ENGINEERING SPECIFICATION

I. OBJECTIVE:

This specification is established to provide a weldable structural steel with a minimum yield strength of 90,000 and 100,000 psi for parts fabricated from plates, bars and shapes.

II. REQUIREMENTS:

CHEMICAL COMPOSITION, % LADLE ANALYSIS, MAXIMUM

CARBON	0.21	MOLYBDENUM	0.65
MANGANESE	1.50	VANADIUM	0.08
PHOSPHORUS	0.035	TITANIUM	0.10
SULFUR	0.04	ZIRCONIUM	0.15
SILICON	0.90	COPPER	0.50
NICKEL	1.50	BORON	0.006
CHROMIUM	2.00		

NOTE: These alloying elements are used in varying quantities by each producer to provide the necessary hardenability in the section thickness specified. However, the content of any one element should not exceed that quantity specified above.

MECHANICAL PROPERTIES, MINIMUM

	THICKNESS, inches	
	To 2-1/2 incl.	Over 2-1/2 to 4 incl.
TENSILE STRENGTH, psi (Kgf/mm^2)	115,000 (80.9)	105,000 (73.8)
YIELD STRENGTH, psi (Kgf/mm^2)[1]	100,000 (70.3)	90,000 (63.3)
ELONGATION in 2 in, % (50.8 mm)	18	17
REDUCTION OF AREA, %	40	50
BRINELL HARDNESS NUMBER[2]	235-293	229-293

1. Yield strength to be determined using the 0.2% offset method described in ASTM E8.
2. Brinell hardness number is subordinate to tensile properties.

BEND TEST

The bend test specimen shall be taken longitudinally from the plate, flat bar or structural shape and shall represent the full section thickness. If the test is performed on a specimen of reduced thickness, the rolled surface shall be on the outer curve of the bend. The sides of the test specimen may have the corners rounded to a maximum radius of 1/16 inch. Bend test specimens shall stand being bent cold through 180 degrees without cracking on the outside of the bent portion, to an inside diameter which shall have a relation to the thickness of the sample as follows:

MATERIAL THICKNESS INCHES	RATIO OF BEND DIAMETER TO SPECIMEN THICKNESS
1 and under	2
Over 1 to 2-1/2, incl.	3
Over 2-1/2 to 4, incl.	4

NOTE: Bend test values are intended for material qualification only and NOT as design limits. Where plates and bars are to be bent in a fabricating operation, more liberal bend radii should be used.

GRAIN SIZE

Fine grain, ASTM No. 5 or finer as determined in accordance with ASTM E112, specifically, plate IV.

QUALITY

Fully killed, structural quality.

Surface imperfections may be conditioned by grinding in accordance with ASTM A6 but no welding shall be done to conditioned surfaces or edges.

HEAT TREATMENT

The material shall be heat treated by the supplier to conform to the mechanical property requirements specified by heating to not less than 1650 F, quenching in water or oil and tempering at not less than 110 F.

DIMENSIONAL TOLERANCES

Shall conform to ASTM A6 requirements.

When specified, flatness tolerances closer than Table 16 of ASTM A6 are available and should be negotiated with the supplier.

CERTIFICATION

The supplier shall include with each material or subcontracted part lot shipped to Hyster Company a written statement certifying compliance with HC-17 requirements signed by an authorized representative of the supplier. Actual chemical composition and mechanical properties must be reported for each heat of steel supplied to Hyster Company.

ALTERNATE SPECIFICATIONS

Overseas plants may use the following materials when HC-17 is specified. All requirements specified in HC-17 must be met.

AUSTRALIAN	
BRITISH	Loycon QT
GERMANY	Deutsche Edelstahl Werke A.G.; Pantanas 235
SOUTH AFRICA	Superelso 70 or Wel-Ten 80C

III. GENERAL INFORMATION (NOT PART OF REQUIREMENTS)

ENGINEERING

APPLICATION

The material covered by this specification is intended for general use in fabricating parts which require a minimum yield strength of 90,000 to 100,000 psi with good formability and weldability. Typical applications are cross bars on carriages, steering arms, steering axles, stubshafts, etc.

The use of this material in any application requires a critical review of manufacturing processes and stress concentrations. Quality of welds, joint design and the size of weld fillets are areas of concern.

AVAILABILITY

The plate product is readily available from most commercial steel warehouses. Flat bars are also available from commercial steel warehouses in some sizes. Structural shapes and round bars are strictly mill items and must be negotiated with the producer.

In the case of structural shapes, flat bars and round bars, it is imperative that the designer consult the "Preferred Mill Steel Sizes" list to determine which sizes are available. If the size desired is not available, consult materials engineering for size availability or suitable alternate materials. When sizes specified on prints are not available to non-USA plants, consult materials engineering for suitable alternate materials.

REFERENCES

ASTM A434-64, Class BC Standard Specification for Quenched and Tempered Alloy Steel Bars, Hot Rolled or Cold Finished.

ASTM A514-70 Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.

METHODS OF SPECIFYING

Material HC-17

NOTE: Dimensions related to product form (e.g., thickness and structural shape) shall be shown in the material block. Welded joints must indicate welding rod to be used (see page G2.025).

MANUFACTURING

RECERTIFICATION

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

WELDING

PROCESSES

The quenched and tempered materials covered by this specification can be welded with the shielded metal arc, gas metal arc and submerged arc processes.

SURFACE CONDITION

Welds shall be deposited under low hydrogen conditions. Material surfaces shall be free of moisture, oil, paint and other hydrogen sources to minimize hydrogen diffusion into base metal heat affected zones and prevent underbead cracks and minimize the possibility of brittle failures of parts in service.

ELECTRODES

Low hydrogen electrodes for processes shall be used to weld the material.

PREHEATING

Parts manufactured from this material shall be preheated to the temperatures indicated before welding. These preheat and interpass temperatures are from AWS D2.0-69, Table 4 and referred to in OSHA of May 1971.

MATERIAL THICKNESS inches	MINIMUM PREHEAT AND INTERPASS TEMPERATURE °F
To 3/4, incl.	50
Over 3/4 to 1-1/2, incl.	125
Over 1-1/2 to 2-1/2, incl.	175
Over 2-1/2 to 4, incl.	225

The maximum preheat and interpass temperature shall not exceed 400 F since higher temperatures will adversely effect joint physical properties.

Electrodes of the AWS E110XX or E12XX class will produce weld physical properties approximating those of the base metal. Lower strength electrodes may be used when lower joint strength is acceptable and specified on the engineering drawing.

TABLE 1

HEAT INPUT,

Joules/inch of weld.

ASTM A514 TYPE A-D, J, G, H, L, M & N PLATE

THICKNESS	PREHEAT AND INTERPASS TEMPERATURE				
In.	70F	150F	200F	300F	400F
3/16	17,500	15,300	14,000	11,500	9,000
1/4	23,700	20,900	19,200	15,800	12,300
3/8	35,000	30,700	28,000	23,500	18,500
1/2	47,400	41,900	38,500	31,900	25,900
5/8	64,500	57,400	53,000	43,500	33,500
3/4	88,600	77,400	69,900	55,700	41,900
1	Any	120,000	110,300	86,000	65,600
1-1/2 to 2, incl.	Any	Any	154,000	120,000	94,000

TABLE 2

HEAT INPUT,

Joules/inch of weld

ASTM A514 TYPE E, F, & D PLATE.

THICKNESS	PREHEAT AND INTERPASS TEMPERATURE				
In.	70F	N150F	200F	300F	400F
3/16	27,000	23,000	21,000	17,000	13,000
1/4	36,000	32,000	29,000	24,000	19,000
1/2	76,000	62,000	56,000	47,000	40,000
3/4	121,000	107,000	99,000	82,000	65,000
1	Any	188,000	173,000	125,000	93,000
1-1/4	Any	Any	Any	175,000	127,000
1-1/2	Any	Any	Any	Any	165,000
2 to 4, incl.	Any	Any	Any	Any	Any

HEAT INPUT

Weld heat input and maximum interpass temperature must be controlled to prevent impairment of the base metal physical properties. Table 1 is a guide for maximum safe heat input at various plate thicknesses and interpass temperatures for ASTM A514, type A through D and J, G, H, L, M and N plate. Table 2 contains the same information for ASTM A514, type E, F and D plate.

$$\text{Heat input} = \frac{\text{amperes} \times \text{arc volts} \times 60}{\text{welding speed (inches per minute)}} = \frac{\text{watt seconds (Joules)}}{\text{inch of weld}}$$