Hyster-Yale Group, Inc.	Document Control Number:
Title: MEDIUM CARBON ALLOY STEEL	**HC-5**
Page 1 of **3** **Document Author:** Caitlin Toohey	**Effective Date:** 01-Mar-2017 **Revision No.** 2017-03

I. OBJECTIVE

This specification is established to provide a general purpose direct hardening alloy steel for components requiring a minimum yield strength of 100,000 psi or greater and do not require welding in their fabrication.

For cylinder rods, use HC-114 for new designs.

For older drawings specifying HC-5A use SAE 4135 or 4130; for HC-5D use SAE 4147 or 4150, and for HC-5B or HC5C use HC-5 to this specification.

II. CITED

See Master Index or attached Appendix for a complete list of Citing & Cited Documents.

III. REQUIREMENTS

Chemical Composition, % Ladle Analysis (Similar to AISI/SAE 4140H/4142H)

Carbon	0.38 - 0.45
Chromium	0.80 - 1.10
Manganese	0.75 - 1.00
Molybdenum	0.15 - 0.25
Phosphorus	0.035 max.
Silicon	0.15 - 0.30
Sulfur	0.040 max.

NOTE: 1. Chemical composition is subordinate to hardenability requirements.

2. Small quantities of unspecified elements are often present in alloy steels and may be present in the following maximum amounts: Copper 0.35% and Nickel 0.25%

Alternate Specifications

British:	Grade 708M40 per BS 970-1 or Grade A42 per 708
Chinese:	Grade 42CrMo per GB/T 3077-1999
European:	Grade 42CrMo4 per EN 10083-1
Japanese:	Grade SCM 440H per JIS G4052

Hardenability

At J1 HRc 53-62; At J8 HRc 47 min.; At J16 HRc 35 min.

Quality

Annealed Barstock and Forgings: Regular quality, fully killed, fine grained (Grain Size 5 - 8)

Special Applications Barstock: Special Bar Quality (SBQ) when specified on the Engineering Drawing. Special Bar Quality (SBQ) steel (referred as "Engineering Steel" in Europe) shall be free from surface defects, fully killed, fine grained (Grain Size 5 to 8 as per ASTM E-112)

Heat Treatment

Forgings and Barstock: Anneal to a predominately pearlitic microstructure, BHN 212 max.

Dimensional Tolerances

Forgings: Commercial forging tolerances, unless otherwise specified.
Barstock: As stated within ASTM A29/A29M.

Certification

The supplier shall include with each material or subcontracted lot shipped to HYG a statement certifying compliance with HC-5 requirements, signed by an authorized representative of the supplier.

IV. GENERAL INFORMATION (Not Part of Requirements)

Engineering

Application

This specification is primarily intended for parts which are highly stressed in direct tension or shear and require high strength. Parts highly stressed in bending or torsion can generally be more economically manufactured by surface hardening carbon steels such as HC-4, HC-43 or HC-73 except in the case of massive parts.

This material is not intended for use in the as-rolled or as-forged conditions nor for components requiring welding in their fabrication. Proper welding of this material is extremely costly and requires extensive process control. If the component requires welding, consider using HC-2 or HC-6. If it is absolutely necessary to weld this material in fabrication, the design engineer should consult with welding and materials engineering.

Mechanical Properties

The table below indicates the standard hardness ranges obtained as a result of heat treatment HC-5 material and the approximate mechanical properties. There is nothing sacred about these hardness ranges. They have simply evolved throughout industry over the years in order to standardize on tempering temperatures for economy in manufacturing.

The commercial designations indicate the trade name of products available from USA steel service centers and mills which are already heat treated to the certified strength level when received by HYG. Whether or not the component is machined from one of these products or from unhardened bar stock and the individual parts heat treated to the specified hardness is the choice of the manufacturing plant. Generally, considerable economy can be realized in component cost using these products if machining is minimal.

SPECIFIED HARDNESS HRC	COMMERCIAL DESIGNATION	EQUIVALENT TENSILE STRENGTH KSI (Mpa)	EQUIVALENT YIELD STRENGTH KSI (Mpa)	ELONGATION IN 2 INCHES %	REDUCTION OF AREA %
25 - 32	HTS	120 - 145 (827-1000)	100-125 (689-862)	20	55
38 - 42	NONE	170 - 190 (1172-1310)	150-170 (1034-1172)	14	45
42 - 45	NONE	190 - 205 (1310-1413)	170-185 (1172-1276)	10	35

Method of Specifying

HC-5; HRC ____ or

(Method of Specifying when Special Bar Quality Steel (SBQ) is required)

HC-5, SBQ, HRC _____

Example: HC-5; HRC 38 - 42

Manufacturing

Certification

Recertification of incoming materials or parts to a planned quality level will be performed, consistent with production classification, vendor performance and total quality cost.

Availability

This material is readily available in most sizes from USA steel service centers in rounds, squares, flats, hexagons, and tubing. It is not available in plate product. Because this material is readily available, no material substitutions should be required and should not be made without Engineering authorization.

Color Code

Non-heat treated:	Purple background - (See color code for stripe)
Heat treated:	White background

Annex

Cited Documents

ASTM A29/A29M, Standard specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for…

ASTM E112, Standard Test Methods for Determining Average Grain Size

BS 970 P1, Non-Destructive Examination of Fusion Welds – Visual Examination

EN 10269, Steels and Nickel Alloys for Fasteners with Specified Elevated and/or Low Temperature Properties

HC-2, Low Carbon Alloy Steel for Carburizing and Through Hardening

HC-4, Medium Carbon Steel Barstock

HC-6, Low Carbon – High Alloy Steel for Carburizing and Through Hardening

HC-43, Medium Carbon Steel

HC-73, Free Machining Medium Carbon Severely Cold Drawn Barstock

HC-114, Bar for Hydraulic Cylinder Rods

JIS G4052, Structural Steels with Specified Hardenability Bands