

**PLAINTIFF'S
EXHIBIT**

ARO-235

Final Specification

For

#4 Slab Reheat Furnace
86" H.S.M., Middletown Works

Project 7147

Armco Steel Corporation
Middletown, Ohio

November 19, 1969

SLAB REHEAT FURNACE

1.0 SCOPE OF WORK

- 1.1 The work to be performed under the terms of this specification shall consist of furnishing all materials, transportation and labor required to design, detail, fabricate, deliver, unload, store, erect, and start-up one (1) walking beam type Slab Reheat Furnace for the 86" Hot Strip Mill at Middletown Works all as specified herein.
- 1.2 The Vendor shall be responsible for the structural, mechanical and electrical design of the furnace, and for the installation and start-up of the furnace.
- 1.3 The Vendor shall furnish a complete installation including (but not limited to) all fuel, steam, water, and air piping, and appurtenances; combustion controls; walking beam mechanism controls; foundation anchor bolts; boiler inlet flue with isolation damper; natural draft stack with furnace pressure control damper; and an instrument and control house, unless otherwise specified herein.
- 1.4 The Vendor shall furnish and install all electrical equipment and wiring unless otherwise specified herein.
- 1.5 The Vendor shall design the furnace and the furnace control and instrumentation systems for compatibility with computer control subject to Purchaser's approval.
- 1.6 The Vendor shall design the furnace and the furnace control and instrumentation systems for compatibility with a Waste Heat Boiler, all final design to be subject to Purchaser's approval.
- 1.7 The Vendor shall supply all drawings and bills of material in accordance with Schedule 1 attached hereto.

2.0 SUPPLIED BY OTHERS

- 2.1 All foundations with buried conduit and grounding, and backfill in place as shown on the Vendor's foundation drawings. Anchor bolts furnished by Vendor will be installed by Purchaser.
- 2.2 All permanent buildings with the exception of the instrumentation and control house.

- 2.3 Entry skids between charge table and furnace; discharge skids between furnace and delivery table.
- 2.4 All high bay lighting.
- 2.5 The following utilities for furnace operations:
 - 2.5.1 440-480 volt, 3 phase, 60 hertz power. (Vendor shall specify quantity required.)
 - 2.5.2 2400 volt, 3 phase, 60 hertz power. (Vendor shall specify quantity required.)
 - 2.5.3 Plant air at 90 psig maximum, 60 psig minimum, and dry - (Vendor shall specify quantity required.)
 - 2.5.4 Water at a minimum of 35 psig and a maximum of 120 psig. - (Vendor shall specify quantity required with 70% insulated skids and with 100% insulated skids.)
 - 2.5.5 Natural gas at 50 psig and 950 BTU/SCF - (Vendor shall specify quantity required.)
 - 2.5.6 No. 6 Fuel Oil at 150 psig and 125° F. - (Vendor shall specify quantity required.)
 - 2.5.7 Atomizing steam at 165 psig and 500° F. maximum - (Vendor shall specify quantity required.)
 - 2.5.8 Tracer steam at 10 psig and saturated - (Vendor shall specify quantity required.)
- 2.6 Mechanical slab extractor and slab pusher.
- 2.7 All construction power and utilities and limited use of the mill aisle overhead crane. Crane will not be available on Mondays.
- 2.8 One waste heat boiler complete with air heater, which shall interface with the furnace at elevation 154' at the boiler inlet flue and at the furnace combustion air header inlet; other interfaces in the instrumentation and control system shall be coordinated with the waste heat boiler supplier.
- 2.9 One turbine-driven F.D. fan for preheated combustion air. Preheated combustion air will be delivered at approximately 500°F. maximum.

- 2.10 One turbine-driven I.D. fan with stack for exhausting the waste gases through the waste heat boiler.
- 2.11 Closed circuit television equipment to view the discharge of slabs from both sides of the furnace.
- 2.12 Resalloy door sections for charge door.

3.0 DESIGN CRITERIA

3.1 Maximum Temperature Requirement

Furnace shall be designed to heat low carbon steel slabs (for automotive and deep drawing quality) to a maximum uniform temperature of 2375°F. The temperature gradient between the hottest and coldest points in each slab must not be greater than 50°F. Slab furnace design temperature shall not exceed 2475°F.

3.2 Slab Information

Furnace shall be capable of handling the following slab sizes and conditions:

<u>Slab Sizes</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Type</u>
Thickness	7"	10"	Rolled Slabs
Thickness	9"	11"	Continuous Cast Slabs
Width	26"	82"	Rolled Slabs
Width	26"	82"	Continuous Cast Slabs
Length-Double Row	13'-0"	16'-0"	Rolled Slabs
Length-Single Row	28'-0"	33'-0"	Rolled or Continuous Cast Slabs
Weights	11,000#	90,000#	Rolled or Continuous Cast Slabs (Rolled to a maximum 1100 P.I.W. coil)

3.3 Heating Capacity

Vendor shall submit the designed furnace heating capacity expressed in pounds per hour per square foot to utilized hearth for 8 in., 9 in., 10 in., and 11 in. thick slabs. Vendor shall also express heating rate in tons per hour based on single length slabs, 33 feet long, with no gap between slabs. Heating curves shall be supplied plotting slab surface and center temperature versus furnace temperature for each thickness. The connected firing rate shall not exceed 1,000,000,000 BTU/hour.

3.4 Information for Boiler Design

Vendor shall submit in his proposal the following information which is required for the design of the waste heat boiler:

- 3.4.1 Flue gas flow into boiler _____ lbs/hr.
(Including air infiltration)
- 3.4.2 Flue gas temperature into boiler _____ °F.
- 3.4.3 Draft at boiler inlet _____ in. W.C.

The above information shall be provided for each of the following conditions: (assume 100% skid pipe insulation).

- (1) Maximum (connected) firing rate.
- (2) Normal firing rate for 8", 9", 10", and 11" thick slabs.
- (3) Holding firing rate (assume 1800°F.).

3.5 General Design

3.5.1 Furnace shall be six (6) zone, walking beam type with the following dimensions:

- (1) Inside width 36 ft. - 0 in.
- (2) Effective hearth length 114 ft. - 0 in.
- (3) Effective hearth area 114 x 33 = 3762 sq. ft.
- (4) Centerline to centerline of roll tables 145 ft. - 6 in.

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| (5) Centerline to centerline of
furnace bays | 80 ft. - 0 in. |
| (6) Mill table elevation | 110 ft. - 0 in. |
| (7) Furnace tub floor elevation | 87 ft. - 0 in. |
| (8) Centerline charging table to
inside charge door | 16 ft. - 0 in. |
| (9) Centerline charging table to
back limit of walking
beam travel | 6 ft. - 0 in. |

Vendor shall submit a minimum of two general arrangement drawings showing a longitudinal section and a cross section of the furnace and uptake flues including:

- (1) Length of each zone.
- (2) Overall furnace configuration with dimensions.
- (3) Skid arrangement and spacing.
- (4) Burner spacing.
- (5) Boiler and stack damper arrangements.

3.5.2 Zones shall be as follows:

- (1) Bottom charge zone.
- (2) Top charge zone.
- (3) Bottom heat zone.
- (4) Top heat zone.
- (5) Bottom soak zone.
- (6) Top soak zone.

3.5.3

Furnace shall be arranged for end charge and end discharge. Furnace shall be designed for a mechanical slab extractor to lift slabs from the furnace and place them on the furnace delivery table, and for a light weight slab pusher for charging slabs. Discharge door design shall be coordinated with United Engineering and Foundry.

- 3.5.4 Vendor shall coordinate with Purchaser to locate television equipment to view the discharge of slabs from both sides of the furnace.

3.6 Combustion

- 3.6.1 Burners - Vendor shall recommend the size (BTU rating), number and location of burners for each zone. Bottom zone burners shall be opposed rather than staggered. Vendor shall submit preheated combustion air requirements for connected firing rate, normal firing rate and holding firing rate (assume 100% skid insulation).
- (1) Roof-type, cold -air burners (Bloom H.T.R.) with continuous pilots shall be used for the top soak zone.
 - (a) Equipment shall be provided to facilitate manual ignition of the top soak zone burners.
 - (2) All other burners shall be dual fuel hot air burners as follows: (Vendor shall specify burner supplier).
 - (a) Capable of withstanding 200°F. above maximum combustion air temperatures.
 - (b) Oil burners shall be removable and retractable (when not in use) and shall have locking device to lock in the "in" or "out" position.
 - (c) All burners shall have a turndown capable of holding furnace at 1800°F.
 - (d) All burners shall be capable of lighting from an external location.
 - (3) Bottom zone burners shall be equipped with two gas tubes supplied from individual inlet connections. Each inlet shall be equipped with a shut off valve and a manually adjustable or replaceable flow control orifice for adjustment of flame length to insure even heat distribution from side to side of the furnace when the zone firing rate is cut back.

3.6.2 Fuels - All zones except the top soak zone shall be fired with natural gas or No. 6 fuel oil as follows:

- (1) Natural gas - 950 BTU/Cu. Ft. Net
- (2) No. 6 fuel oil - 144,000 BTU/Gal. Net

Top soak zone shall use only natural gas. No. 6 fuel oil will be used on the other zones during periods of natural gas curtailment.

3.6.3 Soak Zone Combustion Air Blower - Vendor shall furnish the cold air blower and motor for supplying combustion air to the top soak zone burners. Purchaser will supply the starter for the soak zone blower motor from an existing motor control center located at elev. 154' near Column 7. The blower shall be located approximately 100 feet from the MCC and at the same elevation. Vendor shall specify static pressure and quantity of cold combustion air required in addition to horsepower of motor. Ambient air at inlet to fan will be a maximum of 120°F. Fan shall be designed for 120% of theoretical requirement.

3.6.4 Atomization of No. 6 Fuel Oil - The furnace shall be equipped for steam atomization of No. 6 fuel oil for all zones except the top soak zone. All valves shall be capable of withstanding an excess of 200°F. above steam temperature. All insulation shall be protected from damage by sheet metal covering.

3.6.5 Fuel Oil Heater - Vendor shall supply a heater to preheat oil to the correct temperature for proper flow through pipelines and for proper combustion. Heater shall be installed at elev. 154' within 40 feet of the furnace centerline.

3.6.6 Valves and Accessory Equipment - Vendor shall submit a recommended list of quantities, sizes, and suppliers of all furnace equipment. Purchaser will retain the right to upgrade the quality, increase the quantity or dictate the source of supply where necessary to conform to existing mill standards and practices.

3.6.7 Standards - All fuel and combustion control firing equipment shall conform to F.I.A. and N.B.F.U. rules and standards. All piping shall conform to Armco Piping Standards, ACS-400.

3.7 Natural Draft Stack

Vendor shall provide a natural draft by-pass stack, with connecting flue, to exhaust waste gases from the furnace when the waste heat boiler inlet damper is closed. The stack shall be designed for the maximum firing rate of the furnace and shall terminate at elev. 279'-3". Vendor shall specify stack diameter, thickness and refractoriness of the stack lining and submit an estimate of the stack shell temperature at maximum firing rate. Stack design shall include furnace pressure control dampers with associated control equipment. Motor operated, water cooled butterfly dampers shall be installed in flue below boiler house floor (elev. 154'-0"). Vendor shall submit an estimate of weights of stack and flue for determination by Purchaser of adequate structural steel for their support.

3.8 Furnace Control House

An extension to the existing furnace control house located south of the extractor pulpit at approximate elev. 120', shall be provided by Vendor. The control house shall be of the same size and construction as shown on Armco drawings 609968, 609969, 609970, and 601164 and shall be extended 38'-0" south. A 60,000 BTU/hr. cooling capacity air-conditioner (5-ton unit) shall be supplied with control house as well as all lighting. The existing south end wall and door shall be removed to make one large control room. A door will be required at the south end of the building and at the center front.

3.9 Scale Removal System

The Vendor shall furnish a complete scale removal system which will discharge into Purchaser's flume at either end of furnace.

4.0 REFRACTORIES AND INSULATION

The refractory materials listed below shall be the type of refractory exposed to the furnace heat. The Vendor shall design the thickness of all sections and the recommended insulation backup required.

Type of Refractory

High Heat Duty Firebrick
Super Duty Firebrick
60% Alumina Firebrick

Acceptable Vendors

{ General Refractories
A. P. Green
North American Refractories Co.

Type of Refractory

Acceptable Vendors

Insulating Fire Brick

{ Johns-Manville
Babcock & Wilcox
Refractory & Insulation Corp.

Super Duty Plastic (air setting type)

{ C-E Refractories
Kaiser
Plibrico

All refractories shall conform to Armco Steel Corporation Refractories Specification, when applicable. (Refer to attached Specification ASC-102/65.) Vendor shall specify M.H. Detrick suspension system.

4.1 Sidewalls

From bottom of furnace to bottom of arch shall be 16½" composite wall construction of M.H. Detrick design. The construction shall consist of super duty hot face anchors to support the 7½" depth of super duty plastic, a permanent back-up of first quality tile, necessary castings, mortar, and steel retaining clips. The void between the casing and cold face refractory will consist of poured concrete (Decrete 40). Plastic panels shall be 4 ft. x 4 ft.

4.2 Roof (Except Soak Zone)

Top charge and top heat zones shall be M.H. Detrick Versa-Tile design consisting of 60% Alumina refractory, 10" hung tile on 16" center, 7½" filler tile, castings and alumina silicate felt expansion joints. Block insulation 2" thick and ½" castable shall insulate the arch.

4.3 Bottom

Shall be 12" of Pli-Cast #31 or C.E. Refractories equivalent, (Moldit-D) and 5" of 2000°F. insulating firebrick. Floor to be covered with 3" of yellow silica sand.

4.4 Burner Walls

Top zone burner walls shall be 18" of super duty plastic backed with 1½" block insulation. Anchoring system will be M.H. Detrick anchor clusters and Meehanite castings on 2'-0" centers. The hot face tile in each cluster will be 60% Alumina. Refractories and the other tile will be of first quality refractory material.

4.5 Nose Construction

The charge end nose (#1) shall be of M.H. Detrick "DETRED" arch construction extending to approximate elevation of 114'-6".

Noses #2, #3, and #4 shall be 9" super duty plastic with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 12" centers with necessary Meehanite radial and clip castings and 25-12 alloy shelf castings.

4.6 Soak Zone Roof

Shall be flat with roof burners in it. Roof shall be 9" super duty plastic with M. H. Detrick suspension system, consisting of 10" super duty anchor tile on 12" centers and the necessary castings for attachment. Piping for combustion air and gas shall be designed to allow for differential thermal expansion. Soak zone shall be designed with a 20' x 20' removable section for maintenance.

4.7 Uptakes and Flues

4.7.1 Side Walls

Shall be 9" super duty plastic backed with a minimum of 3½" block insulation with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 18" centers and necessary castings for attachment. Rows of shelf castings shall be provided at 3' intervals. Vendor shall state skin temperature of furnace casing assuming a hot face temperature of 2400°F.

4.7.2 Arch

Shall be 9" super duty plastic with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 12" centers and the necessary castings for attachment.

Sloping wall leading to stack uptake at approximate elev. 125' shall be M.H. Detrick "DETRED" construction consisting of 10" first quality firebrick.

4.7.3 Bottom

Shall be 9" super duty plastic or Plicast #31 with 1½" of 1600°F. insulating firebrick.

BLOCK

B.C. JOHNSON
11-25-69

4.7.4 Boiler Inlet Flue

Shall be super duty plastic same as 4.7.1 with the top of the flue at elev. 154' rammed to conform to the shape of the boiler header at that elevation.

4.8 Skid Pipe and Supports

All movable and stationary posts and longitudinals shall be insulated with 2" of castable over cooling studs (Plicast 27-S or equal).

4.9 Combustion Air Headers

Shall be lined with $4\frac{1}{2}$ " of 800°F. insulating firebrick. Burner AREA lagging shall be $2\frac{1}{2}$ " Superex M plus $\frac{1}{2}$ " J.M. #352 finishing cement. *MINIMUM MAY BE 1600°F*

4.10 Inspection Door Lining

Each door will be lined with 7" of Pli-Cast #31 high temperature castable, or approved equal.

4.11 Discharge Doors

Shall be lined with 5" medium weight, high strength 2600°F. insulating castable with 1" block insulation. Steelwork shall be water-cooled at all edges.

4.12 Discharge Wall Curtain

Shall consist of M.H. Detrick chain wall design, $13\frac{1}{2}$ " super duty refractory and necessary castings.

4.13 Oil and Steam Pipe Insulation

Shall conform to Purchaser's standard specification #ASC-400-35.

5.0 STEELWORK

5.1 Structural Steel

5.1.1 The steel used to support and bind the furnace shall be of sufficient section to withstand temperature and stresses encountered. Buckstays of steel slabs shall be used for the critical areas (soak zone and the required portion of the heat zone). Vendor shall specify size of main structural members.

- 5.1.2 The furnace shall be supported on steel columns and structural framework. The columns shall be supported by basement foundation. All areas under the furnace shall be accessible insofar as practicable.
- 5.1.3 Side wall casing shall be 1/4 inch plate minimum.
- 5.1.4 Burner wall casing (including bottom side-fired burners) shall be 1/2 inch plate minimum.
- 5.1.5 Hearth (Bottom Zones) shall have 1/2 inch plate minimum with structural support of 6 inch channel.
- 5.1.6 Structural supports shall be water cooled at all critical points (i.e., door lintels, furnace noses, etc.). Lintels shall be pressure tested at 120 psig.
- 5.1.7 Skid pipes shall be supported by water-cooled pipe supports.

5.2 Doors

- 5.2.1 Charge door shall be in two halves of three resalloy plates each to withstand furnace temperature and designed for air cylinder operation, controlled to hold each half door in any position from open to closed. Purchaser will supply resalloy door sections made from Armco pattern No. 17101. Vendor will supply all other door equipment.
- 5.2.2 Discharge door shall be Vendor's design subject to Purchaser's approval, to withstand furnace temperature and designed to interlock with the mechanical extractor. Design of discharge door shall be coordinated with United Engineering and Foundry Company. Door shall be constructed in two halves with each half operated by a 10 HP motor driving a line shaft through less than 360° rotation. Door halves shall be hung on chains secured to sheaves on the line shaft. Separate small doors shall be provided to cover the extractor arm slots in the furnace endwall.
- 5.2.3 Inspection doors shall consist of twenty (20) ductile iron doors, 3' high by 2' wide, with cheek plates and mantles for the furnace. All doors shall be independently operated by air cylinders from a valve stand. Doors shall be located to allow inspection of water-cooled support pipes in addition to tops of slabs

(bottom of door at approximate elev. 108').

- 5.2.4 Location of eight (8) brick bulkheads for clean-out shall be decided by Purchaser at a later date.

6.0 WALKING BEAM MECHANISM

6.1 Walking Beam Frame

- 6.1.1 Vendor shall propose his recommended design for the walking beam frame including sufficient detail to make an engineering evaluation.
- 6.1.2 Vendor shall submit a general arrangement drawing showing size of main structural members, scale removal provisions, details of walking beam slot seals, and skid support pipe attachment to frame.
- 6.1.3 Vendor shall state design stresses used for structural members including factor of safety added to calculated stresses.
- 6.1.4 The walking beam frame shall be designed with a means of lowering safely and with no extreme shock in the event of power failure while in a raised position with a full load of slabs.
- 6.1.5 Skid pipes shall be 5½" O.D. steel tubing with 1" wall thickness. Six (6) stationary and four (4) walking skids shall be required. Each skid pipe shall have suitable alloy riders, wear bars, or buttons in the heat and soak zones. Each skid shall be constructed in a least two longitudinal sections to minimize the effect of thermal expansion. Spacing of skids across the furnace width shall be subject to final approval by Purchaser.

6.2 Lifting and Traverse Mechanism

Vendor shall propose his recommended design for the walking beam mechanism including sufficient detail to make an Engineering evaluation. Vendor shall specify type of drive, horsepower requirements, principle of operation, and all auxiliary equipment associated with the drive system. In the case of a hydraulic system, multiple pumps and motors will be required with one (1) complete installed spare so that failure of one pump/motor combination will not shut down the furnace.

6.3 Controls and Sequence of Operation

- 6.3.1 Vendor shall specify and supply the control system required to charge, walk through, and discharge slabs including a complete time/motion study of the walking beam travel. Production limitations shall be calculated based on all widths and thicknesses of slabs for single and double row charging.
- 6.3.2 Controls shall include a means of slowing the lift stroke so the walking beams contact the slabs at a velocity of one-half inch per second, or less.
- 6.3.3 The walking cycle shall be designed to bring the trailing edge of the slab to be extracted to the same exact location each time. Intelligence shall be provided to measure the apparent width of each slab charged and store this width in memory until it is needed to cycle that slab to the extract position. Vendor shall supply complete hardware for measuring the walking beam stroke, measuring the pusher stroke, calculating the number of walks and length of walk required for the next extract, and calculating the space available for charging a slab. Details of the control system shall be subject to Purchaser's approval.

6.4 Frame Loading Criteria

The walking beam skids and frame shall be designed to support a full load of 12-inch thick slabs, 33 feet long, with no space between slabs. Vendor shall state total dead load of the walking beam frame.

7.0 COMPUTER CONTROL AND DATA LOGGING FUNCTIONS

7.1 Data Logging Functions

Computer shall continuously monitor temperature for each zone of the furnace. Vendor shall supply a 0.5 volt signal proportional to zone temperature for use by computer.

7.2 Control Functions

Capability of furnace temperature set points to be set by computer. Initiation of walk cycle, push, and extract shall be by computer or by manual control.

8.0 FURNACE CONTROLS AND INSTRUMENTATION

- 8.1 All controls and instrumentation, including all mounting hardware, connections, special fittings, heat shields and safety devices, shall be furnished and installed by the Vendor with the exception of special instrumentation or controls furnished for the computer by Westinghouse Electric Corporation.
- 8.2 Furnace shall be capable of being operated remotely from the instrumentation and control room in manual or automatic modes, or zone temperature set points by the computer.
- 8.3 All controls and instrumentation shall be supplied by L & N as closely as possible to the controls on #1, #2, and #3 slab furnaces. Vendor's proposal should include L & N's proposal for the complete instrumentation package.
 - 8.3.1 All fuel valve operators shall be electric motor operated.
 - 8.3.2 All combustion air valve operators shall be electric motor operated.
 - 8.3.3 All air butterfly valves shall be Continental Butterfly, and have the same temperature rating as burners.
 - 8.3.4 Zone temperature shall be measured by a pt-pt 13% rh T.C. wired directly to an L & N Model "H" circular chart recorder with set point indicator. Temperature control shall be Model "C" P.A.T. with an additional computer controlled set point module and switch for going from "computer" to "local" control.
 - 8.3.5 Furnace pressure shall be controlled by electric motor operated butterfly dampers in the natural draft stack inlet flue. The controller shall be an L & N Model "C" P.A.T.
 - 8.3.6 Fuel-air ratio controls shall be L & N Model "C" P.A.T. A fuel limit control shall prevent excess fuel with respect to air flow. Recorders shall be M-line strip chart (4 inch) type with chart speed of one (1) inch per hour for fuel flow and air flow for each zone. Total fuel flow and steam flow to each furnace shall be recorded and integrated on a separate main meter. Preheated combustion air flow transmitters shall be temperature compensated.

- 8.3.7 Fuel oil flow transmitters shall be supplied by Fischer & Porter.
- 8.3.8 The furnace shall be equipped with a continuous waste gas oxygen analyzing system with a circular chart recorder on the control panel board.
- 8.3.9 Control panels shall be pre-wired with yellow wire for 110 volt level and gray wire for low level. All wire to be tagged at both ends with Brady markers. Terminal strips shall be located in an accessible location. Purchaser retains the right to review and approve the entire control package.
- 8.4 All field-mounted instruments shall be suitably weatherproofed, with particular emphasis on protection for a dusty environment.
- 8.5 All instrumentation and control wiring shall be installed in conduit. Care shall be taken to avoid mixing power and signal wiring in the same conduit or tunnel for safety reasons and to minimize extraneous noise.
- 8.6 One 10-point annunciator panel shall be provided by the Vendor to indicate selected critical furnace functions and off-limit conditions. Annunciator shall incorporate a "first out" sequence.
- 8.7 Vendor shall include all equipment required to provide quality and pressures of compressed air needed for the instrumentation and control system, from the plant air provided by the Purchaser.
- 8.8 Vendor shall provide a complete insulated control and instrumentation house which includes a heating and air-conditioning system to provide positive pressure and a constant temperature of 75°F., all lighting, and all other required equipment for a complete installation unless otherwise specified herein.
- 8.9 Power Requirements
 - 8.9.1 The Purchaser shall provide a single 480 volt, 3 phase, 60 hertz, power supply at the furnace instrumentation and control house for furnace instrumentation and control. This 480 volt, 3 phase, 60 hertz, power supply will be unregulated and will vary between 440 to 480 volts. Furnace instrumentation and control voltages shall not exceed 120 volts. The required step down transformer shall be provided by the Vendor. The furnace shall have an independent and separate instrumentation and control system including an independent source of instrumentation and control voltage.

- 8.9.2 Purchaser shall provide a 480 volt, 3 phase, 60 hertz feeder to the furnace tub for connection to Vendor's MCC for walking beam power.

9.0 ELECTRICAL

- 9.1 Vendor shall furnish and install lighting fixtures, switches, and accessory equipment required for illumination at the furnace control house and in the furnace area.
- 9.2 Temperature controls and auxiliaries shall use 120 volt, 60 cycle, single phase.
- 9.3 All assemblies shall be pre-wired insofar as practicable. All wiring shall have specifications to meet operating environment. All grounding, wiring, and electrical equipment shall conform to Purchaser's Electrical Design and Construction Standards (where applicable) added to this specification.
- 9.4 Acceptable Vendors for all AC motors include G.E., Allis Chalmers, Westinghouse, Reliance, Delco, and A.O. Smith.

10.0 PLATFORMS, WALKWAYS AND STAIRWAYS

- 10.1 All accesses between different elevations shall be by stairs only. These stairs shall be a minimum of 30 inches wide and at an angle no steeper than 45 degrees unless otherwise agreed between the Purchaser and the Vendor. Underside of stairs shall be covered by 16 gauge steel sheet, if personnel may be in danger from falling objects.
- 10.2 All stairs shall be welded steel grating supported by structural steel. Grating shall be Blaw-Knox type J-21; Main bar 1 in. x 3/16 in. on 15/16 in. center, cross bars on 4 in. centers, and maximum span of 3 ft. - 0 in.
- 10.3 All platforms, walkways, or steel floors shall be Blaw-Knox steel grating or plate supported by structural steel. Design load (live) shall be a minimum of 300 lbs/sq. ft. for platforms. Design load (live) shall be a minimum of 150 lbs/sq. ft. for walkways.

Exceptions:

- (1) From the east girder of the charging tables to a distance 10'-0" east of the tables shall be a minimum of 2" steel plate. Plate and supporting structural steel shall be

designed to withstand impact of 90,000 # slab falling off of charging table. (floor elev. = 107'-0", table elev. = 110'-0")

- (2) Two 6'-0" wide sections, one on each side of #4 furnace, extending from charging tables to delivery tables, shall be designed to support 6 ton towmotor tractor with load. This section of plate shall be at same elevation of surrounding grating. (top elev. 107'-0")

- 10.4 All handrails and stairs shall conform to Armco Standard Drawing Nos. 678983, 678984, and 574545.
- 10.5 Walkways shall provide access to the following on the furnace:
 - 10.5.1 Soak Zone - Roof Fired Burners.
 - 10.5.2 Burner Platform - Top Charge Zone.
 - 10.5.3 Burner Platform - Top Heat Zone.
 - 10.5.4 All Bottom Zone Burners.
 - 10.5.5 Oxygen Analyzer Sample Probe.
 - 10.5.6 All pressure and temperature sensing devices and control valves.
 - 10.5.7 Main water supply valves with access from the work platform.
- 10.6 A walkway shall be provided to connect the soak zone burner platform with existing #3 furnace.
- 10.7 Work platform alongside the entire length of the furnace shall be provided for observation of slabs in the furnace. Platform shall extend from sidewall of furnace to centerline of building columns, approximately 20' in width.
- 10.8 All walkways exposed to excessive temperature shall be protected by heat shields of corrugated sheeting on sides and firebrick on bottom.

11.0 ARMCO STANDARDS PROGRAM

Vendor shall incorporate the following standard items into the design of the furnaces.

11.1 Air Cylinders

All air cylinders for operating furnace doors shall be heavy duty, mill type cylinders. Cylinder shall have a wiper at piston rod. Cylinders shall conform to J.I.C. Standards. Air cylinders shall be sized for a minimum air supply of 60 PSIG.

11.2 Air Valves (manual) Directional

Supplier of manual directional air valves shall be specified by Vendor. Valves shall be steel, poppet type with horizontal lever handle constructed to conform to J.I.C. Standards.

11.3 Grease Fittings

Shall be 3/8" Alemite, steel, giant button head type, standard fittings, sized to provide quick filling of grease receptacle. Relief fittings shall be Lincoln set for 5 oz. pressure relief. A Farval system shall be provided for greasing remote or inaccessible bearings.

12.0 START-UP SUPERVISION AND PERSONNEL TRAINING

Vendor shall furnish engineering and start-up supervision for a specified period and shall furnish the personnel required to train Purchaser's operators in the operation of the furnace.

13.0 PAINTING

All fabricated steel work shall have a shop coat of heat-resisting prime paint before shipment and after erection. All exposed structural steel, plate work, and door castings shall be painted with heat resisting paint after installation. The control room shall be painted both interior and exterior with an approved color of paint. All painting shall conform to Armco Corporate Paint Standards (applicable sections are attached hereto).

14.0 RECOMMENDED SPARES

Vendor shall provide a list of recommended spares for all equipment furnished or installed by the Vendor. List shall indicate type, part number, manufacturer's name, size, unit price, and all other required information and the recommended number of spares.

15.0 SAFETY DEVICES

Vendor shall equip the work covered by this specification with all proper safety devices for the protection of workmen and shall provide suitable, removable safety guards for all exposed moving parts, such as belts, couplings, and the like. Vendor warrants that such work will meet the requirements of, and be in conformity with Armco Safety Department and any and all applicable Federal and local laws, rules, regulations and ordinances. Vendor shall provide personnel protection from burns insofar as practicable.

16.0 GUARANTEE

The Vendor shall and does hereby guarantee the equipment furnished by him under the terms of the Contract will be well designed and manufactured, will perform successfully the operation for which it is purchased at the speed, rating and capacity stated in the specification, and that all materials used will be of first class quality and suitable for their respective purposes.

- 3.6.7 Standards - All fuel and combustion control firing equipment shall conform to F.I.A. and N.B.F.U. rules and standards. All piping shall conform to Armco Piping Standards, ACS-400.

4.0 REFRATORIES AND INSULATION

The refractory materials listed below shall be the type of refractory exposed to the furnace heat. The Vendor shall design the thickness of all sections and the recommended insulation backup required.

<u>Type of Refractory</u>	<u>Acceptable Vendors</u>
High Heat Duty Firebrick Super Duty Firebrick 60% Alumina Firebrick	{ General Refractories A. P. Green North American Refractories Co.
Insulating Fire Brick	{ Johns-Manville Babcock & Wilcox Refractory & Insulation Corp.
Super Duty Plastic (air setting type) RAMITE WSP (includes Super-25-Ramtite and 90% High Alumina Ram) and castable material.	{ Ramtite C.E. REFRACTORIES KALIS Plibrico

All refractories shall conform to Armco Steel Corporation Refractories Specification, when applicable. (Refer to attached Specification ASC-102/65.) Vendor shall specify suspension system, M. H. Detrick or equal.

4.1 Sidewalls

1 1/2" INSULATION BLOCK 7 1/2" SUPER DUTY FIREBRICK
7 1/2" " " BRICK ANCHORS
16 1/2" TOTAL

From skidline-up shall be a composite wall construction using super duty fire brick anchors and paneled with super duty plastic. Panels shall be approximately 3 ft. x 4 ft. or 4 ft. x 4 ft.

4.2 Roof (Except Soak Zone)

Shall be 60% alumina fire brick with M. H. Detrick suspension system.

4.3 Bottom

Shall be a cast bottom of castable material (Pli-Cast #31 or C-E Refractories equivalent.)

4.4 All Burner Walls

Shall be super duty plastic.

4.5 Nose Construction

Shall be super duty plastic with a separate suspension design similar to the existing furnaces.

4.6 Soak Zone Roof

Shall be flat with roof burners in it. Roof shall be of monolithic construction suspended by high heat duty fire brick anchors (M. H. Detrick suspension system), rammed with super duty plastic. Piping for combustion air and gas shall be designed so as to allow for differential thermal expansion.

4 - BULKHEADS AT LOWER EL. (AT FCC FLOOR)

4.7 Uptakes

PROVIDE 2'x3' BULKHEAD ON NORTH & SOUTH SIDE - FOR MASONRY ENTRY
Shall be super duty plastic (M. H. Detrick design).

4.8 Skid Pipes and Supports

50" x 180" 2" DIAL
ALL DISCHARGE PIPE TO HAVE DIAL THERMOMETERS, EXIT VALVES TO HAVE 1 1/4" HOLE IN DISK
Skid pipes shall be of heavy cross-section and spaced as required to properly support the slabs. Vendor shall recommend his choice of skid pipe and support pipe insulation designed to give the best protection with the longest service life. DUAL HOSE FEED AT ENTRY END
PROVISIONS FOR FIRE STATION - FROM 36" LINE

4.9 Combustion Air Headers

All preheated combustion air headers shall be suitably insulated.

5.0 STEELWORK

(NOTE:
MORE ELECT. & WATER OUTLETS)

5.1 Structural Steel

5.1.1 The steel used to support and bind the furnace shall be of sufficient section to withstand temperature and stresses encountered. Buckstays of steel slabs shall be used for the critical areas (soak zone and the required portion of the heat zone). Vendor shall specify size of main structural members.

5.1.2 The furnace shall be supported on steel columns and structural framework. The columns shall be supported by basement foundation. All areas under the furnace shall be accessible insofar as practicable.

Final Specification

For

#4 Slab Reheat Furnace
86" H.S.M., Middletown Works

Project 7147

Armco Steel Corporation
Middletown, Ohio

November 19, 1969

SLAB REHEAT FURNACE

1.0 SCOPE OF WORK

- 1.1 The work to be performed under the terms of this specification shall consist of furnishing all materials, transportation and labor required to design, detail, fabricate, deliver, unload, store, erect, and start-up one (1) walking beam type Slab Reheat Furnace for the 86" Hot Strip Mill at Middletown Works all as specified herein.
- 1.2 The Vendor shall be responsible for the structural, mechanical and electrical design of the furnace, and for the installation and start-up of the furnace.
- 1.3 The Vendor shall furnish a complete installation including (but not limited to) all fuel, steam, water, and air piping, and appurtenances; combustion controls; walking beam mechanism controls; foundation anchor bolts; boiler inlet flue with isolation damper; natural draft stack with furnace pressure control damper; and an instrument and control house, unless otherwise specified herein.
- 1.4 The Vendor shall furnish and install all electrical equipment and wiring unless otherwise specified herein.
- 1.5 The Vendor shall design the furnace and the furnace control and instrumentation systems for compatibility with computer control subject to Purchaser's approval.
- 1.6 The Vendor shall design the furnace and the furnace control and instrumentation systems for compatibility with a Waste Heat Boiler, all final design to be subject to Purchaser's approval.
- 1.7 The Vendor shall supply all drawings and bills of material in accordance with Schedule 1 attached hereto.

2.0 SUPPLIED BY OTHERS

- 2.1 All foundations with buried conduit and grounding, and backfill in place as shown on the Vendor's foundation drawings. Anchor bolts furnished by Vendor will be installed by Purchaser.
- 2.2 All permanent buildings with the exception of the instrumentation and control house.

- 2.3 Entry skids between charge table and furnace; discharge skids between furnace and delivery table.
- 2.4 All high bay lighting.
- 2.5 The following utilities for furnace operations:
 - 2.5.1 440-480 volt, 3 phase, 60 hertz power. (Vendor shall specify quantity required.)
 - 2.5.2 2400 volt, 3 phase, 60 hertz power. (Vendor shall specify quantity required.)
 - 2.5.3 Plant air at 90 psig maximum, 60 psig minimum, and dry - (Vendor shall specify quantity required.)
 - 2.5.4 Water at a minimum of 35 psig and a maximum of 120 psig. - (Vendor shall specify quantity required with 70% insulated skids and with 100% insulated skids.)
 - 2.5.5 Natural gas at 50 psig and 950 BTU/SCF - (Vendor shall specify quantity required.)
 - 2.5.6 No. 6 Fuel Oil at 150 psig and 125° F. - (Vendor shall specify quantity required.)
 - 2.5.7 Atomizing steam at 165 psig and 500° F. maximum - (Vendor shall specify quantity required.)
 - 2.5.8 Tracer steam at 10 psig and saturated - (Vendor shall specify quantity required.)
- 2.6 Mechanical slab extractor and slab pusher.
- 2.7 All construction power and utilities and limited use of the mill aisle overhead crane. Crane will not be available on Mondays.
- 2.8 One waste heat boiler complete with air heater, which shall interface with the furnace at elevation 154' at the boiler inlet flue and at the furnace combustion air header inlet; other interfaces in the instrumentation and control system shall be coordinated with the waste heat boiler supplier.
- 2.9 One turbine-driven F.D. fan for preheated combustion air. Preheated combustion air will be delivered at approximately 500°F. maximum.

- 2.10 One turbine-driven I.D. fan with stack for exhausting the waste gases through the waste heat boiler.
- 2.11 Closed circuit television equipment to view the discharge of slabs from both sides of the furnace.
- 2.12 Resalloy door sections for charge door.

3.0 DESIGN CRITERIA

3.1 Maximum Temperature Requirement

Furnace shall be designed to heat low carbon steel slabs (for automotive and deep drawing quality) to a maximum uniform temperature of 2375°F. The temperature gradient between the hottest and coldest points in each slab must not be greater than 50°F. Slab furnace design temperature shall not exceed 2475°F.

3.2 Slab Information

Furnace shall be capable of handling the following slab sizes and conditions:

<u>Slab Sizes</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Type</u>
Thickness	7"	10"	Rolled Slabs
Thickness	9"	11"	Continuous Cast Slabs
Width	26"	82"	Rolled Slabs
Width	26"	82"	Continuous Cast Slabs
Length-Double Row	13'-0"	16'-0"	Rolled Slabs
Length-Single Row	28'-0"	33'-0"	Rolled or Continuous Cast Slabs
Weights	11,000#	90,000#	Rolled or Continuous Cast Slabs (Rolled to a maximum 1100 P.I.W. coil)

3.3 Heating Capacity

Vendor shall submit the designed furnace heating capacity expressed in pounds per hour per square foot to utilized hearth for 8 in., 9 in., 10 in., and 11 in. thick slabs. Vendor shall also express heating rate in tons per hour based on single length slabs, 33 feet long, with no gap between slabs. Heating curves shall be supplied plotting slab surface and center temperature versus furnace temperature for each thickness. The connected firing rate shall not exceed 1,000,000,000 BTU/hour.

3.4 Information for Boiler Design

Vendor shall submit in his proposal the following information which is required for the design of the waste heat boiler:

- 3.4.1 Flue gas flow into boiler _____ lbs/hr.
(Including air infiltration)
- 3.4.2 Flue gas temperature into boiler _____ °F.
- 3.4.3 Draft at boiler inlet _____ in. W.C.

The above information shall be provided for each of the following conditions: (assume 100% skid pipe insulation).

- (1) Maximum (connected) firing rate.
- (2) Normal firing rate for 8", 9", 10", and 11" thick slabs.
- (3) Holding firing rate (assume 1800°F.).

3.5 General Design

3.5.1 Furnace shall be six (6) zone, walking beam type with the following dimensions:

- (1) Inside width 36 ft. - 0 in.
- (2) Effective hearth length 114 ft. - 0 in.
- (3) Effective hearth area 114 x 33 = 3762 sq. ft.
- (4) Centerline to centerline of roll tables 145 ft. - 6 in.

- | | |
|--|-----------------|
| (5) Centerline to centerline of
furnace bays | 80 ft. - 0 in. |
| (6) Mill table elevation | 110 ft. - 0 in. |
| (7) Furnace tub floor elevation | 87 ft. - 0 in. |
| (8) Centerline charging table to
inside charge door | 16 ft. - 0 in. |
| (9) Centerline charging table to
back limit of walking
beam travel | 6 ft. - 0 in. |

Vendor shall submit a minimum of two general arrangement drawings showing a longitudinal section and a cross section of the furnace and uptake flues including:

- (1) Length of each zone.
- (2) Overall furnace configuration with dimensions.
- (3) Skid arrangement and spacing.
- (4) Burner spacing.
- (5) Boiler and stack damper arrangements.

3.5.2 Zones shall be as follows:

- (1) Bottom charge zone.
- (2) Top charge zone.
- (3) Bottom heat zone.
- (4) Top heat zone.
- (5) Bottom soak zone.
- (6) Top soak zone.

3.5.3

Furnace shall be arranged for end charge and end discharge. Furnace shall be designed for a mechanical slab extractor to lift slabs from the furnace and place them on the furnace delivery table, and for a light weight slab pusher for charging slabs. Discharge door design shall be coordinated with United Engineering and Foundry.

- 3.5.4 Vendor shall coordinate with Purchaser to locate television equipment to view the discharge of slabs from both sides of the furnace.

3.6 Combustion

- 3.6.1 Burners - Vendor shall recommend the size (BTU rating), number and location of burners for each zone. Bottom zone burners shall be opposed rather than staggered. Vendor shall submit preheated combustion air requirements for connected firing rate, normal firing rate and holding firing rate (assume 100% skid insulation).
- (1) Roof-type, cold -air burners (Bloom H.T.R.) with continuous pilots shall be used for the top soak zone.
 - (a) Equipment shall be provided to facilitate manual ignition of the top soak zone burners.
 - (2) All other burners shall be dual fuel hot air burners as follows: (Vendor shall specify burner supplier).
 - (a) Capable of withstanding 200°F. above maximum combustion air temperatures.
 - (b) Oil burners shall be removable and retractable (when not in use) and shall have locking device to lock in the "in" or "out" position.
 - (c) All burners shall have a turndown capable of holding furnace at 1800°F.
 - (d) All burners shall be capable of lighting from an external location.
 - (3) Bottom zone burners shall be equipped with two gas tubes supplied from individual inlet connections. Each inlet shall be equipped with a shut off valve and a manually adjustable or replaceable flow control orifice for adjustment of flame length to insure even heat distribution from side to side of the furnace when the zone firing rate is cut back.

3.6.2 Fuels - All zones except the top soak zone shall be fired with natural gas or No. 6 fuel oil as follows:

(1) Natural gas - 950 BTU/Cu. Ft. Net

(2) No. 6 fuel oil - 144,000 BTU/Gal. Net

Top soak zone shall use only natural gas. No. 6 fuel oil will be used on the other zones during periods of natural gas curtailment.

3.6.3 Soak Zone Combustion Air Blower - Vendor shall furnish the cold air blower and motor for supplying combustion air to the top soak zone burners. Purchaser will supply the starter for the soak zone blower motor from an existing motor control center located at elev. 154' near Column 7. The blower shall be located approximately 100 feet from the MCC and at the same elevation. Vendor shall specify static pressure and quantity of cold combustion air required in addition to horsepower of motor. Ambient air at inlet to fan will be a maximum of 120°F. Fan shall be designed for 120% of theoretical requirement.

3.6.4 Atomization of No. 6 Fuel Oil - The furnace shall be equipped for steam atomization of No. 6 fuel oil for all zones except the top soak zone. All valves shall be capable of withstanding an excess of 200°F. above steam temperature. All insulation shall be protected from damage by sheet metal covering.

3.6.5 Fuel Oil Heater - Vendor shall supply a heater to preheat oil to the correct temperature for proper flow through pipelines and for proper combustion. Heater shall be installed at elev. 154' within 40 feet of the furnace centerline.

3.6.6 Valves and Accessory Equipment - Vendor shall submit a recommended list of quantities, sizes, and suppliers of all furnace equipment. Purchaser will retain the right to upgrade the quality, increase the quantity or dictate the source of supply where necessary to conform to existing mill standards and practices.

3.6.7 Standards - All fuel and combustion control firing equipment shall conform to F.I.A. and N.B.F.U. rules and standards. All piping shall conform to Armco Piping Standards, ACS-400.

3.7 Natural Draft Stack

Vendor shall provide a natural draft by-pass stack, with connecting flue, to exhaust waste gases from the furnace when the waste heat boiler inlet damper is closed. The stack shall be designed for the maximum firing rate of the furnace and shall terminate at elev. 279'-3". Vendor shall specify stack diameter, thickness and refractoriness of the stack lining and submit an estimate of the stack shell temperature at maximum firing rate. Stack design shall include furnace pressure control dampers with associated control equipment. Motor operated, water cooled butterfly dampers shall be installed in flue below boiler house floor (elev. 154'-0"). Vendor shall submit an estimate of weights of stack and flue for determination by Purchaser of adequate structural steel for their support.

3.8 Furnace Control House

An extension to the existing furnace control house located south of the extractor pulpit at approximate elev. 120', shall be provided by Vendor. The control house shall be of the same size and construction as shown on Armco drawings 609968, 609969, 609970, and 601164 and shall be extended 38'-0" south. A 60,000 BTU/hr. cooling capacity air-conditioner (5-ton unit) shall be supplied with control house as well as all lighting. The existing south end wall and door shall be removed to make one large control room. A door will be required at the south end of the building and at the center front.

3.9 Scale Removal System

The Vendor shall furnish a complete scale removal system which will discharge into Purchaser's flume at either end of furnace.

4.0 REFRATORIES AND INSULATION

The refractory materials listed below shall be the type of refractory exposed to the furnace heat. The Vendor shall design the thickness of all sections and the recommended insulation backup required.

Type of Refractory

High Heat Duty Firebrick
Super Duty Firebrick
60% Alumina Firebrick

Acceptable Vendors

General Refractories
A. P. Green
Kaiser ← ADD 1-1-70
North American Refractories Co.

<u>Type of Refractory</u>	<u>Acceptable Vendors</u>
Insulating Fire Brick	{ Johns-Manville Babcock & Wilcox KAISER ← ADD 1-1-70 Refractory & Insulation Corp. }
Super Duty Plastic (air setting type)	{ C-E Refractories Kaiser Plibrico }

All refractories shall conform to Armco Steel Corporation Refractories Specification, when applicable. (Refer to attached Specification ASC-102/65.) Vendor shall specify M.H. Detrick suspension system.

4.1 Sidewalls

From bottom of furnace to bottom of arch shall be 16½" composite wall construction of M.H. Detrick design. The construction shall consist of super duty hot face anchors to support the 7½" depth of super duty plastic, a permanent back-up of first quality tile, necessary castings, mortar, and steel retaining clips. The void between the casing and cold face refractory will consist of poured concrete (Decrete 40). Plastic panels shall be 4 ft. x 4 ft.

4.2 Roof (Except Soak Zone)

Top charge and top heat zones shall be M.H. Detrick Versa-Tile design consisting of 60% Alumina refractory, 10" hung tile on 16" center, 7½" filler tile, castings and alumina silicate felt expansion joints. Block insulation 2" thick and ½" castable shall insulate the arch.

4.3 Bottom

Shall be 12" of Pli-Cast #31 or C.E. Refractories equivalent, (Moldit-D) and 5" of 2000°F. insulating firebrick. Floor to be covered with 3" of yellow silica sand.

4.4 Burner Walls

Top zone burner walls shall be 18" of super duty plastic backed with 1½" block insulation. Anchoring system will be M.H. Detrick anchor clusters and Meehanite castings on 2'-0" centers. The hot face tile in each cluster will be 60% Alumina. Refractories and the other tile will be of first quality refractory material.

4.5 Nose Construction

The charge end nose (#1) shall be of M.H. Detrick "DETRED" arch construction extending to approximate elevation of 114'-6".

Noses #2, #3, and #4 shall be 9" super duty plastic with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 12" centers with necessary Meehanite radial and clip castings and 25-12 alloy shelf castings.

4.6 Soak Zone Roof

Shall be flat with roof burners in it. Roof shall be 9" super duty plastic with M. H. Detrick suspension system consisting of 10" super duty anchor tile on 12" centers and the necessary castings for attachment. Piping for combustion air and gas shall be designed to allow for differential thermal expansion. Soak zone shall be designed with a 20' x 20' removable section for maintenance.

4.7 Uptakes and Flues

4.7.1 Side Walls

Shall be 9" super duty plastic backed with a minimum of 3½" block insulation with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 18" centers and necessary castings for attachment. Rows of shelf castings shall be provided at 3' intervals. Vendor shall state skin temperature of furnace casing assuming a hot face temperature of 2400°F.

4.7.2 Arch

Shall be 9" super duty plastic with M.H. Detrick suspension system consisting of 10" super duty anchor tile on 12" centers and the necessary castings for attachment.

Sloping wall leading to stack uptake at approximate elev. 125' shall be M.H. Detrick "DETRED" construction consisting of 10" first quality firebrick.

4.7.3 Bottom

Shall be 9" super duty plastic or Plicast #31 with 1½" of 1600°F. insulating firebrick.

4.7.4 Boiler Inlet Flue

Shall be super duty plastic same as 4.7.1 with the top of the flue at elev. 154' rammed to conform to the shape of the boiler header at that elevation.

4.8 Skid Pipe and Supports

All movable and stationary posts and longitudinals shall be insulated with 2" of castable over cooling studs (Plicast 27-S or equal).

4.9 Combustion Air Headers

Shall be lined with $4\frac{1}{2}$ " of 800°F. insulating firebrick. Burner lagging shall be $2\frac{1}{2}$ " Superex M plus $\frac{1}{2}$ " J.M. #352 finishing cement.

4.10 Inspection Door Lining

Each door will be lined with 7" of Pli-Cast #31 high temperature castable, or approved equal.

4.11 Discharge Doors

Shall be lined with 5" medium weight, high strength 2600°F. insulating castable with 1" block insulation. Steelwork shall be water-cooled at all edges.

4.12 Discharge Wall Curtain

Shall consist of M.H. Detrick chain wall design, $13\frac{1}{2}$ " super duty refractory and necessary castings.

4.13 Oil and Steam Pipe Insulation

Shall conform to Purchaser's standard specification #ASC-400-35.

5.0 STEELWORK

5.1 Structural Steel

5.1.1 The steel used to support and bind the furnace shall be of sufficient section to withstand temperature and stresses encountered. Buckstays of steel slabs shall be used for the critical areas (soak zone and the required portion of the heat zone). Vendor shall specify size of main structural members.

- 5.1.2 The furnace shall be supported on steel columns and structural framework. The columns shall be supported by basement foundation. All areas under the furnace shall be accessible insofar as practicable.
- 5.1.3 Side wall casing shall be 1/4 inch plate minimum.
- 5.1.4 Burner wall casing (including bottom side-fired burners) shall be 1/2 inch plate minimum.
- 5.1.5 Hearth (Bottom Zones) shall have 1/2 inch plate minimum with structural support of 6 inch channel.
- 5.1.6 Structural supports shall be water cooled at all critical points (i.e., door lintels, furnace noses, etc.). Lintels shall be pressure tested at 120 psig.
- 5.1.7 Skid pipes shall be supported by water-cooled pipe supports.

5.2 Doors

- 5.2.1 Charge door shall be in two halves of three resalloy plates each to withstand furnace temperature and designed for air cylinder operation, controlled to hold each half door in any position from open to closed. Purchaser will supply resalloy door sections made from Armco pattern No. 17101. Vendor will supply all other door equipment.
- 5.2.2 Discharge door shall be Vendor's design subject to Purchaser's approval, to withstand furnace temperature and designed to interlock with the mechanical extractor. Design of discharge door shall be coordinated with United Engineering and Foundry Company. Door shall be constructed in two halves with each half operated by a 10 HP motor driving a line shaft through less than 360° rotation. Door halves shall be hung on chains secured to sheaves on the line shaft. Separate small doors shall be provided to cover the extractor arm slots in the furnace endwall.
- 5.2.3 Inspection doors shall consist of twenty (20) ductile iron doors, 3' high by 2' wide, with cheek plates and mantles for the furnace. All doors shall be independently operated by air cylinders from a valve stand. Doors shall be located to allow inspection of water-cooled support pipes in addition to tops of slabs

(bottom of door at approximate elev. 108').

- 5.2.4 Location of eight (8) brick bulkheads for clean-out shall be decided by Purchaser at a later date.

6.0 WALKING BEAM MECHANISM

6.1 Walking Beam Frame

- 6.1.1 Vendor shall propose his recommended design for the walking beam frame including sufficient detail to make an engineering evaluation.
- 6.1.2 Vendor shall submit a general arrangement drawing showing size of main structural members, scale removal provisions, details of walking beam slot seals, and skid support pipe attachment to frame.
- 6.1.3 Vendor shall state design stresses used for structural members including factor of safety added to calculated stresses.
- 6.1.4 The walking beam frame shall be designed with a means of lowering safely and with no extreme shock in the event of power failure while in a raised position with a full load of slabs.
- 6.1.5 Skid pipes shall be 5½" O.D. steel tubing with 1" wall thickness. Six (6) stationary and four (4) walking skids shall be required. Each skid pipe shall have suitable alloy riders, wear bars, or buttons in the heat and soak zones. Each skid shall be constructed in a least two longitudinal sections to minimize the effect of thermal expansion. Spacing of skids across the furnace width shall be subject to final approval by Purchaser.

6.2 Lifting and Traverse Mechanism

Vendor shall propose his recommended design for the walking beam mechanism including sufficient detail to make an Engineering evaluation. Vendor shall specify type of drive, horsepower requirements, principle of operation, and all auxiliary equipment associated with the drive system. In the case of a hydraulic system, multiple pumps and motors will be required with one (1) complete installed spare so that failure of one pump/motor combination will not shut down the furnace.

6.3 Controls and Sequence of Operation

- 6.3.1 Vendor shall specify and supply the control system required to charge, walk through, and discharge slabs including a complete time/motion study of the walking beam travel. Production limitations shall be calculated based on all widths and thicknesses of slabs for single and double row charging.
- 6.3.2 Controls shall include a means of slowing the lift stroke so the walking beams contact the slabs at a velocity of one-half inch per second.
- 6.3.3 The walking cycle shall be designed to bring the trailing edge of the slab to be extracted to the same exact location each time. Intelligence shall be provided to measure the apparent width of each slab charged and store this width in memory until it is needed to cycle that slab to the extract position. Vendor shall supply complete hardware for measuring the walking beam stroke, measuring the pusher stroke, calculating the number of walks and length of walk required for the next extract, and calculating the space available for charging a slab. Details of the control system shall be subject to Purchaser's approval.

6.4 Frame Loading Criteria

The walking beam skids and frame shall be designed to support a full load of 12-inch thick slabs, 33 feet long, with no space between slabs. Vendor shall state total dead load of the walking beam frame.

7.0 COMPUTER CONTROL AND DATA LOGGING FUNCTIONS

7.1 Data Logging Functions

Computer shall continuously monitor temperature for each zone of the furnace. Vendor shall supply a 0.5 volt signal proportional to zone temperature for use by computer.

7.2 Control Functions

Capability of furnace temperature set points to be set by computer. Initiation of walk cycle, push, and extract shall be by computer or by manual control.

8.0 FURNACE CONTROLS AND INSTRUMENTATION

- 8.1 All controls and instrumentation, including all mounting hardware, connections, special fittings, heat shields and safety devices, shall be furnished and installed by the Vendor with the exception of special instrumentation or controls furnished for the computer by Westinghouse Electric Corporation.
- 8.2 Furnace shall be capable of being operated remotely from the instrumentation and control room in manual or automatic modes, or zone temperature set points by the computer.
- 8.3 All controls and instrumentation shall be supplied by L & N as closely as possible to the controls on #1, #2, and #3 slab furnaces. Vendor's proposal should include L & N's proposal for the complete instrumentation package.
 - 8.3.1 All fuel valve operators shall be electric motor operated.
 - 8.3.2 All combustion air valve operators shall be electric motor operated.
 - 8.3.3 All air butterfly valves shall be Continental Butterfly, and have the same temperature rating as burners.
 - 8.3.4 Zone temperature shall be measured by a pt-pt 13% rh T.C. wired directly to an L & N Model "H" circular chart recorder with set point indicator. Temperature control shall be Model "C" P.A.T. with an additional computer controlled set point module and switch for going from "computer" to "local" control.
 - 8.3.5 Furnace pressure shall be controlled by electric motor operated butterfly dampers in the natural draft stack inlet flue. The controller shall be an L & N Model "C" P.A.T.
 - 8.3.6 Fuel-air ratio controls shall be L & N Model "C" P.A.T. A fuel limit control shall prevent excess fuel with respect to air flow. Recorders shall be M-line strip chart (4 inch) type with chart speed of one (1) inch per hour for fuel flow and air flow for each zone. Total fuel flow and steam flow to each furnace shall be recorded and integrated on a separate main meter. Preheated combustion air flow transmitters shall be temperature compensated.

- 8.3.7 Fuel oil flow transmitters shall be supplied by Fischer & Porter.
- 8.3.8 The furnace shall be equipped with a continuous waste gas oxygen analyzing system with a circular chart recorder on the control panel board.
- 8.3.9 Control panels shall be pre-wired with yellow wire for 110 volt level and gray wire for low level. All wire to be tagged at both ends with Brady markers. Terminal strips shall be located in an accessible location. Purchaser retains the right to review and approve the entire control package.
- 8.4 All field-mounted instruments shall be suitably weatherproofed, with particular emphasis on protection for a dusty environment.
- 8.5 All instrumentation and control wiring shall be installed in conduit. Care shall be taken to avoid mixing power and signal wiring in the same conduit or tunnel for safety reasons and to minimize extraneous noise.
- 8.6 One 10-point annunciator panel shall be provided by the Vendor to indicate selected critical furnace functions and off-limit conditions. Annunciator shall incorporate a "first out" sequence.
- 8.7 Vendor shall include all equipment required to provide quality and pressures of compressed air needed for the instrumentation and control system, from the plant air provided by the Purchaser.
- 8.8 Vendor shall provide a complete insulated control and instrumentation house which includes a heating and air-conditioning system to provide positive pressure and a constant temperature of 75°F., all lighting, and all other required equipment for a complete installation unless otherwise specified herein.
- 8.9 Power Requirements
- 8.9.1 The Purchaser shall provide a single 480 volt, 3 phase, 60 hertz, power supply at the furnace instrumentation and control house for furnace instrumentation and control. This 480 volt, 3 phase, 60 hertz, power supply will be unregulated and will vary between 440 to 480 volts. Furnace instrumentation and control voltages shall not exceed 120 volts. The required step down transformer shall be provided by the Vendor. The furnace shall have an independent and separate instrumentation and control system including an independent source of instrumentation and control voltage.

- 8.9.2 Purchaser shall provide a 480 volt, 3 phase, 60 hertz feeder to the furnace tub for connection to Vendor's MCC for walking beam power.

9.0 ELECTRICAL

- 9.1 Vendor shall furnish and install lighting fixtures, switches, and accessory equipment required for illumination at the furnace control house and in the furnace area.
- 9.2 Temperature controls and auxiliaries shall use 120 volt, 60 cycle, single phase.
- 9.3 All assemblies shall be pre-wired insofar as practicable. All wiring shall have specifications to meet operating environment. All grounding, wiring, and electrical equipment shall conform to Purchaser's Electrical Design and Construction Standards (where applicable) addended to this specification.
- 9.4 Acceptable Vendors for all AC motors include G.E., Allis Chalmers, Westinghouse, Reliance, Delco, and A.O. Smith.

10.0 PLATFORMS, WALKWAYS AND STAIRWAYS

- 10.1 All accesses between different elevations shall be by stairs only. These stairs shall be a minimum of 30 inches wide and at an angle no steeper than 45 degrees unless otherwise agreed between the Purchaser and the Vendor. Underside of stairs shall be covered by 16 gauge steel sheet, if personnel may be in danger from falling objects.
- 10.2 All stairs shall be welded steel grating supported by structural steel. Grating shall be Blaw-Knox type J-21; Main bar 1 in. x 3/16 in. on 15/16 in. center, cross bars on 4 in. centers, and maximum span of 3 ft. - 0 in.
- 10.3 All platforms, walkways, or steel floors shall be Blaw-Knox steel grating or plate supported by structural steel. Design load (live) shall be a minimum of 300 lbs/sq. ft. for platforms. Design load (live) shall be a minimum of 150 lbs/sq. ft. for walkways.

Exceptions:

- (1) From the east girder of the charging tables to a distance 10'-0" east of the tables shall be a minimum of 2" steel plate. Plate and supporting structural steel shall be

designed to withstand impact of 90,000 # slab falling off of charging table. (floor elev. = 107'-0", table elev. = 110'-0")

- (2) Two 6'-0" wide sections, one on each side of #4 furnace, extending from charging tables to delivery tables, shall be designed to support 6 ton towmotor tractor with load. This section of plate shall be at same elevation of surrounding grating. (top elev. 107'-0")
- 10.4 All handrails and stairs shall conform to Armco Standard Drawing Nos. 678983, 678984, and 574545.
- 10.5 Walkways shall provide access to the following on the furnace:
 - 10.5.1 Soak Zone - Roof Fired Burners.
 - 10.5.2 Burner Platform - Top Charge Zone.
 - 10.5.3 Burner Platform - Top Heat Zone.
 - 10.5.4 All Bottom Zone Burners.
 - 10.5.5 Oxygen Analyzer Sample Probe.
 - 10.5.6 All pressure and temperature sensing devices and control valves.
 - 10.5.7 Main water supply valves with access from the work platform.
- 10.6 A walkway shall be provided to connect the soak zone burner platform with existing #3 furnace.
- 10.7 Work platform alongside the entire length of the furnace shall be provided for observation of slabs in the furnace. Platform shall extend from sidewall of furnace to centerline of building columns, approximately 20' in width.
- 10.8 All walkways exposed to excessive temperature shall be protected by heat shields of corrugated sheeting on sides and firebrick on bottom.

11.0 ARMCO STANDARDS PROGRAM

Vendor shall incorporate the following standard items into the design of the furnaces.

11.1 Air Cylinders

All air cylinders for operating furnace doors shall be heavy duty, mill type cylinders. Cylinder shall have a wiper at piston rod. Cylinders shall conform to J.I.C. Standards. Air cylinders shall be sized for a minimum air supply of 60 PSIG.

11.2 Air Valves (manual) Directional

Supplier of manual directional air valves shall be specified by Vendor. Valves shall be steel, poppet type with horizontal lever handle constructed to conform to J.I.C. Standards.

11.3 Grease Fittings

Shall be 3/8" Alemite, steel, giant button head type, standard fittings, sized to provide quick filling of grease receptacle. Relief fittings shall be Lincoln set for 5 oz. pressure relief. A Farval system shall be provided for greasing remote or inaccessible bearings.

12.0 START-UP SUPERVISION AND PERSONNEL TRAINING

Vendor shall furnish engineering and start-up supervision for a specified period and shall furnish the personnel required to train Purchaser's operators in the operation of the furnace.

13.0 PAINTING

All fabricated steel work shall have a shop coat of heat-resisting prime paint before shipment and after erection. All exposed structural steel, plate work, and door castings shall be painted with heat resisting paint after installation. The control room shall be painted both interior and exterior with an approved color of paint. All painting shall conform to Armco Corporate Paint Standards (applicable sections are attached hereto).

14.0 RECOMMENDED SPARES

Vendor shall provide a list of recommended spares for all equipment furnished or installed by the Vendor. List shall indicate type, part number, manufacturer's name, size, unit price, and all other required information and the recommended number of spares.

15.0 SAFETY DEVICES

Vendor shall equip the work covered by this specification with all proper safety devices for the protection of workmen and shall provide suitable, removable safety guards for all exposed moving parts, such as belts, couplings, and the like. Vendor warrants that such work will meet the requirements of, and be in conformity with Armco Safety Department and any and all applicable Federal and local laws, rules, regulations and ordinances. Vendor shall provide personnel protection from burns insofar as practicable.

16.0 GUARANTEE

The Vendor shall and does hereby guarantee the equipment furnished by him under the terms of the Contract will be well designed and manufactured, will perform successfully the operation for which it is purchased at the speed, rating and capacity stated in the specification, and that all materials used will be of first class quality and suitable for their respective purposes.

INDEX

Armco Standard Specifications

Refractories

ACS-19/1965 (Supercedes ACS-102/1965)	Fireclay Brick for Slab Furnace Applications
ACS-104/1965	Super Duty Plastic for Slab Furnace Applications

Electrical Equipment

MWS-500-02	Conduit
MWS-500-03	Wire and Cable
MWS-500-07	Relay Cabinet and Solenoid Control
MWS-500-11	Junction Boxes, Pull Boxes, and Outlet Boxes
MWS-500-14	Safety Disconnect Switches
MWS-570-03	Individual AC Motor Starters
MWS-570-06	Motors and Generators

Electrical Installation

ACS-500

Mechanical

ES4-1	Gear and Pinion Classification
ES5-1	Hydraulic Power System and Component Requirements

Piping

ACS-400-01	Piping - General
ACS-400-02	Piping - Steam - 150 psig - Saturated
ACS-400-03	Piping - Steam - 165 psig at 500°F.
ACS-400-06	Piping - Water - Contaminated 150 psig
ACS-400-12	Piping - Air - Compressed
ACS-400-14	Piping - Gas - Natural
ACS-400-18	Piping - Oil - Lubrication
ACS-400-19	Piping - Oil - Hydraulic - 975 psig
ACS-400-20	Piping - Oil - Hydraulic - 976 to 1500 psig
ACS-400-21	Piping - Oil - Hydraulic - 1501 to 3000 psig
ACS-400-22	Piping - Oil - Fuel
ACS-400-32	Piping - Grease Systems

ACS-400-33	Piping - Tubing and Hoses
ACS-400-34	Piping - Pickling and Cleaning
ACS-400-35	Piping and Equipment Insulation
ACS-400-36	Heating, Ventilating, and Air-Conditioning Ductwork
ACS-400-37	Piping - Color Code

Paint Standards

Corporate Paint Standards Section B - Surface Preparation
Section C - Application
Section E - Safety

Color chips and paint specifications to be submitted to Vendor as required to cover scope of work.

Safety

Dwg. No. 678983	Design Standards - Handrail Details
Dwg. No. 678984	Design Standards - Stair Details
Dwg. No. 574545	Standard Ladder and Safety Basket

SCHEDULE 1

ENGINEERING DATA REQUIRED WITH PROPOSAL AND PURCHASE ORDER OR SUB-CONTRACT

Inquiry No. EP-7147-867		Specification No.		Purchase Order or Sub-Contract No.	
See Definitions of Engineering Data On Reverse Side	Required with Quotation	Required After Purchase			
	4 Sets "Preliminary"	For Approval 3 Sets Prints	Certified as Approved 3 Sets Prints (See Note b)	Packed with Shipment 1 Set Prints (see Note c)	As-Built Print & Reproducible 1 Set Each (see Note d)
1. Drawing List		X	X		X
2. General Arrangement Drawings	X	X	X		X
3. Detailed Drawings		X	X		X
4. Dimension Drawings	X	X	X		X
5. Electrical Drawings		X	X		X
a. Single Line Drawings		X	X		X
b. Schematic Drawings		X	X		X
c. Interconnection Drawings		X	X		X
d. Panel Wiring Diagrams		X	X		X
e. Outline Drawings		X	X		X
6. Erection Drawings		X	X		X
7. Foundation Drawings		X	X		X
8. Piping Drawings		X	X		X
9. Hydraulic Piping Drawings		X	X		X
10. Load Diagrams		X	X		X
11. Performance Data		X	X		X
12. Wearing Part Drawings		X	X		X
13. Motor List		X	X		X
*14. Quotation for Recommended Spare Parts Showing Unit Prices		X	X	X	X
15. Bills of Material		X	X	X	X
*16. Operating Data Spare Parts List		X	X	X	X
Installation Instructions		X	X	X	X
Operating Instructions		X	X	X	X
Maintenance Manuals		X	X	X	X

*8 copies to the Project Engineer, (address shown below).

SPECIAL INSTRUCTIONS

- All drawings must be dimensioned in feet and inches. Drawing size must not be less than 18" x 24", nor larger than 24" x 36" without specific written approval from the Purchaser. All prints must be dark line on white background, direct reading type to conform to the minimum requirements for microfilming as shown on the reverse side. We WILL NOT ACCEPT BLUE-PRINTS.
- Certified drawings must be so marked by the Seller. They must conform to approval drawings as finally approved by the undersigned and must be forwarded promptly to the address shown below. Also, when applicable, an additional 2 copies shall be sent to the related equipment builder (address furnished later).
- Data to be packed with shipment is, in addition to Packing List specified in the marking and shipping instructions. Containers to be clearly marked "Operating Data and Erection Drawings enclosed."
- Reproducibles shall conform to the standard reproducible specifications as shown on reverse side, and sent to the address shown below.
- One print of each "preliminary" drawing, if required, shall be attached to each copy (priced and unpriced) of the proposal and returned to the addresses indicated in the request for quotation.
- One copy of transmittal correspondence, less data, to be directed to: Kaiser Engineers, 6000 18th St., Middletown, Ohio, 45042, Attn: ~~XXXXXXXXXX~~ Ken Campbell
- Drawings for approval, unless otherwise specified, are to be simultaneously directed as follows:

Approval
3 Prints

Certified
3 Prints

Approval
Prints

Certified
Prints

To: ~~XXXXXXXXXX~~

To: ~~XXXXXXXXXX~~

Armco Steel Corp. Engr. & Const.
P. O. Box 600 Middletown, Ohio

Mark Spec. No.

Attn: Project Engineer John Hodge

Mark Spec. No.

Attn:



DEFINITIONS OF ENGINEERING DATA REQUIRED

1. **Drawing List** - A complete list of all drawings and data, by title, and the drawing submittal schedule which the seller expects to supply on this order.
2. **General Arrangement Drawings** - Outline drawings to scale showing location and size of building facility and/or major equipment, including location of related accessories and entire line arrangements.
3. **Detailed Drawings** - All details of components required for assembly. These shall be cross-referenced to all other drawings.
4. **Dimension Drawings** - Show dimensions required for location of each major piece of equipment.
5. **Electrical Drawings** - All data pertaining to power supply and electrical equipment. Include "one-line" drawings, schematic and interconnection wiring diagrams. All panel, desk, and control station internal wiring diagrams. Outline and arrangement drawings of all panels, desks, and control stations. Outline dimension drawings for all rotating equipment such as motor generator sets, motors, pilot generators, etc. Static power supplies such as transformers, rectifiers, etc., and all control devices such as limit switches, hot metal detectors, push buttons, etc.
6. **Erection Drawings** - All details and data in sequence required for the erection of the facility.
7. **Foundation Drawings** - All dimensions and details required for foundation design including location, blockouts, imbedded items, grout required, size, type and projection of anchor bolts.
8. **Piping Drawings** - All piping drawings except hydraulic piping (See Item 9) furnished with the equipment must show the locations of purchaser's connection points and required flows and pressures. All air piping schematic and interconnection diagrams must be in accordance with J.I.C. standards.
9. **Hydraulic Piping Drawings** - All piping drawing of hydraulic systems must include a graphical diagram using J.I.C. symbols, as described by figure 3 ASA Y14, paragraph 17-4.3. Also a drawing showing sequence of operation, time cycle, operating pressures and flows must be furnished, as described by figure 30 ASA Y14, paragraph 17-9.3 for fluid power diagrams.
10. **Load Diagrams** - Total static and dynamic loads and load centers.
11. **Performance Data** - All performance data including graphs, test reports and other pertinent information for the equipment and machinery of the facility.
12. **Wearing Parts Drawings** - Exact scale drawings showing material of all component parts which require replacement due to wear in normal operation. Heat treat data to be included where applicable.
13. **Motor List** - A complete list of all electric motors supplied including all normal nameplate data.
14. **Quotation for Recommended Spare Parts Showing Unit Prices** - (Complete list including component, manufacturer's name and part number). Spare parts will either be purchased with the equipment or in the future.
15. **Bills of Material** - Complete, detailed Bills of Material shall be supplied prior to shipment. These must show Item No., Shop Order No., Mark, Part No., or Pattern No.; Reference-Drawing Description. Packing slips described in the marking and shipping instructions must have the same Item No. and identification as shown on the applicable Bills of Material.
16. **OPERATING DATA** -
 - Spare Parts List** - Should be a complete list or manual (including component manufacturer's name and part number) of all replaceable parts, illustrated if possible.
 - Installation Instructions** - As complete and detailed as possible both for original installation and future removal and replacement of equipment and all components and accessories.
 - Operating Instructions** - Should include all the details necessary to insure proper procedure and sequences of operation.
 - Maintenance Manuals** - All phases of both preventive and repair maintenance are required, including a detailed lubrication chart, showing every point requiring lubrication, the grade of lubricant, schedule for lubrication and where indicated the correct amount of oil or grease necessary for refill after drainage.

REPRODUCIBLE DRAWING REQUIREMENTS

- A - In addition to the prints required above, the seller shall furnish one (1) complete set of unfolded prints and one (1) set of reproducibles of "As-Shipped" drawings of:
- (1) All machinery outlines, general arrangement drawings, all assemblies and details, and complete bill of material.
 - (2) All service piping schematic and interconnection diagrams.
 - (3) All hydraulic piping system schematic and interconnection diagrams.
 - (4) All electrical schematic and interconnection wiring diagrams. All panel, desk, and control station internal wiring diagrams, outline and arrangement drawings.
- B - Reproducibles shall be dark line on white background, direct reading type, first generation reproduction, untouched, on vellum, of one of the following acceptable grades except, electrical schematic diagrams and desk layouts shall be on Mylar film or Linen.
- | | | |
|----------------------------------|----------|----------------------------|
| For Moist Machine (Fluid) | | |
| K&E | #26-3145 | Sepia Paper |
| Bruning | #26-200 | Translucent Sepia |
| Post | #444 | Sepia Line Paper VERI-VEL |
| Dietzgen | #254-A | Directo Sepia Paper |
| Kodak | #AT1 | Autopositive Paper |
| For Dry Machine (ammonia) | | |
| K&E | #21-3145 | Sepia Line Paper |
| Bruning | #30-1124 | Sepia Line Paper |
| Post | #209 | Standard Sepia Line Paper |
| Dietzgen | #244 | Dry Print Sepia Line Paper |
| Kodak | #AT1 | Autopositive Paper |
- C - All reproducibles shall be full-size copy, with no grouping of drawings permitted. Our standard drawing size is 24" x 36", however, we will accept smaller size drawings when printed individually, and full size, on one 18" x 24" reproducible.

MINIMUM DRAFTING STANDARDS FOR MICROFILM PRACTICE

A - LETTERING

- (1) Only one (1) style of lettering shall be used throughout each drawing.
- (2) All lettering shall be at least 1/8" high.
- (3) Single stroke Gothic upper case lettering is preferred.
- (4) Either vertical or inclined style is approved.
- (5) The size of the lettering shall not vary according to the size of the format, or the scale at which the drawing is made.
- (6) Space between lines of lettering shall be 1/2 to 1-1/2 times the letter height, depending upon whether common fractions are included.
- (7) The dividing line between the numerator and denominator, in common fractions, shall be horizontal if hand lettered.
- (8) Lettering shall be made with HB Grade (or softer) lead.

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B - LINE QUALITY

- (1) All lines, regardless of width, shall be of uniform density. Width variations will comprise "Alphabet of Lines", not density variation.
- (2) Pencil lines made with 4H Grade and harder lead are not acceptable.
- (3) Closely spaced section lining shall be avoided.
- (4) Parallel dimension lines shall be spaced not less than 1/4" apart.
- (5) No dimension line shall be closer than 3/8" to the outline of the part.

C - TITLE BLOCK

A 3" x 6" space shall be provided within the body of the drawing (preferably in the lower right hand corner) for the addition by Amco of an appropriate title block.