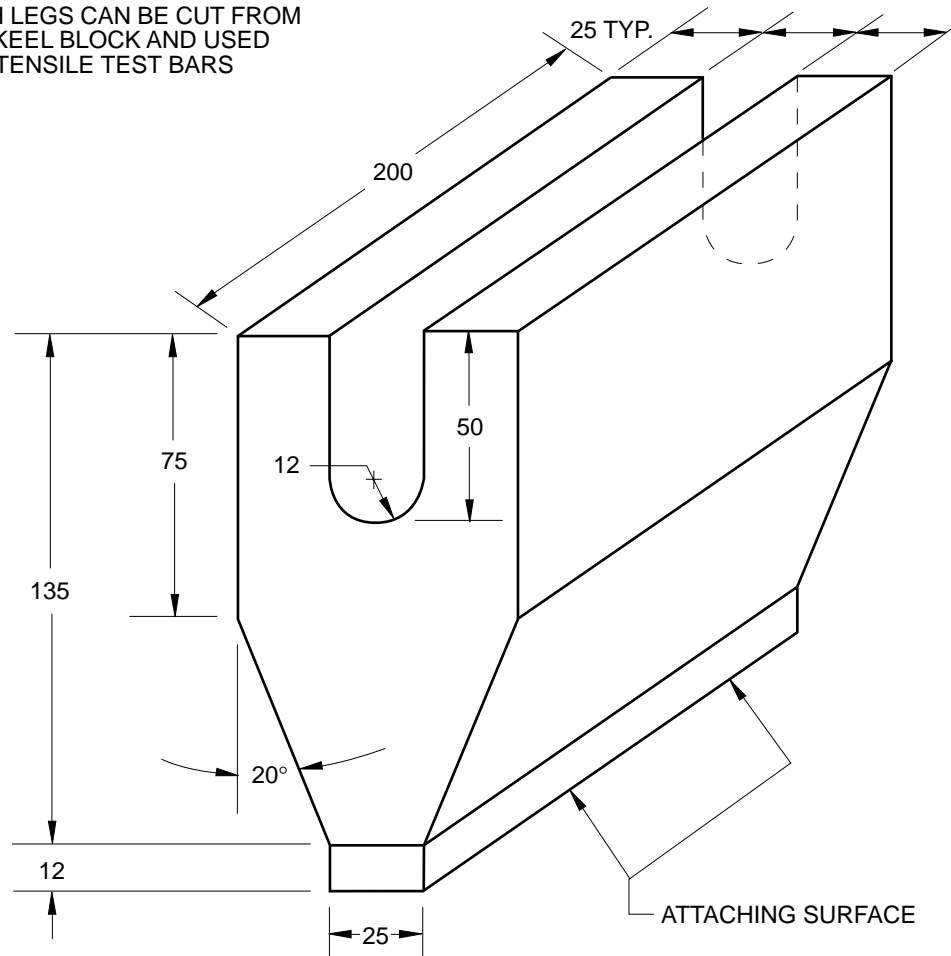


Figure 2 Cast-On Keel Block

## 3. MECHANICAL PROPERTIES

### 3.1 GENERAL

The microstructure and mechanical properties, specifically hardness and strength, are the primary requirements for grading and classifying the castings in this specification.

Samples shall be retained by the foundry for 5 years to enable analysis of microstructure and mechanical properties when required. All mechanical properties shall meet or exceed the minimum product requirements.

### 3.2 COMPOSITION

The composition ranges are given in Table 1. Composition shall be measured as described in Section 2.1.

### 3.3 MICROSTRUCTURE

The microstructure requirements are given in Tables 2a and 2b. Microstructures are to be determined as described in Sections 2.2 and 3.1.

### 3.4 MECHANICAL PROPERTIES

The mechanical properties are given in Table 3.

Casting hardness shall be measured as described in Section 2.3.

Strength and elongation shall be measured as described in Section 2.4.

Note: the tensile properties are from the type C test bar, Y block, or keel block only. Sections taken from the die itself may not meet the specification for tensile properties due to variations caused by changes in section thickness.

# GENERAL INFORMATION

Table 1  
Composition Requirements (Weight Percent)\*

Material #/NAAMS	C	Si	Mn	Cr	Mo	Ni	Cu	V	S (max)	P (max)
G2500	2.9-3.5	1.9-2.3	0.5-0.9	0.25 max					0.20	0.20
G25HP	3.0-3.4	1.4-2.0	0.5-1.0	0.50 max			0.7 max		0.12	0.12
G3500	2.8-3.2	1.5-2.2	0.7-1.0	0.35-0.50	0.35-0.50		0.7 max		0.15	0.15
D4512	3.25-3.75	2.25-2.60	0.2-0.5	0.25 max		0.5-1.0			0.015	0.080
D6510**	3.0-3.8	2.0-2.4	0.3-0.6	0.12 max	0.35-0.50	0.5-1.5	0.35-1.0		0.012	0.05
S0030	0.20-0.30	0.3-0.5	0.5-0.7						0.05	0.045
S0050A	0.4-0.5	0.2-0.5	0.9-1.2	0.8-1.1	0.35-0.50			0.15 max	0.05	0.045
S2333	0.56-0.64	0.20-0.50	0.70-0.90	4.30-4.70	0.40-0.60			0.20-0.30	0.035	0.035
S7140	0.45-0.50	0.40-0.80	0.80-1.00	1.30-1.70					0.035	0.035
TA2	0.85-1.05	0.25-0.40	0.5-0.7	4.75-5.25	0.95-1.2			0.2-0.4	0.03	0.03
TD2	1.4-1.6	1.50 max	1.00 max	11.0-13.0	0.70-1.20			1.00 max	0.03	0.03
TS7	0.45-0.55	0.20-1.00	0.20-0.80	3.00-3.50	1.30-1.80			0.20-0.30	0.03	0.03

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\*Trace amounts shall be limited to standard practice, so that there are no detrimental microstructure or mechanical property effects.

\*\*Magnesium composition for D6510 is 0.040-0.060

# GENERAL INFORMATION

Table 2a  
 Cast Iron Microstructure Specifications

Material #/NAAMS	Graphite Type	Flake Size or Nodule Count	Nodularity (min)	Pearlite*	Ferrite*	Carbide* (max)
G2500	Type A	4-6	n/a	50% min	45% max	5%
G25HP	Type A	4-7	n/a	75% min	10% max	5%
G3500	Type A	4-6	n/a	87% min	10% max	3%
D4512	I & II	50/mm <sup>2</sup> min	85%	10% max	87% min	3%
D6510	I & II	100/mm <sup>2</sup> min	90%	70-80%	20-30%	0.5%

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\* Note that the pearlite, ferrite, and carbide contents add up to 100% for the matrix microstructure. Microstructure results are for approved test bars as specified in Section 2.4. Actual casting microstructure may vary as previously described in Section 1.2.

Table 2b  
 Steel Microstructure Specifications (annealed)

Material #/NAAMS	ASTM Grain Size	Microstructure (100x)	% Carbide	Other
S0030	Not Specified	Homogenous mixture of ferrite and pearlite	3% max	No dendritic structure
S0050A	#5 or finer	Homogenous mixture of pearlite and ferrite	5% max	
S7140	#5 or finer	Homogenous mixture of pearlite and ferrite and no dendritic structure	5% max	
S2333	#5 or finer	Homogenous mixture of pearlite and ferrite and no dendritic structure	5% max	
TA2	Not Specified	Homogenous mixture of pearlite and ferrite	Not Specified	
TD2	Not Specified	Homogenous mixture of pearlite and ferrite	Not Specified	
TS7	Not Specified	Homogenous mixture of pearlite and ferrite	Not Specified	

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# GENERAL INFORMATION

GLOBAL STANDARD COMPONENTS



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**Table 3**  
**Mechanical Property Requirements As Shipped From Foundry**

Material #/NAAMS	Brinell Hardness Number	Test Bar Minimum Tensile Strength (MPa)*	Test Bar Minimum Yield Strength (MPa)*	Test Bar Minimum Elongation (%)
G2500	163 - 212	205	N/A	N/A
G25HP	175 - 235	280	N/A	N/A
G3500	197 - 241	310	N/A	N/A
D4512	143 - 190	415	310	12
D6510	190 - 248	570	350	4
S0030	120 - 170	450	240	24
S0050A	170 - 229	585	310	16
S2333	190 - 230	700	330	7
S7140	190 - 230	600	450	10
TA2	201 - 229	Not specified	Not specified	Not specified
TD2	217 - 255	Not specified	Not specified	Not specified
TS7	187 - 223	Not specified	Not specified	Not specified

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\* To convert to ksi multiply MPa by 0.145

### 3.5 SURFACE QUALITY

All as-cast surfaces shall meet specified criteria for discontinuities. Acceptance criteria shall be based on ASTM A802 for steel and ASTM A834 for iron. Acceptance levels utilize SCRATA (Steel Casting Research And Trade Association) graded reference comparators. Acceptance levels shall be as follows:

Category	Plate No.
(A) Surface Texture (cold shuts, cracks, sand burn in)	[A3]
(B) Nonmetallic Inclusions	[B4]
(C) Gas Porosity	[C3]
(D) Fusion Discontinuities	[D2]
(E) Expansion Discontinuities (scabs)	[E3]
(G) Metal Removal Marks – Thermal (riser/gates)	[G3]
(H) Metal Removal Marks – Mechanical	[H4]
(J) Weld	[J3]

### 4. HEAT TREATMENT

It is mandatory that all castings requiring furnace stress relief and annealing be processed as specified for each individual alloy.

It is the suppliers responsibility to assure that hardnesses and microstructures, for all cast materials, conform to those specified in Tables 2a, 2b, and 3.

5. IDENTIFICATION

Each casting shall be identified with the NAAMS material number as listed in Section 1.4.

6. INSPECTION AND REJECTION

The purchaser reserves the right to sample incoming shipments, even though it is the responsibility of the supplier to meet the requirements without dependence upon the purchaser's inspection. Frequency of testing is to be agreed upon between the purchaser and the supplier.

6.1 COMPOSITION

The purchaser reserves the right to reject any casting if the value of any element falls outside the limits listed in Table 1. However, since microstructure and mechanical properties are the primary requirements for this specification, as stated in Section 3.1, their conformance shall be a consideration in any out-of-specification situation.

6.2 MICROSTRUCTURE

The purchaser reserves the right to reject any casting if the microstructure does not meet the requirements listed in Tables 2a and 2b.  
The microstructure shall be determined as described in Sections 2.2 and 3.1.

6.3 HARDNESS

For large casting with multiple hardness checks, the purchaser reserves the right to reject any casting if more than 20% of the hardness measurements taken fall outside the hardness limits listed in Table 3. Hardness shall be measured as described in Section 2.3.

6.4 MECHANICAL PROPERTIES

The purchaser reserves the right to reject any casting, if the tensile sample representative of the casting exhibits a tensile strength, yield strength, or elongation below the values listed in Table 3. Mechanical properties shall be measured as described in Section 2.4.

6.5 SURFACE QUALITY

The purchaser reserves the right to reject a casting that exhibits a surface discontinuity as described and referenced in Section 3.5

7. ORIGIN

This standard was originated by the Auto/Steel Partnership's NAAMS Die Materials Subcommittee, November, 2002.

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# NON-ALLOYED GRAY CAST IRON (G2500/NAAMS)

GLOBAL STANDARD COMPONENTS



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A

## 1. MECHANICAL PROPERTIES

Hardness: 163-212 HBW  
Minimum Tensile Strength: 205 MPa

## 2. MICROSTRUCTURE (100X)

Flake Type:	Type A 70% min	Pearlite:	50% min
Flake Size:	4-6	Ferrite:	45% max
		Carbide:	5% max

## 3. COMPOSITION (in weight %)\*

Carbon (C)	2.9-3.5	Chromium (Cr)	0.25 max
Silicon (Si)	1.9-2.3	Sulfur (S)	0.20 max
Manganese (Mn)	0.5-0.9	Phosphorus (P)	0.20 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

No heat treatment required for G2500/NAAMS castings.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

# LOW-ALLOYED GRAY CAST IRON (G25HP/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

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## 1. MECHANICAL PROPERTIES

Hardness: 175-235 HBW  
Minimum Tensile Strength: 280 MPa

## 2. MICROSTRUCTURE (100X)

Pearlite: 75% min  
Carbide: 5% max

## 3. COMPOSITION (in weight %)\*

Carbon (C)	3.0-3.4	Copper (Cu)	0.7 max
Silicon (Si)	1.40-2.00	Sulfur (S)	0.12 max
Manganese (Mn)	0.5-1.0	Phosphorus (P)	0.12 max
Chromium (Cr)	0.50 max		

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

No heat treatment required for G25HP/NAAMS castings if castings remain in mold until a temperature of 315° C max.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

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# ALLOYED GRAY CAST IRON (G3500/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

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1. MECHANICAL PROPERTIES (Stress-Relieved)

Hardness: 197-241 HBW  
Minimum Tensile Strength: 310 MPa

2. MICROSTRUCTURE (100X)

Flake Type:	Type A 80%min	Pearlite:	87% min
Flake Size:	4-6	Ferrite:	10% max
		Carbide:	3% max

3. COMPOSITION (in weight %)\*

Carbon (C)	2.8-3.2	Molybdenum (Mo)	0.35-0.50
Silicon (Si)	1.5-2.2	Copper (Cu)	0.7 max
Manganese (Mn)	0.7-1.0	Sulfur (S)	0.15 max
Chromium (Cr)	0.35-0.50	Phosphorus (P)	0.15 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

4. HEAT TREATMENT

All G3500/NAAMS castings shall be furnace stress relieved by holding at 565-595°C for a minimum of one hour plus one hour per 25 mm of section thickness (using the maximum section thickness). Castings shall be cooled at a maximum rate of 55°C per hour to 260°C or lower followed by cooling in still air.

5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

# NON-ALLOYED FERRITIC DUCTILE IRON (D4512/NAAMS)™

GLOBAL STANDARD COMPONENTS

# NAAMS



Stamping

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## 1. MECHANICAL PROPERTIES (Subcritical Annealed)

Hardness:	143-190 HBW
Minimum Tensile Strength:	415 MPa
Minimum Yield Strength:	310 MPa
Minimum Elongation:	12%

## 2. MICROSTRUCTURE (100X)

Nodule Type:	I & II	Pearlite:	10% max
Nodule Count:	50/mm <sup>2</sup> min	Ferrite:	87% min
Nodularity:	85% min	Carbide:	3% max

## 3. COMPOSITION (in weight %)\*

Carbon (C)	3.25-3.75	Chromium (Cr)	0.25 max
Silicon (Si)	2.25-2.60	Sulfur (S)	0.015 max
Manganese (Mn)	0.2-0.5	Phosphorus (P)	0.080 max
Nickel (Ni)	0.5-1.0		

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

Subcritical anneal all D4512/NAAMS castings with less than 80% ferrite content in the as-cast microstructure by the following process: heat to 700-730°C; hold for a minimum of 5 hours plus one hour per 25 mm of section thickness using the maximum section thickness; furnace cool at a maximum rate of 55°C per hour to 260°C or lower; and cool to room temperature in still air. Castings with 80% or greater ferrite content in the as-cast microstructure do not require subcritical annealing. However, the castings do require stress relieving. Stress relieve in a furnace by heating to 565-595°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Furnace cool at a maximum rate of 55°C per hour to 260°C or lower. Cool to room temperature in still air. In-mold cooling to less than 260°C, if approved by the purchaser, is an acceptable stress relief.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

# PEARLITIC DUCTILE IRON (D5506/NAAMS)

1. MECHANICAL PROPERTIES (Stress Relieved)

Hardness:	190-241 BHN
Minimum Tensile Strength:	550 MPa
Minimum Yield Strength:	380 MPa
Minimum Elongation:	6%

2. MICROSTRUCTURE (100X)

Nodule Type:	I & II	Pearlite:	87% min
Nodule Count:	50/mm <sup>2</sup> min	Ferrite:	10% max
Nodularity:	85% min	Carbide:	3% max

3. COMPOSITION (in weight %)\*

Carbon (C)	3.0-3.8	Copper (Cu)	0.3-0.7 (optional)**
Silicon (Si)	2.0-2.6	Chromium (Cr)	0.25 max
Manganese (Mn)	0.5-1.0	Sulfur (S)	0.005 max
Molybdenum (Mo)	0.35-0.50	Phosphorus (P)	0.08 max
Nickel (Ni)	0.5-1.0		

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical properties effects.

\*\*The addition of copper promotes pearlite formation. It is typically added for large castings or castings with large section thicknesses.

4. HEAT TREATMENT

All D5506/NAAMS castings shall be furnace stress relieved by holding at 565-595C for a minimum of one hour per 25 mm of section thickness using the maximum section thickness. Castings shall be cooled at a maximum rate of 55°C per hour to 260C or lower followed by cooling in still air.

5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.

6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

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**REFINED  
PEARLITIC DUCTILE IRON  
(D6510/NAAMS)**

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

1. MECHANICAL PROPERTIES (Stress Relieved)

Hardness:	190-248 HBW
Minimum Tensile Strength:	570 MPa
Minimum Yield Strength:	350 MPa
Minimum Room Temperature Charpy ISO 148-1 2 mm U-notch (root radius 1 mm) with a depth of 2 mm	3 Joules
Minimum Elongation:	4 %

2. MICROSTRUCTURE (100X)

Nodule Type:	I & II	Ferrite:	10-30%
Nodule Count:	100/mm <sup>2</sup> min	Pearlite:	70-90%
Nodularity:	90% min	Carbide:	0.5% max

This specification requires bull's-eye nodule structure.

3. COMPOSITION (in weight %)\*\*

Carbon (C)	3.0-3.8	Copper (Cu)	0.35-1.0
Silicon (Si)	2.0-2.4	Chromium (Cr)	0.12 max
Manganese (Mn)	0.3-0.6	Sulfur (S)	0.02 max
Molybdenum (Mo)	0.35-0.50	Phosphorus (P)	0.05 max
Nickel (Ni)	0.5-1.5	Magnesium (Mg)	0.040-0.060

\*\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

4. HEAT TREATMENT

All D6510/NAAMS castings shall be furnace stress relieved by holding at 565-595°C for a minimum of one hour plus one hour per 25 mm of section thickness (using the maximum section thickness). Castings shall be cooled at a maximum rate of 55°C per hour to 260°C or lower followed by cooling in still air.

5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

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# NON-ALLOYED STEEL (S0030/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Hardness:	120-170 HBW
Minimum Tensile Strength:	450 MPa
Minimum Yield Strength:	240 MPa
Minimum Elongation:	24 %

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of ferrite and pearlite and no dendritic structure  
Carbide: 3 % max

## 3. COMPOSITION (in weight percent)\*

Carbon (C):	0.20-0.30	Sulfur (S):	0.05 max
Silicon (Si):	0.3-0.5	Phosphorus (P):	0.045 max
Manganese (Mn):	0.5-0.7		

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

All S0030/NAAMS castings shall be annealed by heating to 860-895°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness (using the maximum section thickness). Castings shall be furnace cooled to 600°C at a rate not to exceed 45°C per hour then air cooled to room temperature.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

A

# ALLOYED STEEL (S0050A/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Hardness:	170-229 HBW
Minimum Tensile Strength:	585 MPa
Minimum Yield Strength:	310 MPa
Minimum Elongation :	16%

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of pearlite and ferrite and no dendritic structure,

ASTM grain size	#5 or finer
Carbide:	5 % max

## 3. COMPOSITION (in weight percent)\*

Carbon (C):	0.4-0.5	Molybdenum (Mo):	0.35-0.50
Silicon (Si):	0.2-0.5	Vanadium (V):	0.15 max
Manganese (Mn):	0.9-1.2	Sulfur (S):	0.05 max
Chromium (Cr):	0.8-1.1	Phosphorus (P):	0.045 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

All S0050A/NAAMS castings shall be annealed by heating to 860-895°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness using maximum section thickness. Castings shall be furnace cooled to 560°C at a rate not to exceed 45°C per hour, then air cooled at room temperature.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

A

# MEDIUM SHOCK /MEDIUM WEAR RESISTANT TOOL STEEL (TA2/NAAMS)

GLOBAL STANDARD COMPONENTS

TM **NAAMS**



Stamping

08/01/11

1. MECHANICAL PROPERTIES (Annealed)  
Hardness: 201-229 HBW

2. MICROSTRUCTURE (100X)  
Homogenous mixture of pearlite and ferrite and no dendritic structure.

3. COMPOSITION (in weight percent)\*

Carbon (C):	0.85-1.05	Molybdenum (Mo):	0.95-1.20
Silicon (Si):	0.25-0.40	Vanadium (V):	0.2-0.4
Manganese (Mn):	0.5-0.7	Sulfur (S):	0.03 max
Chromium (Cr):	4.75-5.25	Phosphorus (P):	0.03 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental micro-structure or mechanical property effects.

4. HEAT TREATMENT  
All TA2/NAAMS castings shall be annealed by heating slowly and uniformly to 845-870°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Castings shall be cooled at a maximum rate of 35°C per hour to 540°C then air cooled to room temperature.

5. SURFACE QUALITY  
All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

6. INSPECTION AND REJECTION  
For any deviation from the above designations refer to General Information Section 6.

A

# HIGH WEAR /LOW SHOCK RESISTANCE TOOL STEEL (TD2/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Hardness: 217-255 HBW

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of pearlite and ferrite and no dendritic structure.

## 3. COMPOSITION (in weight percent)\*

Carbon (C):	1.4-1.6	Molybdenum (Mo):	0.70-1.20
Silicon (Si):	1.50 max	Vanadium (V):	1.00 max
Manganese (Mn):	1.00 max	Sulfur (S):	0.03 max
Chromium (Cr):	11.0-13.0	Phosphorus (P):	0.03 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

All TD2/NAAMS castings shall be annealed by heating slowly and uniformly to 870-900°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Castings shall be cooled at a maximum rate of 35°C per hour to 540°C then air cooled to room temperature.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

A

# HIGH SHOCK /LOW WEAR RESISTANCE TOOL STEEL (TS7/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Hardness: 187-223 HBW

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of pearlite and ferrite and no dendritic structure.

## 3. COMPOSITION (in weight percent)\*

Carbon (C):	0.45-0.55	Molybdenum (Mo):	1.30-1.80
Silicon (Si):	0.20-1.00	Vanadium (V):	0.20-0.30
Manganese (Mn):	0.20-0.80	Sulfur (S):	0.03 max
Chromium (Cr):	3.00-3.50	Phosphorus (P):	0.03 max

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

All TS7/NAAMS castings shall be annealed by heating uniformly to 815-845°C and holding for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Castings shall be cooled at a maximum rate of 35°C per hour to 540°C then air cooled to room temperature.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

A

# ALLOYED STEEL (S7140/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Hardness:	190-230 HBW
Minimum Tensile Strength:	600 MPa
Minimum Yield Strength:	450 MPa
Minimum Elongation :	10 %

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of pearlite and ferrite and no dendritic structure,

ASTM grain size	#5 or finer
Carbide:	5 % max

## 3. COMPOSITION (in weight percent)\*

Carbon (C):	0.45-0.50	Sulphur (S)	0.035 Max
Silicon (Si):	0.40-0.80	Phosphorus (P)	0.035 Max
Manganese (Mn):	0.80-1.00		
Chromium (Cr):	1.30-1.70		

\* Trace amounts shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

Castings can be delivered annealed or pre-hardened condition per instructions of the purchaser. Pre-hardened casting are typically used for trim steels weighing 20 kg or less.

Annealed: Heat to 840-880°C and hold for a minimum of one hour plus one hour per 25mm of section thickness using maximum section thickness. Castings shall be furnace cooled to 560°C at a rate not to exceed 45°C per hour, then air cooled at room temperature.

Pre-Hardened: Heat to 840-880°C and hold 25 minutes at temperature. Quench with a cooling speed of 15°C per minute. Temper tool as soon as temperature reaches 50-70°C. Temper twice at 560-600°C. Final hardness should be 29-36 Rc.

## 5. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 6. INSPECTION AND REJECTION

For any deviation from the above designations refer to General Information Section 6.

A

# ALLOYED STEEL (S2333/NAAMS)

GLOBAL STANDARD COMPONENTS



Stamping

08/01/11

## 1. MECHANICAL PROPERTIES (Annealed)

Maximum Hardness:	190-230 HBW
Minimum Tensile Strength	700 MPa
Minimum Yield Strength	330 MPa
Minimum Elongation	7 %

## 2. MICROSTRUCTURE (100X)

Homogenous mixture of pearlite and ferrite and no dendritic structure

ASTM grain size	#5 or finer
Carbide	5 % max

## 3. COMPOSITION (in weight percent)\*

Carbon (C)	0.56-0.64	Molybdenum (Mo)	0.40-0.60
Silicon (Si)	0.20-0.50	Vanadium (V)	0.20-0.30
Manganese (Mn)	0.70-0.90	Sulphur (S)	0.035 Max
Chromium (Cr)	4.30-4.70	Phosphorus (P)	0.035 Max

\* Trace amounts of tramp elements shall be limited to standard practice so that there are no detrimental microstructure or mechanical property effects.

## 4. HEAT TREATMENT

Castings can be delivered in the annealed or pre-hardened condition per instructions of the purchaser. Pre-hardened castings are typically used for trim steels weighing 20 kg or less

Annealed: Heat to 840-880C and hold for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Castings shall be furnace cooled to 770 C at a rate not to exceed 20 C per hour, continue cooling in furnace until 650C at a rate not to exceed 10C/hr, then air cooled at room temperature.

Pre-Hardened: Pre-heat to 600-750 C and hold for one hour. Heat to 950-970C and hold for a minimum of one hour plus one hour per 25 mm of section thickness using the maximum section thickness. Air quench with a cooling speed of 15 C per minute. Temper tool as soon as temperature reaches 50-70C. Temper twice at approximately 675C. Minimum holding time at temperature is 2 hours. Temper twice. Adjust tempering temperature as necessary to reach final hardness. Final hardness should be 280-340 HBW.

## 5. CLEANLINESS

Metallic Inclusions per ASTM E45A\*

Type A Thin	1.5 Max	Type C Thin	1.5 Max
Type A Heavy	1.5 Max	Type C Heavy	1.5 Max
Type B Thin	1.5 Max	Type D Thin	1.5 Max
Type B Heavy	1.5 Max	Type D Heavy	1.5 Max

Sum of all metallic inclusions of all types is not to exceed 5.0

% Porosity and Oxide per ASTM E1245 is not to exceed 0.20

\* ASTM E45A is adapted for use here despite the absence of reduction through work.

## 6. SURFACE QUALITY

All castings must be free of any rejectable surface defects, as described in General Information Section 3.5.

## 7. INSPECTION AND REJECTION

For any deviation from the above designation refer to General Information Section 6.