MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

TITLE FURNACE HEAT TREAT EQUIPMENT NUMBER SD-1001
ISSUED BY Randy P. Bal DATE 12/11/95 APPROVED BY
REVISION REV. DATE SHEET 1 OF 107

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I. SCOPE

A. This specification covers the basic requirements for furnace heat treat equipment. It is intended to supplemented by the T99-XXXX series manufacturing equipment specifications that provide specific information on the equipment being purchased.

B. This specification is issued for the purpose of providing standards to assure the safety of personnel, to provide trouble free operation, and to facilitate maintenance. They are not intended to inhibit design or progress of the industrial heating equipment industry.

C. Unless otherwise specified, heat treat equipment shall conform to latest National Fire Protection Association codes. Codes to include, but not limited to:
   a. NFPA 86: Ovens And Furnaces
   b. NFPA 86C: Industrial Furnaces Using A Special Processing Atmosphere
   c. NFPA 86D: Industrial Furnaces using Vacuum as an Atmosphere

D. Supplier shall obtain Industrial Risk Insurers (I.R.I.) approval on all equipment.

E. The build, installation, start-up of heat treat equipment, or any other work performed on Delphi Saginaw Steering Systems floor requires compliance to the following safety Specifications:
   a. Safety Tag Procedure no. 243.5
   b. Lock-out Procedure no. 243.10
   c. Fall Hazard Control Procedure no. 243.9
   d. Confined Space Procedure no. 243.2
   e. Personal Protective Equipment Procedure 243.20
   f. Contractor Safety Program Procedure no. 243.21

F. Compliance to this specification is mandatory, except those items referred to as “should”. These items are highly recommended and preferred.

G. Compliance with these specifications does not, in any way, relieve the supplier of the responsibility to design and build a quality, workable piece of equipment.

H. Deviations to these specifications may be approved prior to issuing a purchase order. All deviations to these specifications shall be itemized in the proposal. Any deviations requested after a purchase order is issued must be approved in writing by the Delphi Saginaw Steering Systems Process Engineer responsible for heat treat equipment.

I. Suppliers are encouraged to submit options to these specifications that result in reduced costs or improved quality.

II. HEAT TREAT EQUIPMENT GENERAL REQUIREMENTS

A. General Information

1. Delphi Saginaw Steering Systems is interested in a quality, highly reliable, low maintenance piece of equipment. Unless otherwise stated on the quotation, all components shall be manufactured to interchangeable standards and shall be replaceable without fit at assembly.

2. All structural design shall be adequate to provide the rigidity and strength necessary for normal operation. Design stresses shall be within the physical limits of the material by an amount sufficient to provide adequate safety factors, including allowance for dynamic and static loading.

3. Provisions must be made for slings, hooks, or skids adequate to handle the machine sections and tooling during erection. When lifting points are critical, they shall be marked.

4. "Locate at assembly" shall not be used except in special cases such as alignment of motor shafts or work stations. In such cases the assembly drawing shall have notes limiting the shaft concentricity, parallelism, and squareness required. Each "locate at assembly" method of location shall be approved in writing by the Delphi Saginaw Steering Systems Process Engineer responsible for the equipment prior to approval of the final layout drawing.

5. All dowel pins shall be designed for removal before disassembly of mating parts, by use of accessible knockout holes or threaded pull-type dowel pins. Tapered dowel pins or roll pins shall not be used unless approved by the Delphi Saginaw Steering Systems Process Engineer responsible for the equipment prior to approval of the final layout drawing.

6. Sliding surfaces shall be made from material pairs resistant to scoring and capable of withstanding high temperatures where required.

7. All components shall be manufactured as specified on drawings, including material, heat treatment, dimensions, and finish surfaces.

8. Material and hardness shall be specified, using universally accepted designations on all fabricated details.

9. All drives shall have slip clutch, shear pin, current trip relay, or other drive protection approved by the Delphi Saginaw Steering Systems Process Engineer responsible for the equipment.

10. Rigidity and inherent dampening shall be sufficient to permit operation at quoted speed without excessive chatter or vibration.

11. All drive components and cylinder motions shall be designed such that they will stall the cylinder, slip a clutch, or shear a pin rather than damage components.

12. A brass plate shall be located adjacent to all shear pins. The brass plate shall contain the following shear pin information.

    a. Drive mechanism name.

    b. Dimensional view of the shear pin showing:
    - Diameter
    - Length
    - Location and size of undercut

    c. Material and hardness.

13. Standard bearings, chains, belts, and gears shall be operated at loadings and speeds within the manufacturer's recommendations.

14. Adjustments of machine components which are not required periodically to maintain process limits shall be analyzed for their necessity and eliminated if practical. Where it is desirable or necessary to provide ability to adjust location of components for set-up purposes, include "sandwich-plate" spacers which can be machined to the proper thickness and re-installed. The use of slotted holes shall be used only as a last resort.

15. All control devices shall be accessible from floor level or a provided platform.

16. Access shall be provided for servicing all components.

17. An access ladder and catwalks with hand rails are required on any furnace where maintenance items exist -- such as thermocouples, motor operated valves, drive motors, reducers, and recirculating fan.

18. The furnace shall be approved for safe operation by the Delphi Saginaw Steering Systems Safety Department prior to shipping.

19. The supplier is responsible to correct any safety violations identified by the Delphi Saginaw Steering Systems Safety Department.

20. Access openings shall be provided for maintenance and clean-out in all furnaces. The access openings can be the charge or discharge door if the furnace is small enough to perform alll maintenance by reaching through the door opening, and the doors are large enough to allow a man to crawl into the furnace.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

21. The use of hydraulic power shall not be used unless approved in writing by the Delphi Saginaw Steering Systems Process Engineer.

22. A minimum of two (2) U-belts shall be provided on all drives.

23. Microsoft Word 6.0 and Microsoft Excel 5.0 shall be used for all operating instructions, service manuals, etc. Data files shall be provided along with all hard specified.

24. All information provided by Delphi Saginaw Steering Systems on our products and processes is considered confidential.

B. High Temperature Materials

1. Pusher carburizer skid rails, separator tiles between rows, and H-tile shall be Alumina. All rails and tile used must be at least 16" long.

2. Brick used in furnaces, shall not exceed 0.8% iron oxide. (Thermal Ceramics is preferred supplier)

3. Cast, heating element tubes shall be ACI type HL or HK.

4. All other metallic parts exposed to the heat shall be:

a. ACI type HT.

b. ACI type HU.

c. Wrought materials should be used only when absolutely necessary. The approved wrought materials are rolled alloys RA330 and RA333.

d. Cast fan impellers and cast chain guides can be made of a "Superalloy". The proposal shall state the items and the alloy being proposed.

e. Any alloy passing through the furnace wall (tube supports, atmosphere inlets, sample ports, etc.) shall be designed to protect it from the 1300° F deterioration phenomenon (such as aluminizing the bottom of inner doors or using ceramic coatings).

f. Deviation from the above materials must be approved in writing by the Delphi Saginaw Steering Systems Process Engineer.

g. All alloy shall conform to SD-1000, "Heat Resistant Alloy Castings".

C. Lubrication

1. Grease fittings shall be centralized and easily accessible from the floor level.

2. Any lubrication point inaccessible from the floor level shall have a filler tube or lubricant line terminating at approximately the five foot level.

3. Steel tubing shall be used for filler tubes or lubricant lines.

4. Each lubrication point shall have an individual fitting.

5. Lubrication points shall include a metallic tag with Delphi Saginaw Steering Systems code and recommended frequency.

D. Insulation

1. All equipment supplied shall be adequately insulated to prevent the air temperature from exceeding 30° F above ambient at one foot from the equipment.

2. Heat treat equipment that operates below 800° F shall have a skin temperature less than 30° F above the ambient temperature.

3. Heat treat equipment that operates from 800° F to 1300° F shall have a skin temperature less than 40° F above the ambient temperature.

4. Heat treat equipment that operates above 1300° F shall have a skin temperature less than 60° F above the ambient temperature.

5. All cold piping less than 60° F shall be insulated to prevent sweating and rusting. Insulating the tower water piping is not required.

6. As a minimum, hot oil tanks and the hot oil piping (over 150° F) shall be insulated with two (2) inches of six lb. per square foot density insulation or equivalent. The oil tank insulation shall be covered with sheet metal. Insulation must not be installed until the tank is leak tested.

7. All steam and condensate piping shall be insulated using 1", 7-1/4 lb. density fiberglass insulation wrapped with factory applied pre-sized glass cloth.

E. Guarding Requirements

1. All drives shall be covered with six sided guards.

2. Guards shall be easily removable to provide access to the item being guarded.

3. Guards shall not be welded to equipment.

F. Painting

1. All equipment supplied for heat treating operations shall be painted with rust and heat resistant (800°F) aluminum paint.(Federal Specification Number 595-17178) Touch up in the field as required.

2. Color code piping as follows:
   Yellow - natural gas
   Orange - endothermic gas
   Light Blue - combustion air

G. Layout Restrictions

1. The maximum width of new equipment that can be received and moved into our plant is limited by the effective receiving door opening, aisle widths, and shall not exceed 11' 6" wide by 18' high.

H. Hazardous Materials

1. The use of asbestos is prohibited.

2. The supplier shall obtain approval per the Hazardous Material Control Procedure no. 126 for all materials shipped to Delphi Saginaw Steering Systems. The use of items supplied that contain any hazardous materials is prohibited unless prior written approval is received from the Delphi Saginaw Steering Sysytems Process Engineer responsible for the equipment. The list shall include, but is not limited to any amount of the following:
   a. Mercury (such as in pressure switches).
   b. Arsenic (such as in paint).
   c. Lead (such as in paint, counterweights, etc.).
   d. Chromium compounds (such as in paint).

I. Ventilation

1. Ventilation consideration shall be given in the design of all heat treat equipment.

2. All required hoods, stacks, dampers, ductwork, fans, and wiring materials to flanges fourteen (14) feet above floor level shall be provided for the furnace.

3. The exhaust fans shall be bifurcators. Fans are to be roof supported with a non-fused disconnect for the motor.

4. Design shall limit the plant ambient heat load yet keep make up air requirements as low as possible.

5. The ventilation fans shall be sized to accommodate a fifty (50) foot run of straight ductwork and still maintain its required CFM.

6. Exhaust fan controls shall be supplied. Controls shall include motor starters, push buttons, pilot lamps, logic, and wiring.

7. Ventilation calculations shall consider existing negative air pressure in the plant.

8. Ventilation design shall conform to industrial ventilation standards by the American Conference of Governmental Industrial Hygienists.

9. Ventilation shall conform to the UAW-GM Health & Safety ventilation requirements, including the 1993 GM/AW National Agreement for cutting fluid aerosol limits of 0.5mg/cubic meter.

10. Detailed engineering information and construction details describing the ventilation system shall be submitted to the responsible Process Engineer during the engineering approval stage of the project.

11. Exhaust fan sound level shall comply with GMC-SL 1.0 “Sound Level Specification for Machinery and Equipment”.

12. A counter-weighted damper shall be provided in the duct work on quench vestibules. The damper shall automatically close the exhaust stack when the CO_2 fire protection is activated. The damper shall be located such that the effluent stack remains open.

J. Cooling Water Systems

1. The water inlet shall include two parallel Y-type strainers complete with purging valves and four shut off valves. A pressure regulator shall be supplied.

2. All cooling water return lines shall terminate at one location at least two feet above floor level.

3. Cooling water return lines shall not contain any valves.

4. The cooling water return lines shall be designated large enough to eliminate any back pressure on the cooled equipment. Drains shall be visible from plant floor and designed to prevent splash over.

5. All water cooled components and piping shall have at least 3/8” water passage.

6. Trerice or Powers temperature regulators used on water systems shall be pre-set in the furnace supplier’s facility. These regulators shall include a dial thermometer.

7. Cooling water jackets shall be individually supplied by a three-line by-pass system. One line shall contain an orifice, properly sized to maintain a 35° F temperature rise in the cooling water under idle conditions. The second line shall contain a Trerice No. 91400 self-operating, temperature-indicating control valve or Powers equivalent. The third line shall contain a manually operated globe valve to by-pass the control valve and orifice when required.

8. The equipment design shall incorporate a cooling water temperature rise of 35° F wherever possible. Components requiring cooler operating temperature shall be described in proposal.

9. Black iron pipe shall be used on all tower water lines.

10. One (1) tower water return system shall be supplied with each furnace line.

    a. The reservoir tank shall hold a minimum of three minutes of water flow.

    b. The reservoir tank shall include short legs to permit access to the drain outlet.

    c. Two (2) pumps shall be provided with each tank.

    d. The pumps shall be Grundfos.

    e. Each pump shall be sized to pump two (2) minutes of water flow minimum per minute at a 120 foot head.

    f. The pumps shall be constructed of cast iron with stainless steel wetted parts and tungsten carbide mechanical seals.

    g. Tank outlet to pumps shall be covered with a removable expanded metal box strainer.

11. The tower water return system shall include the motor starters, selector switches, pilot lamps, logic, and wiring.

    a. A float type switch to turn the pumps on and off. Switch enclosures to be NEMA 12 design.

    b. A back-up float switch to sound an alarm and turn on the second pump if the first pump does not remove the water.

    c. Electrical logic to alternate the pumps with each cycle.

    d. The controls shall be located in a separate “tower water control panel” near the reservoir tank.

    e. The control panel disconnect shall be wired such that turning off the main disconnect on the furnace will not shut the Tower Water Return System.

III. HEAT TREAT EQUIPMENT CONTROLS

A. Utility data

1. The supplier is responsible for all controls necessary to use the following Delphi Saginaw Steering Systems Utilities:

UTILITY		DATA
Electricity		480 volts 60 hertz 3 phase
Compressed Air		80-100 P.S.I.G.
Natural gas	*	10 P.S.I.G. 1,000 BTU / Cu. Ft.
Endothermic Gas		8-12 O.S.I.G.
Nitrogen		35-100 P.S.I.G.
Tower Water		Nominal: 55 P.S.I.G. 85° F Design Range: 50-100 P.S.I.G. 60-100° F
City Water		35-80 P.S.I.G. 40-100° F
Steam		110 P.S.I.G. maximum 75-80 P.S.I.G. nominal 338° F - 353° F
Methanol		25 - 30 P.S.I.G.

* Note: The natural gas supply at Plant 23 in Alabama is 15 P.S.I.G. at 1,000 BTU / Cu. Ft.

2. Delphi Saginaw Steering Systems will make one connection for each utility for each piece of equipment with a separate capital tag number.

3. Unless otherwise specified, the vendor shall supply a single shut off device, valve, fused disconnect, or circuit breaker for each utility connection. The shut off mechanism shall be accessible or operable from the plant floor. All shut valves shall have lock-out devices.

4. The utility company guarantees a maximum voltage variation of +3% to -7%. Transients do exist. Solid state devices requiring protection from voltage spikes are the responsibility of the vendor.

5. The emergency protected power and the local power for furnaces will be:

   a. 480 volts.

   b. 3 phase.

   c. 60 hertz.

   d. Three wire -- the enclosing conduit will be the ground.

6. The power drop will be made using multiples of 250 MCM, 350 MCM, or 500 MCM wire.

7. The furnace vendor shall supply all disconnects, circuit breakers, terminals, interconnecting wire, cable, conduit, raceway, or bus required from the power drops.

8. Emergency protected power transfer switches shall be double throw safety switches, 600 vac, three pole, non-fusible switches. An example of this switch for 60 amp service is a square "D" catalog No. 82342.

9. Delphi Saginaw Steering Systems will provide electrical power drops and make the connection to the terminals supplied and installed by the furnace manufacturer:

   a. One "local power" and one "emergency protected power" to the emergency protected power transfer switch for the operational, atmosphere-alarm and instruments, fan control, and quench control panels on atmosphere furnaces.

   b. One "local power" and one "emergency protected power" to the emergency protected power transfer switch tower water control panels.

   c. One "local power drop" to the disconnect on draw furnaces or low temperature ovens.

   d. One "local power drop" to the electric heating system on quench tanks and furnaces.

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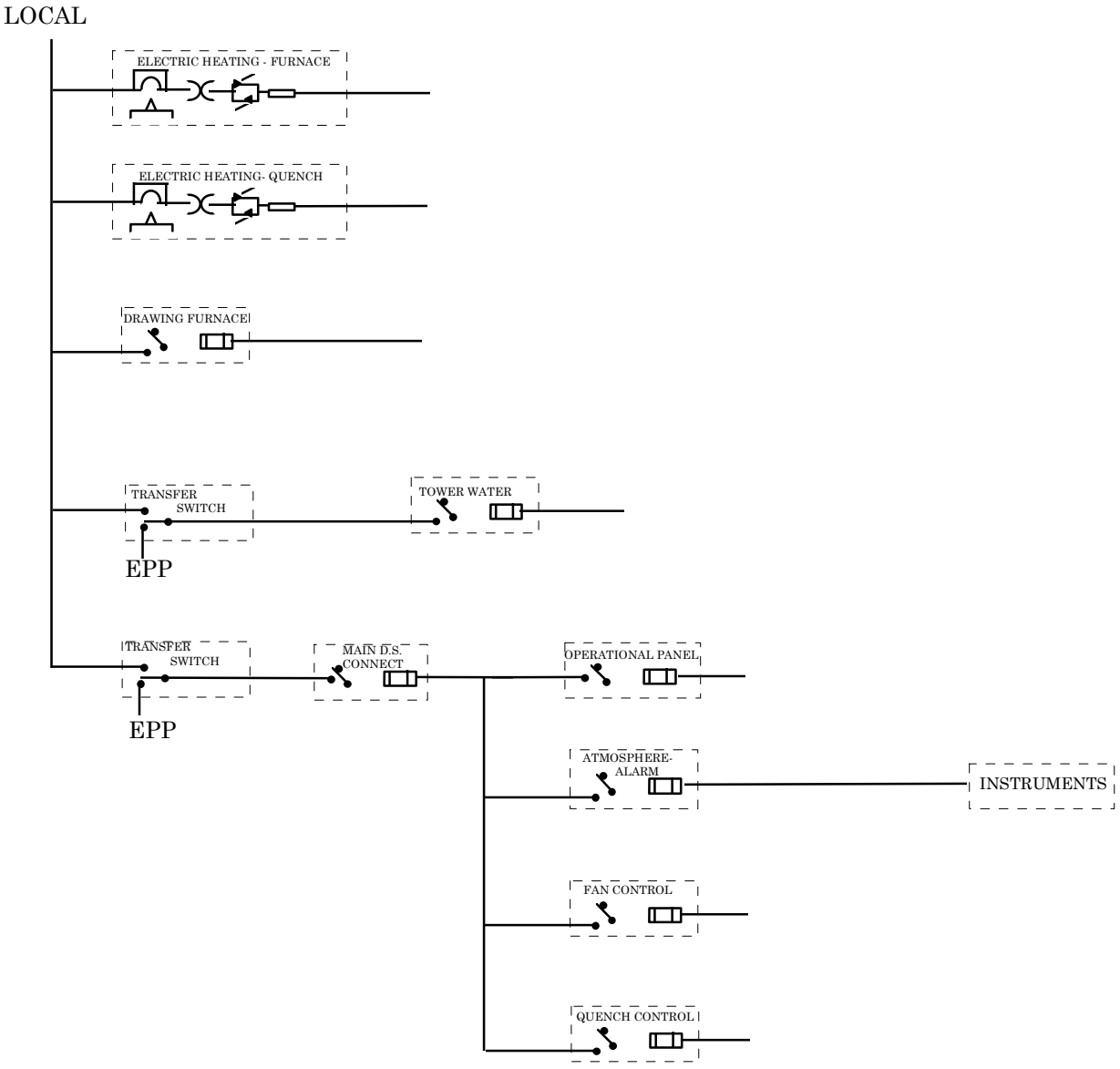
ELECTRICAL POWER DISTRIBUTION



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10. Permanent labels shall be provided on the switch. The labels shall be black letters on a white background. The switch handle positions shall be labeled as follows:

Handle	Saginaw Plants	Other Locations
Up	Local Power Power	Emergency Protected
Center	Off	Off
Down	Emergency Protected	Local Power Power

11. The emergency protected power transfer switches and the disconnect switches for the furnace line control panels shall be located within reach of the plant floor.

12. All 600 volt and 250 volt fuse blocks (including the main disconnect) shall accept only rejection-type fuses.

13. Bussman FRS-type R, or equivalent, fuses shall be used in the fused disconnects.

14. All wire shall be installed in four (4) sided raceways or conduit. Heat release from the conduit, wire, or raceways shall be kept to minimum.

15. Transformers:

    a. Class H, 115° F rise or better.

    b. 65 DB maximum noise level.

B. General Specifications

1. Access shall be provided for servicing all valves, gauges, pressure switches, motors, etc.

    a. All control devices shall be accessible from floor level or a provided platform (approximately 5 feet).

    b. A stairway, catwalk with handrails, and ladder are required for access to the furnace where maintenance items exist, such as thermocouples, motor

operated valves, drive motors, reducers, and recirculating fans. The stairway shall be located near the charge end of the furnace. The ladder should serve as an alternate way off the catwalk and should be located at the discharge end of the furnace.

c. Chained openings shall be provided in guard rails to facilitate access to equipment (such as roof fans, washer pumps, etc.) for maintenance.

d. Grating used on elevated platforms, stairs and crossover walkways shall be 1 1/4" X 3/16" steel bearing bars with 5/16" diameter steel cross bars top and bottom on 4" centers equal to Gary type GW125 (modified). Walkways on top of furnaces may be an industrial grade expanded metal grating. Weight per square foot is 6.25 lbs.

2. Component identification shall be consistent with the operating instruction manual and the engineering drawings.

a. All machine sensors, pressure switches, meters, control panels, disconnects, instruments, thermocouples, pilot lamps, selector switches, push buttons, etc., shall have permanent engraved labels attached indicating their function. Do not abbreviate. The labels shall be black letters on a white background. Labels must be mechanically attached -- adhesive mounting is not permitted. This tag shall be mounted near (not on) the device and shall be readable with furnace guards closed.

b. All valves and machine sensors shall be identified by numbered brass tags wired to the valve/sensor body corresponding to operating instructions. Each device shall have a separate tag number. This tag shall be mounted near (not on) the device and shall be readable with the guards closed.

3. Pipe and conduit cannot be installed at floor level. In narrow passageways, two to three feet wide, the pipe and conduit shall be at least seven feet above the floor. In wider passageways, over three feet, the pipe and conduit shall be at least twelve feet above the floor. In the Quench Pit, the piping should be located next to the tanks, walls, and ceiling whenever practical.

4. All electrical devices shall be effectively shielded from heat, flames, oil, and dirt.

5. Provisions shall be included to completely drain all reservoirs containing liquids. Drains shall be installed in the lowest point and shall have valves. Oil tank valves shall be plugged.

C. Piping Specifications

1. Valves

   a. Gate valves or ball valves shall be used for all liquid shut off valves.

   b. Ball valves under 2" are to be used for atmosphere lines. Teflon-lined plug valves shall be used for all atmosphere valves 2" pipe size or over.

   c. Butterfly and blast gate valves can be used for low pressure air valves.

   d. Fluid control.

      1. Designed orifice plates shall be used to restrict or control all fluid flows that are constant.

      2. Globe valves shall only be used for bypassing control valves or for the control device when frequent adjustment is necessary.

      3. Control devices shall have calibrated dials or markings.

   e. All valves shall have handles.

2. Gauges and Thermometers

   a. Pressure gauges shall be provided in the compressed air, natural gas, endothermic gas, nitrogen, city water, and tower water piping to monitor plant utility supply pressure.

   b. Pressure gauges shall be installed on both sides of all major piping components where the pressure changes.

   c. Pressure gauges shall be installed with three way valves for pressure relief on the gauge.

   d. Gauges shall be Marshalltown or equivalent.

      1. The full scale shall equal or exceed the maximum pressure of the system.

      2. The graduations shall be sized to detect and read a 5% change in the normal operating conditions.

      3. Round dial, 2-1/2" minimum.

   e. Thermometers shall be installed on both sides of all piping components where the water or oil temperature changes.

f. Thermometers shall be Trerice Bimetal or equivalent, thermometers shall include thermowells.

1. 5" round dial with adjustable angle mount (reference Trerice catalog N0. 121).

2. Cold oil or water: range 20-240° F.

3. Hot oil: range 50-400° F.

3. Pressure Switches

a. All pressure switches reset automatically and shall be free of Mercury.

b. All pressure switches shall include a pressure gauge mounted adjacent to the switch.

c. Pressure switches shall be mounted in a manner to allow easy access to cover screws and adjustment.

4. High Pressure Pneumatic System

a. Size all components for operation at 35 PSI or lower.

b. Provide single air connection point on the machine.

1. Ball valve with exhaust at shut off and locking provision.

2. Female supply connection.

3. Tee with 18" drip leg and petcock to drain drip leg.

4. Filter - Regulator with automatic drain.

5. Additional coalescing filter of adequate size shall be used on non-lubed systems.

6. Provide a pressure switch and annunciate when air pressure falls too low. Loss of pressure shall inhibit furnace operation.

c. A three way non-communicating valve shall be installed in the main pneumatic manifold on atmosphere furnaces.

1. This valve will be used to operate the pneumatic system from an emergency nitrogen supply at a minimum pressure of 35 PSI.

2. The furnace manufacturer shall pipe the nitrogen to the third port of the valve.

d. All high pressure air exhaust lines shall have suitably sized muffler-reclassifiers to meet 80 DBA sound level specification.

e. Threaded pipe connections shall be provided on all pneumatic headers for pipe sizes less than 2". Consult Delphi Saginaw Steering Systems Process Engineer for pipe sizes 2" and larger.

f. All pneumatic headers (supply and exhaust) shall be sloped to drainable drip leg.

g. Supply headers shall be equipped with ball-valve in each branch circuit. Ball-valve shall have exhaust and locking provisions, and be mounted at header.

1. Connections shall be made to the top side of headers.

2. Spare connections shall be provided.

h. Pneumatic circuits will utilize schedule 40 black iron pipe unless moving components do not permit.

i. A regulator will be provided when necessary for proper function. The recommended pressure setting shall be specified on the pneumatic circuit drawing and in the service manual.

j. Use manifold mounted valves with non-locking, fully guarded manual operators (except on the quench access door). Valves shall be plug-in type with lights.

k. Detented valves shall not be used on the machine unless written consent is given by the Delphi Saginaw Steering Systems Process Engineer. The use of three position valves should be considered for each application. Unless otherwise specified, a valve solenoid shall be maintained energized when its associated motion is accomplished, and until the opposite motion is initiated.

l. Use Numatic Mark 15 plug-in air valves where design requirements permit.

m. A separate pre-piped pneumatic panel is not required.

n. Air cylinders should not be used for operating any mechanism unless specified or the alternated become complicated or hazardous.

1. High pressure air lines for air cylinders shall contain regulators, filters, and lubricators capable of being filled while under pressure.

2. All air cylinders shall be permanently lubricated.

3. Cylinders with more than 1" stroke shall have cushions at both ends (except air springs).

4. Adjustable locking flow controls shall be used to control cylinder speeds (not required on air springs).

5. Flow control should be mounted at the cylinder on the output side (meter out).

D. Instrumentation

1. Single loop proportioning control instruments shall be provided to control temperature on:

   a. Generators

   b. Draw Furnaces

   c. Ovens

   d. Freezers

   e. Multiple Zone Equipment

2. Single loop proportional control instruments shall be used to control atmosphere on:

   a. Generators

   b. Multiple Zone Atmosphere Furnaces

3. Dual loop temperature/atmosphere proportional control instruments shall be used to control temperature and atmosphere on batch atmosphere furnaces and other furnaces where ramp/soak recipes are required to control both temperature and atmosphere. Dual loop instruments shall have the capability to store a minimum of 12 recipes.

4. A single loop on/off control instrument shall be used for heating/cooling of quench oil systems.

5. A single loop instrument shall be used to monitor annealer belt speeds, draw furnace belt speeds, and quench agitatator RPM.

6. Control modes shall be as follows:

   a. Electric furnaces shall have 4-20 ma current adjusting output.

b. Gas-fired radiant tubes and direct fired generators shall have time proportioning on/off control output. High/low fire is not acceptable.

c. Direct fired ovens and draws shall be position adjusting type controllers.

d. Atmosphere controllers shall be position adjusting controllers.

7. All temperature and atmosphere controllers shall:

a. Have universal input capability. As a minimum they must accept type J,K,S and R thermocouples.

b. Have as a minimum two (2) alarms per control loop. Alarms shall be programmable as process, deviation, or deviation band alarms.

1. All draw furnaces, ovens, freezers, quench systems shall have +/- deviation band alarms.

2. All atmosphere furnaces shall have 1400 °F. atmosphere interlock.

3. Batch atmosphere furnaces shall have 1100 °F. abnormal atmosphere contact.

4. All multiple zone equipment shall have deviation band alarms.

c. Have automatic tuning capability.

d. Require no periodic calibration.

e. have input isolation.

f. Have digital communication and must be compatible with the computer network (supports multi-drop data communication) and future PLC installation (compatible with Modicon and Allen Bradley PLC).

8. All generators, draws, ovens, batch furnaces, quench systems, and each zone of continuous furnaces shall have over temperature instruments.

a. Over temperature instrument is to have manual reset on over temperature.

b. Over temperature instrument shall be capable of being reset remotely.

c. Over temperature instruments shall automatically reset within 0.3 seconds after a power failure if no over temperature condition exists.

d. Over temperature control instruments shall be I.R.I. approved.

e. Generator over temperature instruments shall have an under temperature contact. Silencing an under temperature alarm will not prevent a subsequent over temperature alarm from sounding.

f. The over temperature instrument shall be set at the designed safe maximum operating temperature. An overt emperature condition would shut off the heating system and a pilot light and an alarm shall be provided to notify the operator. The heating system on an endothermic generator will not shut-off in an over temperature condition.

9. The last zone in pusher carburizers shall have a deviation controller in addition to the temperature control instrument. To protect the process, the deviation controller shall be equipped with 25°F. deviation alarm contacts above and below the setpoint. A high or low temperature deviation shall notify the operator with a lamp and an alarm and prevent the next cycle from initiating.

10. All instruments shall have thermocouple fail-safe upscale capability.

11. Instrument requires shall be reviewed in detail with the responsible Delphi Saginaw Steering Systems Process Engineer. Acceptable instrument sources are Barber-Colman 560's, Leeds and Northrup Progeny Family, Eurotherm 900 EPC Controllers and Model 93 Overtemps, Marathon Carbpro or Dualpro Controllers, and Yokogawa.

12. A multipoint recorder shall be provided to monitor all process variables. Approved recorders are:

    a. Leeds and Nortrhrup 25000 Recorder 25000-16-00-10-10-00-6-000-00-000

    b. Esterline-Angus Video-graphic Recorder VGR-SY16-120-RS232-2R

13. Documentation shall be provided describing all temperature control instrumentation in detail. All information required to purchase, install, configure, and program the instruments shall be supplied.

14. All thermocouples and instruments shall be identified as to their function with permanent labels.

15. All required thermocouples, protection tubes, and lead wire shall be supplied by the vendor.

16. Thermoucouples shall be # 8 gage with twist welded construction.

17. Grounded thermocouples shall be used.

18. Separate protection tubes shall be supplied to each thermocouple. Duplex thermocouples are not permitted.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

19. Protection tubes shall be large enough to install a proving thermocouple without removing regular thermocouple. A Y-fitting shall be provided on protection tubes with sealed heads to facilitate installing proving thermocouple. If not possible a separate proving thermocouple protection shall be provided within 8 inches of control thermocouple.

20. Thermocouple extension wire shall be 20 gage teflon with ANSI color codes.

21. Instrumentation panels shall be free standing NEMA 12 enclosures. A Lytron water to air heat exchanger shall be used to cool the instrument panels.

E. Electrical Wire

1. Electrical wire used on heat treat equipment shall be annealed Copper of sufficientsize to safely handle maximum currents in the circuit where it is used. Wire shall be insulated with silicone rubber and covered with glass braid.

2. The following types are approved:

a.	Rockbestos Wire and Cable Company	Table SR-FWC Or SR-ML
b.	General Electric Company	SI-53917
c.	Continental Wire and Cable Company	SRG-S600

3. Exceptions:

a. Inside the electrical control panels.

b. Inside electrical component enclosures.

c. Thermocouple lead wire.

d. Power drops.

4. The splice joint between the pigtail provided with electrical components such as solenoid valves shall be made inside the electrical component. The standard wire of the pigtail shall not extend beyond the electrical component.

5. No method of splicing wires together between terminal connections shall be used.

F. Motors

1. All motors shall conform to Delphi Saginaw Steering Systems Specification 7EQ.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

2. Motor overload contacts shall be located on the hot side of the motor starter coil in the control circuit. This includes forward and reverse motor starters.

3. All motors shall have remote, nonfused disconnects mounted as close to the device as possible but outside the guarding . The disconnect shall be a three (3) pole with auxiliary contact. Shutting any motor off with the disconnect shall interrupt the motor starter circuit in the control panel.

G. Flame Supervision

1. Flame supervision shall consist of Honeywell:

   a. Ultravision Flame Detector C7012E1112
   b. Industrial Flame Safegaurd Relay RM7838A
   c. Subbase Q7800A
   d. Amplifier R7847C
   e. Timer ST7800
   f. Expaned Annunciator ST7830A
   g. Cable Assembly 221818A

2. To facilitate installation and removal of flame detectors, a cable connector is to be installed approximately 24" from the detector unit in the line between the detector and the electrical control panel as follows:

   a. Detector end connector shall be a male amphenol plug, model number 86-PM8-11.

   b. Panel end connector shall be a female amphenol socket, model Number 78-PF8-11.

   c. Pin connections shall be as follows:

      1 (1) White and (1) Black (L2)
      3 Blue (F)
      5 Black (L1)
      7 Yellow (G)
      8 White

      Note: Either black wires and either white wires are interchangeable.

3. A DC micrometer shall be provided on the control panel to monitor flame detector current for each flame detector supplied.

H. Alarm Systems

1. All heat treating furnaces, ovens, and atmosphere generators shall have alarm systems.

2. Alarms shall consist of an audible horn and red pilot lamps to indicate the unsafe or "Not Running" condition.

3. Silencing an alarm for one fault shall not prevent subsequent faults from re-sounding the alarm.

   a. The alarm silence can be a push-button or a series of selector switches.

   b. When the alarm is silenced, a red pilot lamp labeled "Alarm Silenced" shall remain lit until the fault is corrected.

   c. Motor-overload faults can be considered corrected when an alarm reset button is pushed.

4. Only the fault being displayed shall be reset by "Fault Reset" and only after the fault condition has been cleared.

5. All fault circuits shall be designed to "seal" the fault circuit until "Fault Reset".

6. As a minimum, any fault that prevents the furnace cycle from starting or which interrupts the cycle shall be displayed.

7. Federal Signal 300 series select tone horn with TBM shutter tone shall be used.

8. Green pilot lamps shall be provided to indicate that each motor is operating.

9. Red pilot lamps shall be provided for each alarm condition and for the alarm silenced.

I. Control Cabinets

1. As applicable, the the following controls enclosures shall be provided:

   a. Operational logic panels.

   b. Tower water panel.

   c. Safety panel/heating.

d. Temperature-control instrumentation panel.

e. Atmosphere panel.

2. Each panel shall be identified with a sign with one inch high letters. The sign shall describe the panel (i.e.; Tower Water Panel) and list the Delphi Saginaw Steering Systems Number (Delphi _____).

3. NEMA 12 enclosures shall be used for all control circuits.

4. All pilot lamps, push buttons, and selector switches shall be labeled as to their function.

5. Pilot lamps labeled "Running" shall only be used where there is proof of running other than the motor-starter contacts. Motor-starter contacts can only be used when it is not practical to sense the running or operational condition and shall be labeled "on".

6. Selector switches shall be provided for items that require continuous operation.

   a. Recirculating fans.

   b. Air blowers.

   c. Combustion and atmosphere controls.

7. Push buttons shall be used for items that do not require continuous operation.

   a. Auto mode.

   b. Manual mode.

   c. Material handling mechanisms.

   d. Ventilation fans.

   e. Electrical control panel cooling fans.

8. All control cabinets shall include fluorescent light fixtures that are actuated by opening the main door.

9. All control and instrument cabinets shall have Lytron air coolers installed.

IV. INSTALLATION

A. Vendor shall provide installation (if specified) and start-up service of all supplied equipment.

B. A Project Manager shall be provided to see that the equipment installation and start-up meets the applicable specifications and is made operational to Delphi Saginaw Steering System's satisfaction by the required dates. The Project Manager must be acceptable to Delphi Saginaw Steering Systems and must have total project responsibility. The following requirements apply to the Project Manager:

1. All superintendents, field engineers, start-up, and training personnel shall report to this individual. The Project Manager shall select a Project Superintendent acceptable to Delphi Saginaw Steering Systems. The Superintendent shall be on the job whenever his people are.

2. A change in the Project Manager shall require prior approval of the Delphi Saginaw Steering Systems Process Engineer. Changes in other personnel should be kept to an absolute minimum.

3. The Project Manager shall act as liaison between Delphi Saginaw Steering System's personnel and his company to expedite all phases of the project, such as engineering approvals, field erection, coordination with other contractors, engineering revisions, and/or field modifications.

4. Project status reports (timelines) are to be made to the Delphi Saginaw Steering Systems Process Engineer responsible for the project at least once each week during the entire contract. All timelines shall be done in MS Project 4.0. Data files shall be provided along with hard copies specified.

5. The Project Manager shall have a working knowledge of the applicable specifications, provide a complete set at the installation site, and see that the Superintendents and Field Engineers have read these specifications.

6. The Project Manager shall review all preliminary and final engineering drawings and manuals for completeness and accuracy prior to submittal. All necessary revisions will be routed through the Project Manager.

C. Installation shall include all mechanical, electrical, and piping materials to install and inter-connect equipment as required, plus sufficient labor and capable supervision to complete the installation by the required dates.

D. Delphi Saginaw Steering Systems will provide the following services and material as required:

1. Unless otherwise specified, one (1) final utility connection for each service.

2. Pit for the quench tank, including sump, structural steel, decking, stairways and concrete pad.

3. CO_2 Fire Protection System, including installation.

4. Auxiliary waste-header in quench pit for supplier's connection.

5. Install roof openings for ventilation ductwork and install ductwork and fans from height of 14' up through roof.

6. Receive, unload, and move equipment to the job site:

   a. Deliver crib and tool boxes to job site.

   b. Unload lots of wall plates and set in staging area.

   c. Unload and deliver brick to job site.

   d. Deliver furnace casings to job site.

   e. Unload pre-bricked furnace section and set near required centerline.

   f. Unload and deliver miscellaneous components to the job site:

      1. Quench and make-up tanks
      2. Transfers
      3. Push-across tables
      4. Washers
      5. Draw-furnace casings
      6. Tower-water tanks
      7. Electrical panels

7. A debris disposal area.

8. Emergency first aid through the Medical Department.

E. The vendor shall provide the following services and materials:

1. All required contractor's licenses, fees, and permits.

2. A current certificate of insurance covering property damage, public liability, and Workmen's Compensation that meets minimum Delphi Saginaw Steering System's requirements.

3. Premium time and off-site storage or fabrication costs and all other related costs found necessary during any stage of the project to complete the installation by the required dates shall be the responsibility of the supplier. Extra charges required because of significant delays caused by Delphi Saginaw Steering Systems will be negotiable if and when the delays occur. Delphi Saginaw Steering Systems shall be notified within 24 hours of potential extra charges and of the approximate costs. Written authorization must be given before extra work is started.

4. Construction facilities and storage:

   a. Portable fire extinguishers.

   b. Required crib storage area.

   c. Telephone installation, and use charges.

   d. Tools, including gas and air for cutting, welding machines, ladders, and pipe threading machines.

   e. Any required shim stock for leveling the equipment. The concrete floors within Delphi Saginaw Steering Systems normally vary up to one and one-half inch over the length of a long furnace line.

   f. Small debris storage containers including removal to Delphi Saginaw Steering System's debris disposal area.

5. Lift-Truck and Crane Service:

   a. Stand wall plates.

   b. Set radiant tubes in place.

   c. Erect carburizer platforms and set catwalks and stairways.

   d. Final locating of all equipment at the job site.

   e. Set all tanks and pumps in pit.

   f. Set draw-furnace fans in place.

   g. Set transfers and main pusher tables in place.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

i. Set furnace sections in final position.

6. All required piping to the auxiliary waste-header located in the quench pit.

7. Tower water return system and all drain piping.

V. START-UP SERVICE

A. Start-up service shall be included with the purchase (whether installation by supplier or Delphi Saginaw Steering Systems) of all heat-treat equipment.

B. The start-up serviceman shall place the piece of equipment into operation. He shall make all corrections and adjustments necessary to meet these equipment specifications and the metallurgical specifications. Start-up service shall include proving that:

1. All alarms work properly.
2. All current trips are adjusted correctly.
3. All operational interlocks work properly.

C. The Serviceman shall obtain the data for the Operating Instruction Manual. The Serviceman shall supply all required instrumentation to obtain this data.

D. The Serviceman shall conduct training classes on the operation, troubleshooting, normal equipment monitoring, and maintenance required. Training classes shall be conducted for the operating and maintenance personnel on all three shifts.

E. The start-up service shall include a complete run-off of equipment on Delphi Saginaw Steering Systems floor to validate the equipment and process. Run-off to include:

1. Cold cycling the equipment for 8 continuous hours without any stoppages.
2. Hot cycling the equipment for a minimum of 24 continuous hours without any stoppages.
3. Run-off shall include a thermocouple test to verify temperature uniformity on annealers, draw furnaces, ovens, freezers, etc.
    a. The vendor shall supply all manpower and all necessary equipment to process thermocouple test.
    b. The thermocouples shall be buried in the area of greatest mass of the part.
    c. All locations in the furnace (each row of the draw furnace) must be checked at the same time.
        i. On multiple lane basket draw furnaces, one (1) thermocouple shall be provided per lane.
        ii. On bulk loaded belt draw furnaces with belts less than two(2) feet wide, (1) point must be checked.
        iii. On bulk loaded Belt draw furnaces with 2 to 4 foot wide belts, at least two(2) points across the width of the draw furnace must be checked at the same time.

iv. On bulk loaded Belt draw furnaces with belts four (4) feet wide or wider, at least three (3) points across the width of the draw furnace must be checked at the same time.

d. A multiple-point strip-chart recorder or data gathering instrument shall be used.

e. The test shall be run with the equipment loaded at rated capacity.

f. The vendor shall remain on the job and make necessary corrections to obtain thermocouple curves that show uniformity across the furnace and the quoted soak time. The stock temperature must be within 8° F of the furnace-control instrument recording.

g. The chart paper/data shall be retained by the Delphi Saginaw Steering Systems Engineer responsible for the job.

4. Distortion testing to confirm that equipment provides required dimensional results.

a. On batch equipment a minimum of two (2) loads duplicate loads will be processed.

b. On continuous furnaces pieces at the beginning of a run, in the middle and at the end of a run will be checked. Equipment to be full during test.

c. A random sample of pieces will be checked that is representative of the total load.

5. A verification that equipment provides specified process requirements (hardness, case depth, carbon gradient, microstructure, etc.).

a. On batch equipment a minimum of two (2) loads duplicate loads will be processed.

b. On continuous furnaces pieces at the beginning of a run, in the middle and at the end of a run will be checked. Equipment to be full during test.

c. A random sample of pieces will be checked that is representative of the total load.

6. As a minimum, final approval of equipment requires the written sign-off by Saginaw Delphi Steering Systems, Divisional Process Engineer responsible for equipment, Plant Metallurgist and Plant production supervisor/advisor.

F. All equipment and services to analyze, set up, and record atmosphere parameters, such as chemistry, dew point, flow, etc., as well as calibration of instrumentation and data gathering as required in the equipment specifications.

G. All performance tests performed by the supplier which require Delphi Saginaw Steering Systems production parts shall be coordinated with the plant Metallurgist. His disposition on every part is required to prevent improperly heat-treated parts from being mixed with good parts.

H. Contractors, Servicemen, etc. providing installation, repair, or start-up service at Delphi Saginaw Steering Systems shall:

1. Sign in and out on the Delphi Saginaw Steering Systems Gate pass at the patrol booth whenever entering or leaving the plant.

2. Obtain a written pass from the in-plant Process Engineer before removing any material or tools from the plant.

3. Park their personal cars in the employee's parking lot only.

4. Obtain welding permits from the plant patrolman daily.

5. Restrict movements within Delphi Saginaw Steering Systems plants to their immediate construction site.

6. Post "CAUTION" signs whenever men are working overhead.

7. Wear safety glasses. Delphi Saginaw Steering Systems safety rules will be provided at the beginning of field work. Workmen who do not comply with these rules will be required to leave the job site after their second infraction. The request will be made through the Construction Superintendent.

8. Make arrangements with the in-plant Process Engineer or his designate before leaving any heat-treating equipment running unattended, day or night.

9. Clean their work area daily.

10. Place all debris in provided hoppers for removal by Delphi Saginaw Steering Systems.

11. Obtain Delphi Saginaw Steering System's approval before making any changes in the original design. The supplier shall request and receive an alteration to the purchase order before proceeding with any field changes that will result in additional costs to Delphi Saginaw Steering Systems.

12. The supplier shall revise the original master drawings to reflect all changes made in the field and shall forward revised reproducible drawings to the Delphi Saginaw Steering Systems Process Engineer at the completion of the job.

VI. DEEP FREEZE EQUIPMENT AND REFRIGERATION SYSTEMS

A. Deep freeze convection media shall be force circulated air.

B. Refrigeration system piping and electrical control shall be approved by the Delphi Saginaw Steering Systems Process Engineer prior to start of build.

C. The compressors shall be direct driven, or semi-hermetic type.

D. Supplier shall show B.T.U. calculations and proposed equipment capacity in their proposal.

E. The system shall be constructed with safety relief valves and expansion tanks of adequate size for safe handling of the refrigerants during start-up, operation, and shut-down periods.

F. Suction and discharge pressure gauges shall be provided for each compressor. These gauges shall be located in front of the unit for easy operator access.

G. Compressors shall have a manual reset thermal protection device to protect against excessive compressor temperature. The reset button for this device shall be mounted on the main control panel.

H. A pressure relief regulator shall be provided on the output leg of the compressors before the oil separator. This regulator is to be adjustable in the output pressure range of the compressor and is to dump the refrigerant to expansion tanks.

I. The refrigeration system shall be a single-stage cascade design unless the prospective vendor can show proper justification for an alternate design.

J. A de-super heater shall be provided in the output leg of each compressor.

K. All vessels shall have pressure relief valves.

L. Refrigerants shall be a non CFC containing type (Dupont HP-95 or equivalent).

M. The compressor panel shall be air cooled. Forced air exhaust fans shall pull air through the compressor area. The air intakes shall have filters.

N. The freezer shall have an automatic defrost cycle.

O. A stainless steel drain shall be provided to remove condensation during the defrost operation.

P. The freezer shall have a dual refrigeration system:

1. The dual system may consist of a dual chamber design, each chamber being cooled by a separate refrigeration system.

2. The dual system may consist of a single chamber design, dual evaporator system, each evaporator being easily removable from the chamber.

   a. The evaporators shall be removable to facilitate maintenance of the equipment at room temperature.

   b. The system shall permit operating the freezer while a refrigeration system is being repaired.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

VII. LOW TEMPERATURE OVENS AND FURNACES

A. General Information

1. Draw furnaces and ovens shall have a maximum operating temperature of 750° F at reduced capacity.

2. Temperature uniformity in ovens and draw furnaces shall be:

   a. ± 5° F across the width.

   b. ± 5° F from end to end of soak zone.

   c. ± 5° F from top to bottom of load.

   d. Required for all operating temperatures.

B. Gas-Fired Heating System

1. The furnace shall be direct fired, recirculating air.

2. The natural gas heating system as shown on sheet 39 shall include the following:

   a. Position adjusting type proportional controls.

   b. Combustion air pressure switch. This switch shall be automatic reset.

   c. High gas pressure switch located downstream of the safety shut off valve. This switch shall be automatic reset.

   d. Low gas pressure switch located between the pressure regulator and the safety shut off valve. This switch shall be automatic reset.

   e. A Maxon series 808 safety shut off valve with a 115 vac coil and an internally mounted, single pole, double throw microswitch rated at 15 amps shall also be included.

   f. Blocking and venting solenoid valves shall be supplied on direct fired equipment. No checking valve shall be used. The vent pipe shall be supplied to top of equipment.

   g. A spark ignited, interrupted, supervised pilot.

h. One air blower shall be furnished to meet the low pressure air requirements of the furnace.

1. Air blower shall have filter and silencer.

2. The low pressure air shall be monitored with a 0-16 O.S.I.G. pressure switch.

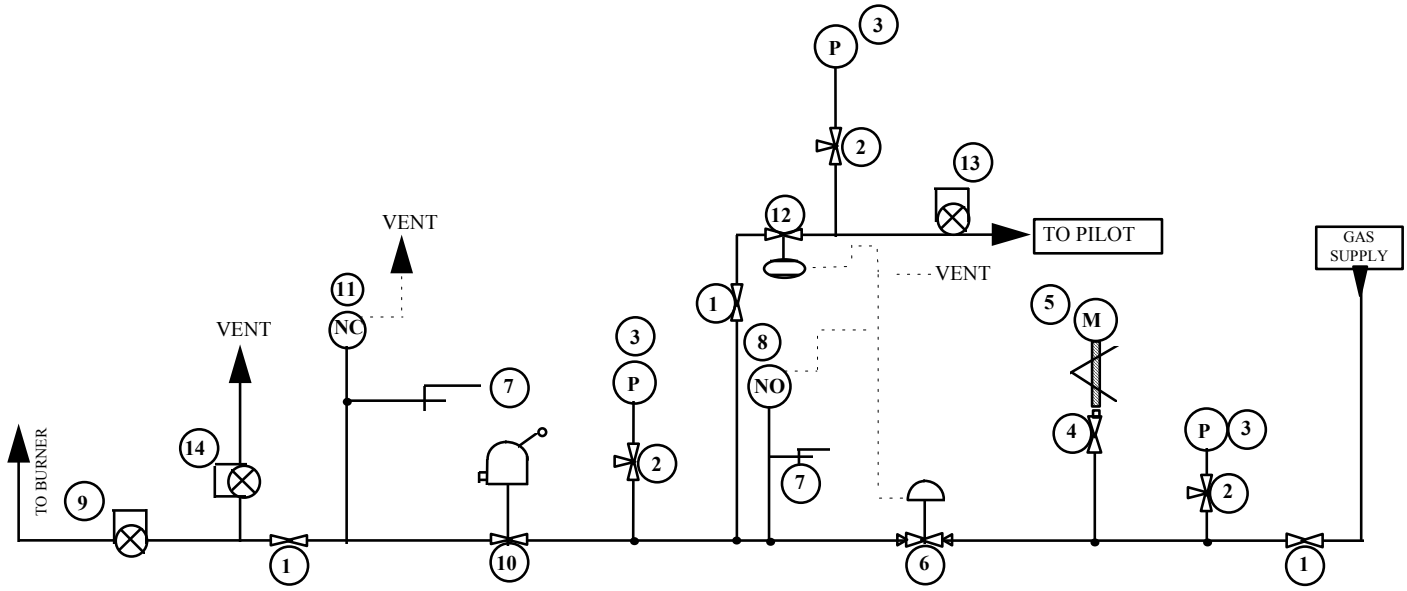
i. A petcock shall be installed in the piping to the Dewey or equivalent airflow switches near the unit for our safety-aid inspection test.

j. One(1) four inch in diameter blast gate with sight glass shall be used to observe the pilot and burner flame.

MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

TITLE FURNACE HEAT TREAT EQUIPMENT NUMBER SD-1001
ISSUED BY Randy P. Bal DATE 12/11/95 APPROVED BY
REVISION REV. DATE SHEET 37 OF 107



Reference Components or Delphi Saginaw Steering Systems Approved Equivalent

1 - - Lubricated Plug Valve
2 - - Weatherhead 3-Way Valve (#6737)
3 - - Pressure Gauge (Marshalltown 2 1/2" Dia.)
4 - - Nibco Bronze Gate Valve
5 - - Empco Turbine Flowmeter #TMP - 600 (Optional)
6 - - Fisher regulator
7 - - Hose Cock
8 - - Mercoid Low Gas Pressure Switch (#PG-3-P1)
9 - - Asco Blocking Solenoid Valve
10 - - Maxon Series 808 Safety Shutoff Valve
11 - - Mercoid Hi Gas Pressure Switch (PG-2-P2)
12 - - North American Regulator
13 - - Asco Pilot Solenoid Valve
14 - - Asco Vent Soleoid Valve

C. Electric Heating System

1. The draw furnace shall be electrically heated and controlled with Silicon-Controlled Rectifiers (SCR) and current adjusting-type proportional controllers.

2. The heating system controls shall be located in a separate NEMA 12 control panel from the primary control panel.

   a. SCR control shall be either two or three-leg synchronous firing control.

   b. Under-voltage trip mechanisms shall be used to trip circuit breakers when:

      1. Transformer reaches an excessive temperature.

      2. Control system components reach excessive temperature.

      3. A current imbalance condition occurs in the heating elements.

      4. Ground fault.

      5. Over temperature by zone.

   c. Proof of power to the heating system shall be provided.

      1 An auxiliary switch shall be provided in the SCR circuit breaker to sound an alarm and light a light on the operational logic panel when the SCR circuit breaker is tripped.

      2. An ammeter shall be provided to measure current in each leg.

      3. A voltmeter shall be provided to measure voltage on each leg.

      4. The instruments shall be dampened to accept the variable voltage applied to the heating system.

D. Belt Draw Furnace Requirements.

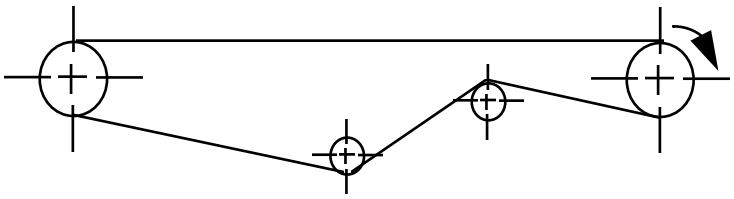
1. Access openings shall be provided every 10 to 15 feet for maintenance of all belt Draw Furnaces.

2. Belt draw furnaces shall have frequent clean-out holes along both sides of the hearth. These openings shall permit the removal of any parts, etc., from below the belt.

3. Normally, Delphi Saginaw Steering Systems will supply the conveyor belt therefore, the price shall be stated as a separate item on the price page. This price shall include drawings completely describing the belt. The installation and adjustment of the belt shall be included in the base furnace price.

4. Belt draw furnace shall utilize take-up mechanisms designed to compensate for changes in the belt length due to wear, temperature changes, variations in load, etc., and to keep belt tension constant at the proper level. An automatic take-up belt stretch plus thermal expansion shall be provided at the drive end of the furnace.

A Typical Belt Take-Up System



5. The drive drum at the discharge end of the furnace shall be constructed such that a sprocket or tooth engages with every strand of chain.

6. The idler and drive drums shall extend beyond all of the furnace structure mechanisms and supports to permit installation of the load and unload material handling equipment under the drums.

7. The conveyor belt drive system shall be fixed speed.

8. Clearance over the belt shall be at least twelve (12) inches.

9. The length of the draw furnace shall be determined by the belt speed, the heat-up rate, and the soak time. Furnace shall be designed such that parts are at heat at the control thermocouple. The controller shall be set at the required operating temperature, a thermal head is not permitted.

10. Charge-end and discharge-end openings shall be covered with curtains for energy conservation(metal slot curtains preferred).

11. If the length of any one zone exceeds twenty-five(25) feet, the furnace shall be provided with the multiple zones.

12. The soak time shall be within plus 30 minutes, minus 0 minutes of the specified time.

13. Each end of the draw furnace shall have ventilation hoods to:

a. Prevent exhaust from entering the plant when the draw furnace curtains are open.

b. Allow adequate access to the draw furnace.

14. A cool-off station shall be provided immediately following the draw furnace, so that the parts can be handled immediately and to limit the heat load on the plant.

a. The station shall utilize outside make-up air.

b. The parts should exit the station within 40° F of ambient.

c. The cool-off station should serve as the discharge end ventilation.

15. A "Proof-Of-Motion" system shall be provided on all conveyor belts.

a. A spoked wheel shall monitor the motion of the conveyor belt.

b. Two(2) timers shall be alternately actuated by the spoked wheel. Either timer timed out indicates loss of motion.

c. The spoked wheel shall be located on an idle roll (a roll that rotates only from the belt motion).

16. Equipment that precedes belt draw furnaces shall include electrical terminals and logic to stop transferring parts when the proof of motion device has indicated that the conveyor belt has stopped. Delphi Saginaw Steering Systems shall make the interconnection.

17. Draw furnaces immediately following induction hardening, plating, or painting operations, shall have logic to stop the furnace conveyor belt if:

a. The heating system is off.

b. Furnace temperature deviates more than 25° F from set point.

18. Start-up service shall be provided.

19. To protect the process the low temperature deviation (10° F below setpoint) shall stop the conveyor.

E. Alarm System

1. An air flow switch shall be provided to determine if the recirculating fan is running.

2. The electrical controls shall include pilot lamps and a silenceable alarm system for the following:

Item	Lamps	Alarm
Recirculating Fans	Running	- - - -
	Not Running	Yes
Exhaust Fans	On	- - - -
	Off	Yes
Cool-Off Station Fans	On	- - - -
	Off	Yes
Conveyor Belt (If Applicable)	Running	- - - -
	Not Running	Yes
Furnace Over-Temperature	By Zone	Single
Process Temperature Deviation	High-By Zone	Single
	Low-By Zone	Single
Alarm Silenced	Red	When Fault Corrected
Main Safety shut off gas valve	Open	- - - -
	Close	Yes
Flame Supervision	On	- - - -
	Off	Yes

F. Control Cabinets

1. The furnace shall include the following control enclosures:

   a. Operational Logic Panels.

   b. Temperature Control Instrumentation Panel.

   c. Electric Heating Panel (if applicable)

2. Each panel shall be identified with a sign with one-inch-high letters.

3. NEMA 12 enclosure shall be used for all control circuits.

4. All pilot lamps, push buttons, and selector switches shall be labeled as to their function.

5. Pilot lamps labeled "running" shall only be used where there is proof of running other than the motor-starter contacts. Motor starter contacts can only be used when it is not practical to sense the running or operational condition and shall be labeled "On".

6. Push buttons shall be used instead of selector switches, except in the alarm circuit.

7. Cabinet doors shall contain the following as a minimum:

    1. "Master Start" - Black flush push button.

    2. "Master Stop" - Red extended push button.

    3. "Power On" - Amber light.

    4. "Emergency Stop" - Red mushroom detented push button.

    5. "Recirculating Fan Running" - Green light per zone.

    6. "Conveyor Running" (if applicable) - Green light

    7. "Exhaust Fan On" - Green light per fan.

    8. "Start Recirculating Fan" - Black flush push button per zone.

    9. "Start Conveyor" (if applicable) - Black flush push button.

    10. "Start Exhaust Fans" - Black flush push button.

    11. "Start Combustion Air Blower" - Black flush push button per zone.

    12. "Combustion Air Blower On" - Green light per zone.

    13. "Stop Recirculating Fan" - Red extended push button per zone.

    14. "Stop Conveyor" (if applicable) - Red extended push button.

    15. "Stop Exhaust Fans" - Red extended push button.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

16. "Recirculating Fan Not Running" - Red light per zone.

17. "Conveyor Not Running" (if applicable) - Red light.

18. "Purging" - Amber yellow light per zone.

19. "Purged" - Green light per zone.

20. "Safety Shut Off Gas Valve Open" - Green light per zone.

21. "Safety Shut Off Gas Valve Closed" - Red light per zone.

22. "Burner Circuit On-Off" - 2 position selector switch.

23. "Burner Circuit On" - Green light per zone.

24. "Pilot Solenoid Gas Valve Open" - Green light per zone.

25. "Ignition" - Red extended push button per zone.

26. "Furnace Over temperature" - Red light per zone.

27. "Alarm Silenced" - Red light.

28. "Temperature Deviation" - Red light per zone.

29. "High Gas Pressure" - Red light per zone.

30. "Low Gas Pressure" - Red light per zone.

31. "On-Off" - 2 position selector switches to enable and silence individual alarms.

32. Black flush push button switches for alarm resets.

33. "Replace Battery" - Red light.

34. "Start Cooling Fans" - Black flush push button.

35. "Stop Cooling Fans" - Red extended push button.

36. "Cooling Fan Off" - Red light per fan.

37. "Cooling Fan On" - Red light per fan.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

8. A plexiglass guard shall be provided on the inside of the control panel door to shield the wiring for lights, push-buttons, meters, switches, etc.

9. All panels shall have fluorescent lights interlocked with the panel door.

10. All guards on the furnace should require tools to open.

11. The guards which can be opened without tools shall be electrically interlocked to the furnace circuitry.

    a. The interlock shall consist of a Brad Harrision plug with chain (cat. #2280) and receptacle (cat.#2280) or approved equivalent.

    b. The plug chain shall be welded in place.

    c. The receptacle shall be mounted in an FS or FD box.

    d. For the equipment with multiple guards, any plug receptacle combination shall be mounted so that a plug can only be inserted into its mating receptacle and not into any adjacent unit.

    e. Removal of a plug during automatic operation shall result in an "emergency stop".

12. The control cabinet is to be installed in a manner that isolates it from any vibration.

13. A cooling system shall be provided for the instrument, control (if programmable controller used) and panels. In most cases use of panel area for cooling is sufficient.An internal, continuous duty, cooling fan shall be provided in panels. No external venting allowed. Power to cooling fans shall be supplied from main panel.

VIII. ANNEALING FURNACE

MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

TITLE FURNACE HEAT TREAT EQUIPMENT NUMBER SD-1001
ISSUED BY Randy P. Bal DATE 12/11/95 APPROVED BY
REVISION REV. DATE SHEET 45 OF 107

A. General Information

1. The parts will be bulk loaded onto the furnace belt with a gon tipper and a ram type loader (with a sound enclosure if required) supplied by Delphi Saginaw Steering Systems. The company installing the furnace shall determine the furnace-loader settings required to process the various quoted parts at the quoted capacity. These settings shall be reported in the furnace operating instruction manual.

2. The furnace supplier shall fabricate and install the chute from the discharge of the loader to the furnace conveyor belt. The design of the chute shall consider the light weight belt design.

3. The furnace belt shall be Delphi Saginaw Steering Systems Alloy Number AL-89721, detail 508, with a nominal width of 96". The installation and adjustment of the belt shall be included in the base furnace price. Delphi Saginaw Steering Systems will supply the belt for installation by the furnace supplier.

4. A manually initiated, pneumatically operated vertical dam which prevents cylindrical parts from rolling under the charge end curtain during start-up or part change over shall be provided.

5. A suitable catch pan shall be provided at the charge end of the furnace to catch parts which may drop through a damaged belt.

6. To assure atmosphere integrity, charge and discharge end curtains shall be multiple layers of materials as described on Delphi Saginaw Steering Systems tool drawing PR-238940. Curtain design shall provide for ease of maintenance.

7. The furnace shall have a 12" clearance above the hearth.

8. The hearth height off the floor should be determined by the elevation required at the discharge end.

9. In order to compensate for permanent belt growth, thermal expansion, tracking, and internal belt guides, the minimum inside wall to wall dimension shall be 9'9" (Nominal belt width + one (1) foot + 1.25" per foot of nominal belt width = minimum inside wall to wall dimension)

10. Cast alloy belts that operate over 1200° F grow approximately 3/4 of one (1) inch per foot of width in their life span. The furnace walls, guide rails, and belt return system shall accept this growth by initial width and/or by the use of adjustable mechanisms.

11. Belt take-ups shall be provided at the charge end of the furnace.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

12. Belt furnaces that operate from 1300° F to 1800° F shall have a driven roller hearth.

13. The furnace conveyor system shall be capable of processing 75 lbs. per square foot net loading at 1750° F without damage occurring.

14. Belt retainers or skids shall be provided in the furnace and cooling sections to assist the belt in tracking and to prevent serious furnace or belt damage.

15. Belt furnaces that operate over 1300° F shall have sturdy, permanent reference points to use for aligning the furnace rolls and drums. The reference points shall be located at:

    a. Each shaft level.

    b. The four corners of the equipment.

    c. At thirty (30) foot increments for equipment over 30 feet long.

16. The furnace conveyor shall have a 3:1 variable speed DC drive.

17. An idle/run selector switch shall be provided on the operational logic panel. When in the idle position the DC drive shall go to a preset creep speed. When in the run position the DC drive shall return to the normal operating speed (adjustable with a potentiometer).

18. A tachometer calibrated in feet per hour shall be provided to indicate the belt speed.

19. If the DC drive is in the idle speed mode, the loader shall be prevented from operating in automatic.

20. A proof of motion system shall be provided on all belt annealing furnaces:

    a. A spoked wheel shall monitor the motion of the conveyor belt.

    b. Two timers shall be alternately actuated by the spoked wheel. Either timer timed out indicates the loss of motion.

    c. The spoked wheel should be located on an idle roll that rotates only with belt motion.

    d. The installation vendor of the annealing furnace shall provide the material and the labor to interconnect the proof of motion signal the furnace loader.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

e. A duplicate set of timers may be required in order to accurately monitor both the idle speed and the run speed.

21. Unless otherwise specified, the parts will be unloaded from the furnace belt into a discharge conveyor supplied by Delphi Saginaw Steering System.

22. The furnace supplier shall provide labor and material to connect the interlock between the discharge conveyor and the furnace. The furnace belt DC drive shall automatically go into the idle mode when the discharge conveyor is shut off.

23. A remote idle/run selector switch shall be provided at the discharge end of the furnace. Turning the selector switch to the idle position places the DC drive in the idle mode and energizes a timer giving the operator ten minutes to change gons before the "conveyor belt stopped" light and alarm come on. Turning the selector switch to the run position shall return the DC drive to the normal belt speed.

24. An alternate method of driving the belt in case of a DC power failure shall consist of an auxiliary A.C. motor, double shaft gear reducer, and dual electric clutches. The auxiliary A.C. motor shall drive the belt at a creep speed and the loader shall be prevented from operating in the automatic mode when the auxiliary AC motor is being used.

25. The furnace shall include a cold belt return.

26. The conveyor belt shall return to the charge end of the furnace on a series of roller tables spaced to allow for proper belt catenary. Channel iron rails shall be located between the roller tables to keep the belt side guards off of the floor.

27. Six (6) inch in diameter vertical rolls shall be used along the belt return to maintain proper belt alignment.

28. The bricked transition section between the hot chamber and the cooling sections shall be at least 15 minutes long but not shorter than four (4) feet.

29. Cooling sections shall be covered with sheet metal, adequately reinforced. Venting any water vapor should be through the loose joints and cutouts.

30. The length of the cooling section control zones shall be determined by the heat load for each section.

a. The cooling zone nearest the furnace shall be the shortest.

b. The last cooling zone shall be the longest, but not more than ten (10) feet long.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

31. Two (2) access openings to the furnace interior shall be provided for maintenance. The openings shall be at least 18" by 24".

    a. One(1) opening shall be located in the heat-up zones.

    b. One(1) opening shall be located in the soak zones.

    c. The openings shall provide access above the belt.

32. Water cooling jackets shall have top entry access openings at least every ten (10) feet. These openings shall be two (2) feet by three (3) feet when practical.

33. Service platforms shall be provided on both sides of the furnace to provide access to the radiant tube burners and pilots.

34. Access/service platforms shall be provided at the charge end of the furnace for working on the charge apron.

35. Access openings shall be provided to clean out all bottom cooling jackets.

36. The temperature uniformity in the annealing furnace shall be:

    a. Plus or minus 10° F across the furnace.

    b. Plus or minus 10° F from end to end of the soak zones.

    c. Required for all quoted operating temperatures.

B. Electric Heating System

1. The furnace shall be electrically heated utilizing Bayonette type elements and radiant tubes. The end of the radiant tube shall sit on a 1/4" plate that sits on the brick and is fastened directly or through a 1/2" rod to the outside of the furnace casing. The inside edge of the plate shall be bent down 90°F to contain the edge of the brick. The rod and plate shall be 330 heat resistant alloy. Approved alternates will be considered.

2. The furnace shall be designed for continuous operation at 1675° F at the stated capacity and 1750° F at a reduced capacity. Specify the capacity at the maximum operating temperature.

3. NEMA 12 enclosures shall be used for all transformers, SCR's and control circuits.

4. The firing circuit components and the heating system controls can be located in the SCR panel if they can withstand the heat. A separate NEMA 12 panel

shall be provided if they cannot withstand the heat. A temperature-sensing switch, alarm, and light shall be provided to monitor this panel.

5. Lytron Liquid-To-Air heat exchanges or similar using city water shall be used inside the heating system panels to re-circulate the air and cool the components inside the panel. The blower, heat exchanger, and related piping shall be isolated from the SCR cabinet area by an interior panel. Maintenance access to the liquid-to-air system shall be provided from the panel exterior. A sealed floor area with a drain and trap shall be provided in case of a waterline rupture.

6. The cooling fan shall operate whenever the heating system is energized.

7. The water supply shall be controlled to prevent excessive cooling and therefore, condensation on the electrical components.

8. The water outlet shall drain into the tower return tank.

9. An alarm and light shall be energized whenever the inside panel temperature exceeds a pre-set level.

10. SCR control can be either two or three-leg control.

11. Under-voltage trip mechanisms shall be used to trip the circuit breakers when:

    a. A SCR reaches an excessive temperature.

    b. Control-system components reach an excessive temperature.

    c. An imbalanced condition occurs in a set of heating elements.

    d. Ground fault.

    e. Over-temperature by zone.

12. The system circuit breakers shall include a 230-volt DC under-volt trip. The 230-volt DC source will be a Delphi Saginaw Steering Systems tool no. 215144 time delay unit. Delphi Saginaw Steering Systems will provide the time delay unit to be mounted and wired by the furnace vendor. A cinch fanning strip, No. 6-161-L, shall be used to wire the time delay, and shall be furnished by the furnace supplier.

13. Main heating system breaker shall have a suitable door-mounted operator. Individual zone breakers shall have flange-mounted operators.

14. Circuit breakers shall be co-ordinated so that the circuit breaker closet to the fault opens first. The second closest C.B. will open next if the fault wasn't cleared.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

15. Voltmeters and ammeters shall be provided to monitor each zone of heating control.

    a. Large dial - 5" maximum.

    b. Three phases of each system shall be monitored.

    c. A selector switch or switches can be provided to select a particular system to monitor and therefore reduce the quantity of meters.

    d. The meters shall be located with the heating system panels.

C. Gas Fired Heating System

1. The heating system shall utilize gas fired, radiant tubes.

2. The annealing furnace shall have a maximum operating temperature of 1750° F at rated capacity.

3. The heating system shall include time proportioning on/off controls. High/low fire is not acceptable.

4. The burners shall be located on alternate sides of the furnace to assure temperature uniformity across the furnace.

5. All radiant tubes shall be removable when the furnace is at operating temperature and the atmosphere is removed.

6. A recuperative burner system shall be used to pre-heat the combustion air with the exhaust of the radiant tube on the top burners of all heat-up zones.

7. The annealing furnace shall include two (2) air blowers, each sized independently to meet the low pressure air requirements of the furnace. The blowers shall be installed in parallel with one serving as a back up low pressure air source for the furnace.

8. All air blowers shall have filters and silencers.

9. The low pressure air shall be monitored with a 1-17 O.S.I.G. pressure switch.

10. The annealing furnace requires natural gas for:

    a. Burners.

    b. Burner Pilots.

c. Four (4) service torches for lighting the various pilots.

11. The annealer shall have the following safety-aid equipment:

a. A Maxon Series 808 manual reset safety shutoff valve with 230 volt DC solenoid shall be provided on the main gas line in conjunction with a Delphi Saginaw Steering Systems time delay unit (TL-215144). An internally mounted, single pole, double throw micro-switch rated at 15 amps shall also be included. Delphi Saginaw Steering Systems will provide the time delay unit for mounting by the vendor. The vendor shall supply a cinch fanning strip, No. 6-161-L, to wire the time delay.

b. A low gas pressure switch (1-17 O.S.I.G.) located between the pressure regulator and the safety shut off valve.

c. A high gas pressure switch (1/2-5 P.S.I.G.) located after the safety shut off valve.

d. The gas train safety logic shall include the combustion air blower motor contacts and the combustion air low pressure switch.

12. Gas pilots shall be provided on all burners as follows:

a. To maintain pilots during a power failure, pilot supply lines shall be installed ahead of the Maxon valve and shall not contain any electrical valves.

b. Each regulated pilot supply line shall have a low gas pressure switch and a high gas pressure switch.

c. Pilots should be located on the exhaust end of the radiant tubes.

d. All burners shall utilize five (5) CFH pilots.

13. The gas train, pressure switch panels, and electrical control panel shall be located as near each other as possible on the same side of the furnace, near the charge end.

14. The gas piping, including main gas shut off valves, pressure regulator, and safety shut-off valve, shall be located not over five (5) feet above floor level.

15. Four (4) torches shall be provided for lighting all of the pilots.

a. A hand valve, rubber hose, shut off petcock, wand, and burner tip shall be provided for each torch. The hand valve shall be located between the

torch gas supply line and the rubber hose. The shut off petcock shall be located between the rubber hose and the wand.

b. Service torches shall be located on both sides of the furnace on both the charge end and the end of the hot chamber.

c. The torch gas supply lines shall be installed ahead of the Maxon valve and shall not contain any electrical valves.

d. A convenient storage location with hangers shall be provided for each torch.

16. Flame supervision shall not be permitted on radiant tube burners and burner pilots.

D. Nitrogen-Methanol Atmosphere Specifications

1. The parts will be processed in a nitrogen/methanol atmosphere, the atmosphere gas chemistry and quantity shall be based on part surface requirements.

2. The nitrogen header shall contain a pressure regulator, differential pressure switch, and a nitrogen Flo-meter.

3. One nitrogen pressure regulator is required to adjust actual nitrogen flow for the furnace. Supply and regulated nitrogen pressure gages shall be provided.

4. The differential pressure switch and restricting orifice shall be used to monitor the flow of nitrogen.

5. A Waukee or Selas flo-meter shall be supplied to monitor the nitrogen atmosphere gas. The flo-meter shall be sized for maximum furnace usage without methanol and it shall include an integral valve. A fixed orifice shall be installed to limit the maximum flow. A separate shut off valve shall be installed and the integral flo-meter valve shall not be used as a shut off valve. The vendor shall specify both the expected flow of nitrogen with methanol and the maximum usage flow of nitrogen without methanol, in cubic feet per hour.

6. The nitrogen supply shall not contain any electrical valves.

7. Nitrogen gas inlets shall be piped into the heating chamber, transition zone, and discharge throat of the annealer.

8. The nitrogen gas inlets shall have properly sized orifices and gas cocks for each inlet. These orifices shall be sized to provide the proper nitrogen flow and atmosphere integrity in the furnace without methanol.

9. The furnace supplier will supply and install the liquid methanol distribution panel.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

10. The panel shall be floor mounted and require minimum floor space. Access must be provided to the back of the panel to service the piping and flowscopes.

11. A piping manifold shall be provided on the back of the distribution panel to provide ease of installation. Each inlet and outlet shall have a 1/2" in diameter ball valve on the manifold.

12. One pressure gauge is required to monitor the actual methanol pressure of the distribution panel inlet line.

13. Each methanol inlet shall have its own direct reading flowscope with dual calibration (gallons per hour and CFH of disassociated gas).

14. Individual flow control valves on the flowscopes are required to adjust flow of methanol within the safe limits for combustible gas (3-1/2 percent of nitrogen usage, maximum).

15. The electrical controls shall be completely separated from the piping and flowscopes to guarantee no moisture penetration into the electrical cabinet.

16. The panel shall be electrically connected to the furnace operational panel.

17. All electrical controls shall be located in the furnace operational cabinet. The methanol panel shall utilize a NEMA 12 junction box to receive all interlocks and connect flow switches and the solenoid valve to a terminal strip. The panel shall have a "start" push button, a "power on" lamp, and a "methanol Flow Failure" light.

18. A two position selector switch shall be provided to select the mode of operation. It shall be labeled "methanol ON/OFF". This switch shall be located on the furnace operational cabinet. The selector switch shall be utilized with the liquid methanol solenoid valve to insure automatic introduction of methanol upon resumption of power after a power failure. The controlling interlocks will determine whether the valve will re-open.

19. Various interlocks shall be used to control the introduction of methanol into the furnace:

    a. Furnace temperature must be above 1100° F.

    b. Furnace must be completely purged with nitrogen.

    c. Nitrogen flow must be proved.

    d. Proof of no methanol flow followed within 5 seconds by proof of methanol flow.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

20. A loss of any of the interlocks shall close the methanol flow solenoid valve and sound an alarm on the furnace electrical cabinet.

21. In case of power failure, the methanol solenoid valve shall close and will re-start automatically if the required interlocks are made.

22. All methanol piping shall be welded, schedule 80 black iron and pressure checked to 100 PSI.

23. The incoming methanol shall have a 60 micron filter. In addition a phase separator shall be provided to remove any nitrogen bubbles. The separator shall be vented to the furnace ventilation hood.

24. A fixed orifice shall be installed to limit the maximum methanol flow.

25. All timers associated with the methanol system shall be solid state design, either fixed or limited adjustability.

F. Alarm Systems

1. Atmosphere annealing furnace lines shall include two (2) rotating, red beacon lights as follows:

   a. One (1) beacon shall be located in front of the GON tipper loading the furnace. The second beacon shall be located near the discharge end of the annealer.

   b. The beacon lights shall notify the operator whenever a fault occurs at the furnace.

2. The electrical controls shall include pilot lamps and a silenceable alarm system for the following:

Item	Lamp	Alarm
Water Recirculating Pumps	On	----
	High Level	Yes
Recirculating Fans	On	----
	Off	Yes
Exhaust Fans	On	----
	Off	Yes

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Furnace Conveyor	Idle Speed	----
	Normal Speed	----
	DC Drive Failure	Yes
	On DC Idle Too Long	Yes
	DC Drive Over-Temp	Yes
Auxiliary Drive	Running	----
Unloader	On	----
	Off	Yes
Nitrogen Flow	Flowing	----
	Low Flow	Yes
Methanol Flow	Normal	----
	Abnormal	Yes
Methanol 1100° F Contacts	Above	----
	Below	Yes
Furnace Over temperature	By Zone	Single
Alarm Silenced	Red	----
Temperature Deviation	By Zone	Single
* Main Gas MRSV	Open	----
	Closed	Yes
* Combustion Air Blower	On	----
	Off	Yes
*High Gas Pressure	High	Yes
*Low Gas Pressure	Low	Yes
*Low Combustion Air Pressure	Low	Yes

* For gas-fired heating systems

IX. ENDOTHERMIC GAS GENERATOR

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

TITLE FURNACE HEAT TREAT EQUIPMENT NUMBER SD-1001
ISSUED BY Randy P. Bal DATE 12/11/95 APPROVED BY
REVISION REV. DATE SHEET 56 OF 107

A. General Information

1. The endothermic gas generator shall be a quality piece of equipment.

2. The generator shall be designed to provide ease of maintenance and use components that will withstand manufacturing plant operating conditions.

3. The generator maximum operating temperature shall be 2000° F.

4. The operating temperature while making endothermic gas is 1950° F.

5. The heating system shall have time proportioning On/Off control.

6. The reaction tubes shall be filled with nickel catalyst and alumdum lumps.

7. The generator shall have a skin temperature less than 60° F above the ambient temperature while operating at 1950° F.

8. All cold piping shall be insulated to prevent sweating and corrosion (less than 60° F).

9. The generator and gas cooling systems shall be completely assembled, pre-piped, and pre-wired prior to shipment. The equipment shall be dis-assembled only as required for shipment. All of the electrical components shall be wired to junction boxes.

10. The endothermic gas vent shall be located to permit easy installation of an exhaust hood by Delphi Saginaw Steering Systems.

B. Burner Piping

1. A Maxon Series 808 manual re-set safety shut off valve shall be provided in the burner gas supply line in conjunction with an SSG time-delay unit (TL-215144). An internally-mounted, single-pole, double-throw microswitch rated at 15 amps shall also be included. SSG will provide the time-delay unit for mounting by the vendor. The vendor shall supply a cinch-fanning strip, No. 6-161-L, to wire the time-delay.

2. Burners shall be ignited only by gas pilots. No spark ignition of burners is allowed.

3. A Spencer or approved equivalent blower shall be provided for the combustion air.

4. No venting or blocking valves are allowed on the main natural-gas line to permit a maintained flame through a short-duration power failure.

C. Pilot Piping

1. Pilots for effluents shall be wind-proof atmospheric pilots.

2. Pilot lines shall not contain any electrical valves.

3. Gas pressure switches:

   a. High gas pressure switch (0 to 10 p.s.i.g.)

   b. Low gas pressure switch (0 to 16 p.s.i.g.)

4. Pilot flame supervision shall not be provided.

5. All valves and controls, including the pilot itself, shall be located within seven (7) feet of the floor near the perimeter of the generator to permit easy access except for the vent pilot.

D. Reaction Air

1. Lower than ambient pressure caused by mixing pump will draw reaction air into the mixer.

   a. The air will be filtered.

   b. A Waukee flowscope or approved equivalent will be provided to measure air flow.

2. Mixture control will be maintained by the induction of ambient air into the mixture.

   a. The air will be filtered.

   b. Control of air flow will be maintained by the provision of a motor operated valve controlled by an infrared analyzer.

   c. A shut off valve will be provided between the I.R. control valve and the mixing pump.

3. Provisions shall be made to burn out carbon deposits in the reaction tubes.

E. Reaction Gas

1. The mixing pump will raise the pressure of the air gas mixture for use in the reaction tubes.

    a. A Maxon Series 808 manual re-set safety shut off valve with a 230 volt DC solenoid in conjunction with a Delphi Saginaw Steering Systems time-delay unit (TL-215144) shall be provided on the natural gas supply line for reaction gas. An internally-mounted, single-pole, double-throw microswitch rated at 15 amps shall also be included. Delphi Saginaw Steering Systems will provide the time-delay unit for mounting by the vendor. The vendor shall supply a cinch fanning strip, No. 6-161-L, to wire the time delay.

    b. Manual shut off valves will be provided on both sides of the shut off valve.

    c. The flow shall be monitored by an orifice with a differential switch.

    d. A Waukee or approved equivalent flowscope will be provided to measure gas flow.

    e. Pressure regulation before the mixer will be provided.

    f. Delphi Saginaw Steering Systems will provide time delay units, TL-215144, for the shut off valve for installation by the vender.

2. The gas-air mixture pump shall be a Roots - Connersville (or equivalent) positive displacement pump.

F. Auto turndown and flow control of air gas mixture.

1. Re-circulation around the mixture pump will be provided.

2. By-pass will be controlled by a regulator.

    a. The regulator shall be back pressure sensing.

    b. The by-pass will be capable of passing 2/3 of the pump's output.

    c. The by-pass will be auto operating.

    d. The regulator will be a spring type.

3. Provisions shall be made for Delphi Saginaw Steering Systems to back load the generator from the plant header pipe and from the generator itself.

4. Venting of the air gas mixture will be provided.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

5. Venting of the mixture will be controlled by a regulator.

   a. The regulator shall be back pressure sensing.

   b. The vent line shall be capable of passing the remainder of the mixture.

   c. The vent will be auto operating.

   d. The regulator will be a spring-type.

6. The vent outlets shall be located approximately ten (10) feet above the floor, near the perimeter of the generator system.

   a. The vent outlets shall be in one location.

   b. Pilot flames will be provided.

G. Endothermic Gas

1. The generator shall produce an endothermic atmosphere gas with the following approximate analysis:

H_2	38.8%	CH_4	0.4%
CO	20.5%	0_2	0.0%
CO_2	0.1%	N_2	Remainder

2. The outlet of the reaction tubes shall pass through separate tower water cooled heat exchangers. The heat exchangers shall include a water trap to remove the condensed water.

3. A three-way valve shall be supplied in the endothermic gas line to permit manually venting the product from the reaction tubes. The three-way valve shall be monitored by a limit switch in the vent position.

H. TYPICAL PIPING SCHEMATIC

I. Alarm System

1. In general, the following items require a silenceable, audible alarm:

   a. High or low temperature ± 25° F from setpoint.

   b. Reaction gas safety shut off valve tripped.

   c. Mixture pressure low.

   d. Reaction gas system fault.

   e. Burner gas safety shut off valve tripped.

   f. Combustion air pressure low.

   g. Burner gas system fault.

   h. High or low fuel gas pressure.

   i. Low air gas mixture pressure.

J. Reaction System Interlocks

1. Start-up conditions:

   a. Generator temperature shall be above 1550° F

   b. Reaction gas pressure shall be ample.

   c. The endothermic gas, three-way valve shall be in the vent position.

   d. The reaction gas safety shut off valve shall be interlocked to prevent opening the valve below 1550°F.

2. Auto shut down of the reaction system:

   a. Generator temperature below 1550° F

   b. Reaction gas pressure low.

6. The burner system shall be interlocked with gas pressures to fail-safe.

X. BATCH CARBURIZERS

A. General Information

1. The furnace shall be a versatile in-and-out batch heat treating furnace designed for carburizing, carbonitriding, clean hardening, carbon restoration, and homogeneous carburizing.

2. All handling shall be automatic while the work is in the furnace and quench. The vestibule may be manually loaded from a charge car.

3. The furnace shall be rated to heat a minimum gross load of 1500 lbs. to 1550° F within one hour.

4. The furnace shall use two Delphi Saginaw Steering Systems cast alloy trays, AL-51806-C, detail 1, to convey the product in and out of the furnace.

5. The furnace load height shall be 56.5".

6. The furnace and quench system shall not require a pit.

7. Clearance for the tray and work shall be 22" minimum.

8. The furnace shall be designed and constructed for continuous operation at 1750° F.

9. The quench system shall be fully enclosed and located in the vestibule of the furnace.

10. The furnace and quench shall be completely assembled, piped, and wired prior to shipment. Disassemble only as required for shipment. All electrical components on the furnace and quench shall be wired to junction boxes.

    a. With exception to the combustion system the furnace shall be connected to supplier's utilities and tested for reliable operation.

    b. All limit and pressure switches, actuators, fans etc. shall be secured in their operating position.

    c. All motions shall be adjusted and/or aligned for correct operation.

B. Electrical Heating System

1. The furnace shall be electrically heated utilizing bayonette type elements and radiant tubes. The end of the radiant tube shall roll on a 1/8" rod that rolls on a 1/4" plate that sits on the brick and is fastened directly or through a 1/2" rod to the inside of the furnace casing. The inside edge of the plate shall be bent down 90° to contain the edge of the brick. The rod and plate shall be 330° F heat resistant alloy. Approved alternates will be considered.

2. The furnace shall be designed for continuos operation at 1675° F at the stated capacity and 1750° F at a reduced capacity. Specify the capacity at the maximum operating temperature.

3. NEMA 12 enclosures shall be used for all transformers, SCR's and control circuits.

4. The firing circuit components and the heating system controls can be located in the SCR panel if they can withstand the heat. A separate NEMA 12 panel shall be provided if they cannot withstand the heat. A temperature-sensing switch, alarm, and light shall be provided to monitor this panel.

5. Lytron liquid-to-air heat exchangers or similar using city water shall be used inside the heating systems panels to re-circulate the air and cool the components inside the panel. The blower, heat exchanger, and related piping shall be isolated from the SCR cabinet area by an interior panel. Maintenance access to the liquid-to-air system shall be provided from the panel exterior. A sealed floor area with a drain and trap shall be provided in case of a waterline rupture.

6. The cooling fan shall operate whenever the heating system is energized.

7. The water supply shall be controlled to prevent excessive cooling and therefore, condensation on the electrical components.

8. The water outlet shall drain into the tower return tank.

9. An alarm and light shall be energized whenever the inside panel temperature exceeds a pre-set level.

10. SCR control can be either two or three-leg control.

11. Under voltage trip mechanisms shall be used to trip the circuit breakers when:

    a. A SCR reaches an excessive temperature.

    b. Control system components reach an excessive temperature.

    c. An imbalanced condition occurs in a set of heating elements.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

d. Ground fault.

e. Over temperature by zone.

12. The system circuit breakers shall include a 230 volt DC under-voltage trip. The 230-volt DC source will be a Delphi Saginaw Steering Systems TL-215144 time delay unit. Delphi Saginaw Steering Systems will provide the time delay unit to be mounted and wired by the furnace vendor. A cinch fanning strip, No. 6-161-L, shall be used to wire the time delay, and shall be furnished by the furnace supplier.

13. Main heating system breaker shall have a suitable door-mounted operator. Individual zone breakers shall have flange-mounted operator's.

14. Circuit breakers shall be co-ordinated so that the circuit breaker closet to the fault opens first. The second closest circuit breaker will open next if the fault wasn't cleared.

15. Voltmeters and ammeters shall be provided to monitor each zone of heating control.

a. Large dial - 5" maximum.

b. Three phases of each system shall be monitored.

c. A selector switch or switches can be provided to select a particular system to monitor and therefore reduce the quantity of meters.

d. The meters shall be located with the heating system panels.

C. Gas Fired Heating System

1. All equipment using natural gas for heating or flame curtains shall have the following safety aid equipment:

a. 0-16 o.s.i.g. combustion air pressure switch.

b. 0-10 p.s.i.g. high gas pressure switch.

c. 0-16 o.s.i.g. low gas pressure switch.

d. A Maxon series 808 manual reset safety shut off valve with 230 volt DC solenoid shall be provided on the radiant tube heating gas supply line in conjunction with a Delphi Saginaw Steering Systems time delay unit, drawing no. TL-215144. An internally mounted single pole, double throw microswitch rated at 15 amps shall also be included. Delphi Saginaw

Steering Systems will provided the time delay unit for mounting by the furnace supplier. A cinch fanning strip, no. 6-161-1, to wire the time delay.

e. The low pressure shall be sensed between the pressure regulator and the safety shut off valve.

f. The high pressure shall be sensed downstream of the safety shut off valve and the on/off natural gas solenoid valve.

2. The furnace shall be designed for continuous operation at 1675° F at stated capacity and 1750° F at reduced capacity. The supplier shall specify in his proposal the capacity at maximum operating temperature.

3. Pilots for cold vestibule doors and endothermic atmosphere effluents shall be windproof atmospheric pilots and shall not contain any electrical valves in their gas lines.

4. Not more than one set of pressure switches and one safety valve shall be included in the equipment without approval from the Delphi Saginaw Steering Systems Process Engineer.

5. The gas piping, pressure switches, and electrical control panel shall be placed on the same side of the equipment and shall be placed as near to each other as practical.

6. Pre-mix gas pilots shall be used only when absolutely necessary. Internal gas pilots shall not be used.

7. The heating system shall utilize gas fired radiant tubes. Sealed recuperative burner systems shall be provided to preheat the combustion air with the exhaust of the radiant tube.

D. Low Pressure Air Systems

1. An air blower shall be priced separately whenever low pressure air, less than 30 o.s.i.g., is required for pre-mix pilots, atmosphere additions, carbon burnouts, heating element purge, etc.

2. The air blowers shall be sized to supply low pressure air to a minimum of four furnaces of the same size.

3. All combustion air blowers shall have filters and silencers.

4. Furnaces shall have provisions for carbon burnout. The inlet pipes shall be used only for carbon burnout.

5. The carbon burnout air supply line shall include a figure eight orifice plate.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

a. The figure eight is located in a four bolt flanged pipe joint.

b. The figure eight is a 1/2" plate.

c. On side of the figure eight is an orifice large enough to supply the carbon burnout air. The opposite site side is a solid plate to prevent any air from entering the furnace.

d. The figure eight shall contain only seven bolt holes so that it will pivot around the center bolt hole.

6. A separate air flowscope for carbon burn out use only, shall be sized to service the entire furnace and located near the figure eight air supply.

E. Atmosphere Piping

1. Flowscopes shall be provided for endothermic atmosphere gas, natural gas, air and ammonia.

2. All flowscopes shall be Waukee with integral control valve and shall be mounted in one location.

3. Endothermic atmosphere.

a. A special modified Maxon series 818 safety shut off valve for Endothermic atmosphere, 115 VAC with internal SPDT auxiliary switch rated at 15 amps. This valve must be electrically satisfied to be manually opened. It closes by manual operation of the valve handle. The valve cover shall be painted bright red. This valve shall be used in the endothermic atmosphere gas feed line to each atmosphere furnace.

1. Opening the atmosphere safety shut off valve requires:

a. The furnace must be above 1400° F.

b. The control instrument must be energized.

c. The atmosphere flow switch must show no flow.

b. The endothermic gas line shall include an orifice and a differential pressure switch to positively sense flow. This orifice shall be located downstream of the Maxon control valve.

c. Enriching natural gas, air, and ammonia additions shall be electrically interlocked with solenoid valves, which shall be open only when the endothermic gas safety shut off valve is open.

d. Flowscopes

1. All flowscope shall be Waukee with integral control valves, unless otherwise specified.

2. All flowscope shall be mounted in one location on a atmosphere panel.

3. Individual flowscope shall be provided for endothermic gas, natural gas, air, and ammonia.

e. Atmosphere sampling ports shall be provided in both the furnace and vestibule.

1. The furnace sample port shall be located in close proximity to the carbon potential oxygen probe.

2. The furnace sample port shall be removable via a 1" N.P.T. threaded coupling.

3. The furnace sample port shall include a ball valve.

4. A petcock with 1/4" hose barb shall T off of the 1" sample port pipe.

f. Nitrogen gas.

1. Nitrogen will be used for:

a. Purging gas in case of emergency or loss of endothermic gas flow.

b. Emergency replacement for the high pressure pneumatic system.

2. Purge nitrogen supply will be monitored with one flowscope provided by the furnace supplier and mounted on the atmosphere panel.
Purge nitrogen flow shall be controlled by fixed orifices and not flow control valves

3. The purge nitrogen flowscope shall be capable of passing at least twice the normal volume of endothermic gas used. The endothermic manifold shall be used for nitrogen purge using a three way,

noncommunicating teflon-lined valve located downstream of the endothermic Maxon valve but before the zone flowscope.

4. The nitrogen supply line shall not contain any electrical valves.

F. Alarm System

1. The following items require a silenceable, audible alarm.

   a. Mechanical drives and overloads.

   b. Recirculating fans.

   c. Quench agitators.

   d. Quench cooling pumps.

   e. Cooling water pressure exceeding the oil pressure in a heat exchanger.

   f. High and low oil levels.

   g. Safety shut off valves.

   h. High and low natural gas pressure.

   i . Low air pressure.

   j. High furnace temperature.

   k. Tripped circuit breakers.

   l. Transformer and heating system controls.

   m. High temperature in heating system panel.

2. The only unsilencable alarm is the endothermic atmosphere gas shutoff valve being open and any of the following events occurring:

   a. Endothermic gas flow failure.

   b. Furnace temperature drops below 1050° F.

   c. Furnace control instrument is deenergized.

G. Furnace Controls

1. Electrical circuits and push button station shall be designed to allow cycling the equipment in either the automatic or manual mode.

2. Each transfer, door, and elevator, shall have a push button for the manual mode operation.

3. Manual push buttons shall function only in manual mode.

4. All motions shall be interlocked in the manual mode as well as in the automatic mode.

5. Interlocking mechanisms shall be limited to:

   a. Preventing mechanism jams with adjacent mechanisms, doors, and elevators.

   b. Safe operating practices for oil quench systems.

   c. Safe operating practices for cold vestibules filled with atmosphere gases.

6. Mechanisms that travel into the furnace shall be monitored by a current trip relay in the forward mode. When the current setting is exceeded, the mechanism shall retract out of the furnace. The motor overloads shall be the only protection in the reverse mode.

7. The quench elevator system shall have a means to positively proving that it is in the up or down position.

8. The quench elevator shall descend into full down position upon loss of air pressure. Upon loss of electrical power, the elevator is to maintain its air powered motion.

9. Push buttons shall be used for mechanisms that must be on the Emergency Protected Power but are not required for continuous operation, such as auto cycle, material handling, and ventilation.

10. Selector switches shall be used for mechanisms that are required to automatically restart when electrical power is returned to the furnace panel, such as furnace fan, quench oil cooling pump, etc.

11. Quench agitator shall have auto on/off modes. In auto mode, agitator will run when heat is on and/or elevator is down.

XI. PUSHER CARBURIZERS

A. General Information

1. The furnace shall be of the side wall fan design.

2. The hearth elevation shall be 41".

3. The clearance height for the trays and fixtures shall be 24".

4. The hearth supporting the base trays shall be two (2) alumina rails designed to support the trays under the ribs.

5. Alumina lead guide tiles shall be beveled to a maximum of 30° to the center line of the title. In addition, the top of the leading edge of the tiles shall have a 45° chamfer.

6. The furnace hearth shall be continuous to eliminate any span for the trays to cross or parts to lodge. Particular attention should be made in the area under the inner doors.

7. The spacing of the guide tiles shall be designed to allow for thermal expansion and permanent tray growth:

   a. For trays that are not automatically rotated 90° every cycle, there is approximately one-half inch permanent tray growth per foot of tray width.

   b. Design thermal expansion per ACI standards.

   c. For trays that are automatically rotated 90° every cycle, this is approximately one-quarter inch permanent tray growth per foot of tray.

8. The inner doors shall be electric motor operated. Chains supporting the inner doors shall be stainless steel with riveted pins.

9. The inner doors shall be insulated with ceramic fiber block insulation. Castable or brick insulation is not acceptable.

10. Vestibule outer doors shall be hinged on the bottom and operated by pneumatic cylinders.

11. Electric motor operated chain-on-edge mechanisms shall be used to move trays in and out of the carburizer. The chain shall be captured in a special "H" section refractory tile in the furnace hearth.

12. Individual electric motor operated row pushers shall be provided for each furnace row. Pusher heads shall be removable while the furnace is at operating temperature.

13. Tray positioners shall be designed to contact base trays at a rib intersection. Some of Delphi Saginaw Steering System's trays contain an expansion slot in the outermost rib. Use of these require an off center tray positioner.

14. Tray positioners shall position trays such that there is a one inch offset between rows. All tray positioning rods should be the same length. The location of the tray positioning rods should be determined by the rod actuators.

15. Tray position limit switch actuators shall be pinned, doweled, or otherwise positively fastened to the index rod.

16. All index or tray positioning rods shall retract fully into the rear wall of the furnace. In the fully retracted position, no portion of the rod shall protrude beyond the surface of the wall.

17. Pusher, tray type furnaces, shall have one 6" x 12" work opening located just above each pusher. These openings will be used to pull trays back onto the charge hearth when necessary.

18. One access opening shall be provided in the discharge end wall just above the hearth line. The opening shall be 15" by 24" minimum. The opening shall be insulated with loose brick (not cemented).

19. The access door at the charge end shall be located on the wall opposite the charge vestibule.

    a. The door shall be hinged to swing open.

    b. The hot faces of the access door and the sight glass pipe through the wall shall be constructed of Ra 333 alloy.

    c. The insulation shall be permanently attached to the door.

    d. The door shall be bolted closed.

    e. The door shall be at the end of the charge hearth. The bottom of the door shall be flush at the hearth level.

    f. The door shall be large enough to slide a loaded tray from the charge hearth out the door.

g. Any devices immediately above the access door (such as wiring) shall be shielded from heat due to the open access door.

20. Four inch diameter blast gates with easily removable sight glasses shall be provided for observation and trouble shooting. As an example, a four row carburizer would require 18 sight glasses.

a. Sight glasses shall be located in between the tray rows and along the outside wall as near as the hearth line as possible to observe the edge of each row of trays. These sight glasses shall be provided on the charge and discharge end walls. For example, a four-row carburizer would require 10 sight glasses.

b. Sight glasses shall be provided on the rear wall to observe the top of each row. The center line of the sight glass shall be directed at the top of the corrugated box or the top of the highest, fixtured parts being specified. For example, a four row carburizer would require four(4) sight glasses.

c. Four (4) sight glasses shall be provided to observe the charge and discharge cross transfer mechanisms. They shall be located on the center line of the cross transfer mechanisms in the furnace and vestibule walls at both ends of the mechanisms.

d. Holes through the brick for the blast gates shall be tapered to allow a reasonable view of the furnace interior.

21. Explosion hatches shall not be provided on the charge or discharge vestibules of the carburizing furnace.

22. Clearance shall be provided around fan housings to allow for growth of fan blades.

B. Electrical Heating System

1. The furnace shall be electrically heated utilizing bayonette type elements and radiant tubes. The end of the radiant tube shall roll on a 1/8" rod that rolls on a 1/4" plate that sits on the brick and is fastened directly or through a 1/2" rod to the inside of the furnace casing. The inside edge of the plate shall be bent down 90° to contain the edge of the brick. The rod and plate shall be 330° F heat resistant alloy. Approved alternates will be considered.

2. The furnace shall be designed for continuos operation at 1675° F at the stated capacity and 1750° F at a reduced capacity. Specify the capacity at the maximum operating temperature.

3. NEMA 12 enclosures shall be used for all transformers, SCR's and control circuits.

4. The firing circuit components and the heating system controls can be located in the SCR panel if they can withstand the heat. A separate NEMA 12 panel shall be provided if they cannot withstand the heat. A temperature-sensing switch, alarm, and light shall be provided to monitor this panel.

5. Lytron liquid-to-air heat exchangers or similar using city water shall be used inside the heating systems panels to re-circulate the air and cool the components inside the panel. The blower, heat exchanger, and related piping shall be isolated from the SCR cabinet area by an interior panel. Maintenance access to the liquid-to-air system shall be provided from the panel exterior. A sealed floor area with a drain and trap shall be provided in case of a waterline rupture.

6. The cooling fan shall operate whenever the heating system is energized.

7. The water supply shall be controlled to prevent excessive cooling and therefore, condensation on the electrical components.

8. The water outlet shall drain into the tower return tank.

9. An alarm and light shall be energized whenever the inside panel temperature exceeds a pre-set level.

10. SCR control can be either two or three-leg control.

11. Under voltage trip mechanisms shall be used to trip the circuit breakers when:

    a. A SCR reaches an excessive temperature.

    b. Control system components reach an excessive temperature.

    c. An imbalanced condition occurs in a set of heating elements.

    d. Ground fault.

    e. Over temperature by zone.

12. The system circuit breakers shall include a 230 volt DC under-voltage trip. The 230 volt DC source will be a Delphi Saginaw Steering Systems tool No. 215144 time delay unit. Delphi Saginaw Steering Systems will provide the time delay unit to be mounted and wired by the furnace vendor. A cinch fanning strip, NO. 6-161-L, shall be used to wire the time delay, and shall be furnished by the furnace supplier.

13. Main heating system breaker shall have a suitable door-mounted operator. Individual zone breakers shall have flange-mounted operator's

14. Circuit breakers shall be co-ordinated so that the circuit breaker closet to the fault opens first. The second closest circuit breaker will open next if the fault wasn't cleared.

15. Voltmeters and ammeters shall be provided to monitor each zone of heating control.

    a. Large dial - 5" maximum.

    b. Three phases of each system shall be monitored.

    c. A selector switch or switches can be provided to select a particular system to monitor and therefore reduce the quantity of meters.

    d. The meters shall be located with the heating system panels.

C. Gas-Fired Heating System

1. The heating system shall utilize gas fired, radiant tubes. The end of the radiant tube shall roll on 1/8" rod that rolls 1/4" plate that sits on the brick and is fastened through a 1/2" rod to the outside of the furnace casing. The inside edge of the plate shall be bend down 90° F to contain the edge of the of the brick. The rod shall be 333 and the plate shall be 330 heat resistant alloy. Approved alternates will be considered.

2. The furnace shall be designed for continuous operation at 1675° F at stated capacity and 1750° F at reduced capacity. Specify capacity at the maximum operating temperature.

3. The heating system shall include time proportioning on/off controllers.

4. The burners shall be located on alternate sides of the furnace to assure temperature uniformity across the furnace.

5. All radiant tubes shall be removable from the burner side of the furnace.

6. All radiant tubes shall be removable. When the furnace is at operating temperature and the atmosphere is removed.

7. Pre-mix gas pilots shall be used only when absolutely necessary. Internal gas pilots shall not be used.

8. Recuperative burner systems shall be provided on the top tubes in the heat-up zones to preheat the combustion air with the exhaust of the radiant tube.

D. Low Pressure Air Systems

1. The carburizing furnace requires low pressure air for:

   a. Atmosphere additions.

   b. Carbon burn outs.

   c. Burners and radiant tube pilots.

2. The carburizing furnace shall include two (2) air blowers, each sized independently to meet the low pressure air requirements of the furnace. The blowers shall be installed in parallel, with one serving as a back up low pressure air source for the other.

3. All air blowers shall have filters and silencers.

4. The low pressure air shall be monitored with a 0-16 o.s.i.g. pressure switch.

5. Air supply for carbon burnout:

   a. All endothermic atmosphere furnaces shall have provisions for carbon burn out. The inlet pipes shall only be used for carbon burn out.

   b. The carbon burnout air system shall be sized to adequately burn out the furnace.

   c. The carbon burnout air supply line shall include a figure eight orifice plate with limit switch.

      1. The figure eight is located in a four bolt flanged pipe joint downstream of the air flowscope.

      2. The figure eight is a one half inch plate.

      3. One side of the figure eight is an orifice large enough to supply the carbon burn out air.

      4. The other side of the figure eight is a solid plate to prevent any air from entering the furnace.

      5. The figure eight shall contain only seven bolt holes so that it will pivot around the center bolt hole.

d. Burnout inlets shall be provided for every pier opening on both sides of the furnace.

e. All carbon burnoff inlet pipes shall be constructed of Ra 333 alloy.

E. Natural gas Requirements

1. The carburizing furnace requires natural gas for:

a. Burners.

b. Burner pilots.

c. Two (2) pilots per vestibule door.

d. One (1) pilot per atmosphere effluent.

e. Four (4) service torches for lighting the various pilots.

f. Atmosphere enrichment.

2. The carburizer shall have the following safety-aid equipment:

a. A Maxon series 808 manual reset safety shut off valve with 230 volt D.C. solenoid shall be provided on the radiant tube heating gas supply line in conjunction with a Delphi Saginaw Steering Systems time delay unit (TL-215144). An internally mounted, single pole, double throw microswitch rated at 15 amps shall also be included. Delphi Saginaw Steering Systems will provide the time delay unit for mounting by the vendor. The vendor shall supply a cinch fanning strip, No. 6-161-L, to wire the time delay.

b. A low gas pressure switch (0-16 o.s.i.g.) located between the pressure regulator and the safety shut off valve.

c. A high gas pressure switch (0-16 o.s.i.g.) located after the safety shut off valve.

d. The gas train safety logic shall include the combustion air blower motor contacts and the combustion air blower low pressure switch.

3. A vent and block system shall not be provided on the main gas train.

4. Effluent and vestibule pilots shall be wind proof, raw gas pilots. An air supply shall not be required for these pilots. All natural gas lines and regulators shall be monitored with high and low pressure switches.

5. To maintain effluent and vestibule pilots during a power failure, the supply line shall be installed ahead of the Maxon valve and shall not contain any electrical valves.

6. The gas train, atmosphere flowscope panel, figure eight orifice plate for burn out air, pressure switch panels, and electrical control panel shall be located as near each other as possible on the same side of the furnace, near the charge end.

7. The gas piping, including main gas shut off valves, pressure regulator, and safety shut off valve, shall be located not over five (5) feet above floor level.

8. Flame supervision shall be provided for one pilot at each vestibule door of the pusher carbuirzer.

9. Pilot flame supervision shall:

   a. Be energized through a selector switch.

   b. Indicate loss of flame signal and:

      1. Prevent opening of vestibule door in the automatic mode.

      2. Sound a silencable alarm.

   c. A silenceable alarm shall sound when the atmosphere shut off valve is open and the pilot flame supervision is shut off.

10. Four (4) torches shall be provided for lighting all of the pilots.

    a. A hand valve, rubber hose, shut off petcock, wand, and burner tip shall be provided for each torch. The hand valve shall be located between the torch gas supply line and the rubber hose; the shut off petcock shall be located between the rubber hose and the wand.

    b. Service torches shall be located on both sides of the furnace on both the charge and discharge ends.

    c. The torch gas supply lines shall be installed ahead of the Maxon valve, and shall not contain any electrical valves.

    d. A convenient storage location with hangers shall be provided for each torch.

11. Flame curtains should not be used on pusher carburizer vestibule doors.

F. Atmosphere Specifications

1. Flowscopes

a. All flowscopes shall be Waukee or Selas with integral control valves, unless otherwise specified.

b. All flowscopes shall be mounted in one location on an atmosphere panel.

c. A flowscope shall be provided for each gas, for each furnace inlet, by zone as required.

1. Endothermic gas.

2. Natural gas.

3. Air.

4. Vestibule super purge (if required).

d. Purge nitrogen supply will be monitored with one flowscope provided by the furnace supplied and mounted on the atmosphere panel. Purge nitrogen flow shall be controlled by fixed orifices and not flow control valves.

e. Vestibule super purges should not be used unless absolutely necessary. If vestibule super purge systems are required, they shall each contain a flowscope without an integral valve. Super purge systems shall include:

1. An orifice sized to control the flow.

2. Maxon series 808 safety shut off valve.

3. Solenoid valves for control.

f. A separate air flowscope, for carbon burn out use only, shall be sized to service the entire furnace, and located near the figure eight air supply.

2. Atmosphere Sampling

a. Atmosphere sampling points shall be provided in the furnace vestibules. The discharge vestibule shall have two (2) sampling points: one just above normal oil level, and one even with the load on the elevator in the up position.

b. Furnace inlets for atmosphere sampling shall be provided in every zone and shall not be used for any other purpose. Sampling inlets for the first and last zones should be on the side opposite the inner doors.

3. Endothermic Gas

a. A Maxon shut off valve controlling the endothermic gas shall be provided. The endothermic atmosphere shut off valve shall be a special modified Maxon series 818 shut off valve for endothermic atmosphere , 115 VAC coil with an internal SPDT auxiliary switch rated at 15 amps. This valve must be electrically satisfied to be manually opened. It closes by manual operation of the valve handle only. The valve cover shall be painted bright red.

b. The endothermic gas line shall include an orifice and a differential pressure switch to positively sense flow. This orifice shall be located downstream of the Maxon valve.

c. Opening the atmosphere shut off valve requires:

1. The furnace shall be above 1400° F.

2. The zone 2 control instrument must be energized.

3. The atmosphere flow switch must show no flow.

d. The atmosphere enriching natural gas, and air shall be electrically interlocked with approved, normally closed, held open solenoid valves, which shall be open only when the endothermic gas shut off valve is open, and adequate gas flow exists.

4. Nitrogen Gas

a. Nitrogen will be used for:

1. Purging gas in each zone of the carburizing furnace in case of emergency or loss of endothermic gas flow.

2. Emergency replacement for the high pressure pneumatic system.

b. The purge nitrogen flowscope shall be capable of passing at least twice the normal volume of endothermic gas used. The endothermic manifold shall be used for nitrogen purge using a three way, noncommunicating teflon-lined valve located downstream of the endothermic Maxon valve but before the zone flowscopes.

c. The purge nitrogen piping shall not include any electrical valves.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

XII. Quench Systems

A. General Information

1. The quench system shall be fully enclosed and located in the discharge vestibule of the carburizing furnace.

2. Furnace quench oil shall be electrically heated using a bayonet type immersion heater.

   a. Heat to 350° F in no more than 16 hours.

   b. The quench heating system circuit breaker shall include a 110 volt AC

3. The quench heating control shall be On/Off.

4. The quench elevator shall have a means to positively prove that it is in the up or down position. Spring arrangements are not acceptable.

5. When the quench elevator is in the full up or full down position at the time of a power failure, the elevator shall remain there. If the elevator is in any other position at the time of an air or power failure, the elevator shall lower to the full down position.

6. Quench elevator bearings mounted on the hot vestibule shall be rated at 500° F minimum.

7. The quench elevator drive gear shall be designed to facilitate ease of maintenance (split steel gear design).

8. The quench vestibule access door shall be provided on the vestibule wall opposite the furnace inner discharge door on pusher carburizers.

   a. The opening shall be large enough to remove a loaded tray.

   b. The discharge vestibule access door shall not have any pilots or flame curtains.

   c. Door travel shall be vertical.

   d. The top of the quench tank shall provide a suitable work space in front of the discharge vestibule access door. In addition, the top of the quench tank and the plant floor must be free of mechanisms or

components obstructing the discharge vestibule access door and must be at the same elevation.

e. The door clamp and vertical motion shall be operated by air cylinders.

f. The air solenoid valves shall not have manual operators, but shall be operated by electrical push buttons located on a small push button panel. The push button panel shall be located approximately seven (7) feet from the vestibule. The operator shall not be able to stand in front of the discharge vestibule access door opening while using the push button panel.

g. The discharge vestibule access door and the push button station shall each include a warning sign.

h. Electrical Interlocks

(1) The discharge vestibule access door can only be opened when the furnace line is in manual mode.

(2) The discharge vestibule access door can only be opened when the outer discharge door is fully opened.

(3) The outer discharge door can be manually operated at any time.

9. Upon loss of electrical power or air pressure, the vestibule outer doors shall open automatically on pusher carburizers.

10. A quench oil make-up system shall be provided to maintain the oil level in the main tank, store make-up oil for the main tank, and provide for the thermal expansion of the oil.

11. Make-up oil pump shall be a vertically mounted pump.

12. All quench tanks shall have oil tight doors to permit access to the agitators and for sludge removal.

13. The quench oil make-up tank shall have an access door.

14. To prevent the accidental input of water, all components on top of the quench tank shall be raised and flange mounted.

15. The vendor shall vent the quench oil tanks to remove the combustible gases above the surface of the oil.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

16. An oil overflow system shall be provided to prevent oil from entering the furnace chamber.

17. When the oil overflow system also serves as an air or atmosphere seal, it must function automatically as a seal and not require frequent inspection and maintenance. The oil overflow pipe shall be routed as near to the quench pit floor as practical and designed to minimize the splashing of hot oil on an operator.

18. A visual oil level indicator shall be provided in all tanks containing oil.

    a. The indicator shall consist of a red pointer or flag mounted on a rod. When the flag is used to actuate a limit switch, it must:

        (1) Be prevented from rotating off the limit switch arm.

        (2) Have positive stops to prevent over traveling the limit switch arm.

        (3) The limit switch arm shall not function as a stop to support the rod and float.

    b. The pointer and rod shall be attached to a ball that is contained inside a pipe that extends well below the low oil level.

    c. The retaining pipe shall contain a dampening orifice.

    d. The oil level indicator shall be easily read from the main plant floor level.

    e. The indicator shall be permanently labeled using an engraved metal legend plate showing:

        1. Full level when hot.

        2. Full level when cold.

        3. Low level when hot.

        4. Low level when cold.

19. Unless otherwise specified, the quench oil agitation shall be a “mass flow” system.

20. Submerged impellers or similar devices shall be used for agitation.

21. The quench oil agitation rate shall be variable.

22. The quench agitation circuit shall include both a continuous and automatic mode.

Note: The above specifications were developed without considering whether patents may or may not be involved. In all cases, therefore, the supplier shall be required to assume patent liability.

a. In the continuous mode the agitators will run continuously.

b. In the automatic mode the agitators will run whenever the quench heaters are on and/or the elevator is down. The agitators must be on and the flow stabilized before the elevator hits the oil.

23. Oil agitation shall be monitored in both the continuous and automatic modes as follows:

a. Impellers or similar devices on mass flow quench systems shall include an RPM meter on the agitator shaft to monitor low RPM. The meter shall be a positive motion detector.

b. Mass flow quench systems shall include an amperage meter on the agitator drive motor to monitor high and low amperage draws.

c. Abnormal quench agitation conditions shall sound an alarm, light a pilot lamp, and prevent the next automatic cycle from initiating.

24. A drain pump shall be provided to pump all the oil from the quench and make-up tanks within two (2) hours maximum to a Delphi Saginaw Steering Systems central storage tank located outside the plant. The pump shall be a horizontal pump with a minimum outlet pressure head of fifty (50) feet. A check valve shall be provided at the pump discharge to prevent back flow into the furnace quench tank.

25. SBS (or equivalent) air to oil heat exchangers shall be used whenever a heat exchanger is required to cool the quench medium.

26. The heat exchanger shall be located on a raised platform supplied by vendor.

27. Heat exchanger shall utilize outside air and return heated air outside.

28. All ventilation design, motors, starters, controls and ductwork to top of heat exchangers shall be supplied.

29. Cooling pumps shall be nonleaking, vertical types, designed for operating conditions and shall be mounted above the quench tank.

30. Multiple heat exchangers on a single cooling pump may be provided, but a spare cooling pump must be provided.

31. The drain pump can serve as the stand by cooling pump.

a. The capacity and head must be as large or larger than the main pumps.

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b. The drain pump must be piped and valved for the dual purpose.

32. Two (2) quick clean strainers in parallel complete with four (4) shut off valves shall be installed between the quench oil cooling pump and the heat exchanger.

33. Stand by oil pumps are required if loss of the regular pump would:

a. Allow the oil to reach an unsafe level.

b. Prevent adequate oil agitation for quenching.

c. Allow the oil in the quench tank or chute to overheat.

34. Two (2) separate oil feed lines from Delphi Saginaw Steering Systems oil supply system shall be provided. One (1) to the main quench tank that is approximately 2" in diameter and one (1) to the make-up tank that is approximately 3/4" in diameter.

35. An oil meter (A.O. Smith or equivalent) shall be supplied in the oil feed line. The meter shall have auto shut-off feature and two(2) read outs:

a. Gallons - - cumulative total, non-resettable.

b. Gallons -- resettable.

36. After quenching, the parts shall drain in the quench vestibule for at least one (1) minute before being discharged.

37. Drip pans shall be provided from the quench tank to the washer. Drain piping from the low point of each pan to a designated location (not to exceed 30 feet) shall also be provided. Piping shall be 1-1/4" diameter and include crosses at 90° F bend for clean out.

B. Operational Logic Controls

1. The furnace line's cycle shall be controlled by a logic system which guides the furnace through its predetermined cycle. The control cabinets will include all motor starters, relays, switches, timers, and accessories.

2. The furnace line shall have two (2) modes of operation -- automatic and manual. Push buttons shall be provided to select the desired mode of operation. All automatic motions shall be initiated from the charge end graphics panel only.

a. The automatic mode of operation shall have both single cycle and continuous cycle capability.

1. Continuous cycle -- by energizing the continuous (repeat auto) cycle push button the furnace line shall operate continuously.

2. Single cycle -- by energizing the single (hold) cycle push button the furnace line shall complete one (1) cycle and hold.

b. The manual mode of operation shall have both hand and jog control features every motion.

1. Hand mode -- energizing an individual mechanism push button causes that mechanism to complete one (1) full cycle.

2. Jog mode -- an individual mechanism will continue forward until its push button is released and then:

a. Hot mechanisms will return to the home position.

b. Cold mechanisms such as dog beam transfers will stop.

3. The electrical circuits and graphic display push button stations shall be designed to allow cycling the equipment in either the manual mode or the automatic mode.

4. Each transfer mechanism, door, and elevator shall have a push button that operates in the manual mode only.

5. A method for shutting off each row independently shall be provided on the charge end graphic display panel. A furnace row can only be shut off in the manual mode. When shut off, the row or rows will be skipped when the furnace is operating in the automatic mode. A blue light on the charge end graphic display panel shall indicate a row(s) is being skipped.

6. The draw furnace material handling system shall operate from the furnace line controls during normal operation. A separate timer and selector switch shall be provided to empty the material handling system from the first tray in the washer loader mechanism through the draw furnace discharge mechanism.

7. When a malfunction occurs, the carburizing furnace shall remain in automatic mode and continue as far as possible in the cycle. An audible horn shall sound and a red beacon lamp shall light whenever the furnace does not continue to auto cycle.

8. It shall be possible to resume a cycle and complete it in automatic mode after a malfunction is corrected in manual mode. Under these conditions, the next automatic cycle will not initiate itself. It shall also be possible to resume the repeating auto cycle once the malfunction is corrected.

9. An audible alarm shall sound and a red beacon lamp shall light if the loading table transfer does not place a tray into the vestibule loader corner position. The furnace shall stop cycling when the vestibule loader is empty.

10. A cycle overtime circuit shall be provided to sound an alarm if the furnace does not continue to auto cycle when it is expected to continue.

11. Machine sensors shall be back-checked during the machine cycle. The checking shall be done inside the system control logic. Back-checking means verifying the operation of the machine sensor for both actuation and de-actuation. If failure occurs under motion:

    a. The tray positioners and quench push out shall stop and an alarm shall sound.

    b. The charge push in, main pushers, and discharge push out shall retract and an alarm shall sound.

12. As a minimum, the following mechanisms shall be monitored by power monitors in the forward mode. As a minimum, square D 8430 load monitors shall be used.

    a. Load table transfer
    b. Charge vestibule loader
    c. Carburizer push in
    d. Main pushers
    e. Carburizer push out
    f. Quench push out
    g. Wash-rinse transfer
    h. Rinse pull-out
    i. Rinse to draw transfer
    j. Draw transfer
    k. Draw unloader

13. When the current setting on mechanisms that travel into the furnace is exceeded, the mechanism shall retract out of the furnace. The current monitoring device will sound an alarm on an over current condition when the mechanism is retracting. The motor overloads shall protect the motor in the retract mode.

14. Once the carburizer push out has started forward in automatic mode, the cycle shall continue until the quench elevator is down and the inner door is closed. The cycle shall complete (unless a carburizer push out overload occurs) even if the furnace drops out of automatic mode after the carburizer push out has started forward.

15. A timer shall be included to indicate and sound an alarm if the time when the inner discharge door starts opening to when the quench elevator reaches the bottom, has exceeded a preset time.

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a. Once initiated, the timer shall continue timing regardless of furnace mode. This system shall not interfere with the furnace operations or motions.

b. When a quench delay occurs in the automatic mode, this system shall prevent the next cycle from initiating automatically.

c. A limit switch on the inner door shall be used to send the quench elevator down. Pneumatic timers are not acceptable.

d. A red "Quench Delayed" light shall be provided on both graphic display panels. On the discharge end graphic panel, the red light shall be a lighted push button. The push button shall serve as the "Trouble Reset" for the quench delay.

16. Upon loss of electrical power the vestibule outer doors shall open automatically.

17. Upon loss of atmosphere pressure:

a. Closed doors stay closed.
b. Open doors stay open.
c. Closing doors open.
d. Opening doors open.
e. No new motions start.

18. All guards shall require tools to open.

C. Operational Interlocks

1. Interlocking mechanisms shall be limited to:

a. Preventing mechanism jams with adjacent mechanisms, doors, and elevators.

b. Safe operating practices for cold vestibules filled with atmosphere gases.

c. Safe operating practices for oil quench systems.

d. Interlocking motions in the manual mode shall not include sequencing restrictions except as required in a, b, and c above.

2. Mechanisms that are interlocked by a momentary clear position shall have additional interlocks in the manual mode to prevent cycling two adjacent mechanisms into each other. For example: in manual mode, the quench elevator cannot be lowered after the discharge push out has started across but before it arrives.

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3. It shall be possible to operate any mechanisms in manual mode as many times as the operator desires, and in any sequence.

4. The motion interlocks shall be as follows:

   a. Loading table transfer advance

      1. Vestibule loader reversed.

   b. Vestibule loader transfer advance or reverse

      1. Loading table transfer cleared.

      2. Vestibule door opened.

      3. Charge push in reversed.

      4. At least one tray available for loading.

   c. Charge vestibule door -- open or close

      1. Vestibule loader cleared.

   d. Charge push in transfer advance

      1. Inner charge door opened.

      2. Main pushers reversed.

      3. Vestibule loader transfer cleared.

   e. Close inner charge door

      1. Charge push in transfer cleared.

   f. Main pushers advance

      1. Tray positioners or index rods advance.

      2. Charge push in reversed.

      3. Discharge push out reversed.

   g. Discharge push out transfer advance

1. Tray positioners or index rods retracted.

2. Inner discharge door opened.

3. Quench elevator raised.

4. Quench elevator empty.

5. Main pushers reversed.

6. Quench push out reversed.

h. Close inner discharge door

1. Discharge push out clear.

i. Quench elevator lower or raise

1. Discharge push out clear.

2. Quench push out reversed.

j. Quench push out transfer advance

1. Discharge push out reversed.

2. Elevator raised.

3. Discharge vestibule door opened.

4. Washer transfer cleared.

k. Discharge vestibule door open or close

1. Quench push out cleared.

2. Access door cleared.

l. Washer transfer advance or reverse

1. Quench push out cleared.

2. Washer charge door opened.

3. Washer elevator raised.

4. Rinse elevator raised.

5. Rinse elevator empty.

6. Rinse transfer cleared.

7. Wash-rinse door opened.

m. Washer door and wash rinse door open or close

1. Spray pump off.

2. Washer loader cleared.

n. Washer elevator raise or lower

1. Washer loader cleared.

2. Immerse time completed.

3. Spray time completed.

o. Rinse doors open or close

1. Rinse spray pump off.

2. Washer transfer cleared.

3. Rinse transfer cleared.

p. Rinse elevator raise or lower

1. Washer loader cleared.

2. Rinse transfer cleared.

3. Spray time completed.

4. Immerse time completed.

q. Rinse transfer advance or reverse

1. Rinse doors opened.

2. Rinse elevator raised.

3. Draw loader reversed.

4. Washer transfer cleared.

r. Draw loader transfer advance or reverse

1. Draw transfer reversed.

2. Rinse transfer reversed.

s. Draw transfer advance or reverse

1. Draw loader cleared.

2. Draw doors opened.

3. Discharge transfer reversed.

t. Close draw doors

1. Draw transfer cleared.

u. Discharge transfer advance or reverse

1. Draw transfer cleared.

D. Alarm Systems

1. Two rotating red beacons shall be provided. One in a location visible to the loading operator station across the front of the carburizing furnace and the other at the discharge end of the pusher.

a. The beacon lights shall notify the operator whenever any fault occurs on the entire furnace line.

b. The beacon lights shall be controlled by the various audible alarm controls.

2. In general, the following items require a silenceable, audible alarm:

a. Mechanical drives and overloads.

b. Re-circulating fans.

c. Delayed quench.

d. Quench agitators.

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e. Quench cooling pumps.

f. Cooling water pressure exceeding the oil pressure in a heat-exchanger.

g. Quench oil level pumps.

h. High and low oil levels before an unsafe condition occurs.

i. Safety shut off valve.

j. High and low natural-gas pressure.

k. Low air pressures.

l. Flame supervision.

m. High temperature.

n. Abnormal furnace temperature.

o. Tripped circuit breakers.

p. Heating system controls.

q. Over current in retract mode -- hot mechanisms.

3. The only unsilenceable alarm shall sound if the endothermic atmosphere gas shut off valve is open and any of the following events occur:

a. Endothermic gas flow failure.

b. Furnace second-zone temperature drops below 1400° F.

c. Furnace second zone control instrument is de-energized.

d. The endothermic atmosphere operation selector switch is turned to the "Off" position.

4. The unsilenceable alarm shall also sound if the endothermic atmosphere gas shut off valve is closed with the atmosphere operation selector switch in the "on" position.

E. Control Cabinets

1. The pusher-carburizer line shall include the following controls enclosures (with approval, panels may be combined):

a. Pusher Carburizer

1. Operational cabinet.

2. Motor power distribution panel.

3. Atmosphere/combustion system alarm panel.

4. Temperature control instrumentation panel.

5. Fan control panel.

6. Tower water panel.

7. Quench control panel.

8. Graphic display panels.

b. Draw Furnace

1. Motor, logic, and safety panel.

2. Graphic display panels

a. Two (2) graphic display panels shall be provided for each furnace line.

1. One (1) panel at the charge end in clear view of the operator's station.

2. One (1) panel near the discharge quench vestibule but not blocking the quench access door.

b. Both graphic displays shall picture a permanent outline of the entire furnace.

1. The outline shall display the actual furnace line to scale. However, the scale can be modified to avoid an unnecessarily long panel.

2. The outline shall include:

a. Carburizer

b. Quench

c. Washer

d. Draw furnace

3. The panel shall be plexiglass-mounted on a steel plate and frame or approved alternates.

4. A white background is preferred.

5. The outline of the furnace line shall be in black.

6. Critical tray positions required to place furnace line in the automatic mode shall be bold, red X's.

c. Both graphic displays shall have:

1. Operational mode push buttons and lights.

2. Alarm silence and re-set push buttons and lights.

3. The monitoring lights for the entire line.

a. No tray at the vestibule loader.

b. All tray transfer mechanisms.

c. Doors.

d. Furnace row next.

e. Index rod position.

f. Main pushers too far forward.

g. Washer status.

h. Rinse status.

i. Draw furnace handling mode.

j. Cycle progress lights.

k. Low compressed air.

d. The charge end graphic display shall have:

1. Push buttons for operating the charge end of the furnace line and skip row selector switches.

2. Delayed quench monitoring light.

e. The graphic display near the quench system shall have:

1. Push buttons for operating:

a. The discharge end of the carburizer.

b. The washer mechanisms.

c. The draw furnace mechanisms -- if the mechanisms cannot be seen from the display panel, a push button panel shall be provided at the draw furnace, near the discharge end.

2. The selector switch to operate the draw furnace material handling:

a. Auto cycle.

b. Empty cycle.

3. A lighted push button to monitor delayed quenches and to reset a quench delay fault.

f. Graphics display panel characteristics:

1. Miniature lamps shall be tested by a separate test push button located on each graphic display panel.

2. Flashing lights to indicate motion.

3. Information provided by the graphic display for any mechanism shall include:

a. The mechanism at rest in its normal position.

b. The mechanism in motion.

c. The mechanism work cycle complete.

d. The mechanism overloaded or malfunctioned.

4. Information provided by the graphic display for any vertical mechanism shall include:

   a. Raised/opened.

   b. Lowered/closed.

   c. Moving.

5. Cycle progress lights shall include:

Quench system	**Washer and rinse**
Quenching	Spraying
Draining	Soaking
Completed	Draining
Quench-Delayed	Completed

6. Upon completing all of the motions, the individual mechanism completed lights shall be extinguished, and the cycle completed light shall be lit. The cycle completed light will be extinguished upon initiating a new cycle.

7. Whenever a light comes on indicating a malfunction has occurred, an alarm shall sound. The alarm must be silenceable, but the indicator light shall not go out until an operator acknowledges that the problem has been fixed through the alarm re-set button.

8. Push button and light colors:

   a. White -- operation complete.

   b. Continuous green -- normal position.

   c. Flashing green -- mechanism and/or door in motion.

   d. Blue -- skip row and critical tray positions (one for each row on the charge hearth, one for each row on the discharge hearth, and one for the quench elevator).

   e. Amber -- caution

      Examples: Row on, next row to push, doors open, tray positioners advanced, elevators down, quenching, draining, spraying, soaking, draining, hand mode, jog mode, draw auto unload, draw full cycle.

f. Red -- malfunction

Examples: Mechanism overload, alarm silenced, alarm re-set, stop push buttons, abnormal atmosphere.

g. Provide a color legend on the display panel

F. Material Handling System

1. The vendor shall provide and install a tray handling system to move trays through the carburizing furnace, the parts washer and the draw furnace and then using a roller conveyor system return the trays from the draw furnace discharge to the carburizer load table.

2. Trays shall be moved through the furnace line by pushing on the back outside tray rib.

a. The operator will load the trays on the roller conveyor in front of the furnace loading table.

b. The loaded trays will be manually shoved onto the loading table.

c. The loading table should have two (2) hours of tray storage capacity.

d. The loading table shall be self-emptying.

e. The trays shall transfer on the loading table by tray-on-tray contact into the vestibule loader mechanism corner.

f. A tray gauge shall be provided at the charge end of all pusher tray furnaces to prevent loading an over sized tray. This gauge shall be the narrowest opening for the entire tray handling system.

1. Enclosed, loop type furnace lines that are automatically loaded shall include a limit switch, light, alarm, and logic to prevent an over sized tray from entering the furnace.

2. The tray gauge for a manually loaded furnace line shall be a mechanical restriction provided by the furnace manufacturer on the return roller conveyor in front of the furnace loading table.

g. The vestibule loader shall transfer each tray separately.

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h. The discharge hearth of the carburizing furnace shall not be used for a tray position at the end of a complete cycle.

i. During the normal furnace cycle, there shall be at least 30 minutes between the quench vestibule and the washer.

j. During the normal furnace cycle, there shall be at least 60 minutes between the washer and the draw furnace to allow the parts to cool to room temperature prior to stress relieving.

k. The trays shall be conveyed through the draw furnace on a dog-beam mechanism.

l. The discharge hearth of the draw furnace shall be at least two trays long.

m. The draw furnace discharge mechanism shall transfer the trays onto the tray return system.

n. The material handling system shall be self-emptying from the first tray position in the washer loader mechanism through the draw furnace discharge mechanism.

XIII. PARTS WASHER SPECIFICATIONS

A. General Information

1. The part and tray washer shall be a two stage, in-line washer and shall conform to SD-0007, "General Washer Specification".

2. Each stage shall:

   a. Be steam heated to 180° F.

   b. Include a Tramp Champ T0-05 decant tank or equivalent to remove oil from the wash solution. The oil skimmer shall be located in a low turbulence area of the tank. A timed water spray shall be provided to flush the oil skimmer and drain trough.

   c. Include an overflow drain suitable for removing floating oil and scum from the wash/rinse solution in the tank. A timed surge of fill water shall be included in both the pump and heating sections to overflow the surface oil into the drain. The over flow shall cycle with an adjustable timer (2 to 24 hour).

3. The wash stage shall:

   a. Include a cycle of:

      1. Spray (timed).

      2. Immerse in agitated solution.

      3. Raise.

      4. Immerse in agitated solution.

      5. Raise.

      6. Immerse in agitated solution (timed).

      7. Raise and spray (timed).

      8. Drain.

   b. Include three (3) adjustable timers. The timers shall provide individual control for each spray and the final immerse cycles.

4. The rinse stage shall:

   a. Include a cycle of spray, immerse in an agitated solution, spray, and drain.

   b. Include three (3) adjustable timers. The timers shall provide individual control for each spray and the immerse cycles.

B. Housing

1. The wash and rinse housings and drain sheets, shall be fabricated of 10 GA. Minimum steel plate with necessary reinforcing angles to prevent buckling.

2. Doors shall be provided at the washer entrance, between stages, and at the rinse exit to confine overspray and to maintain separation of the two (2) different solutions.

3. The wash/rinse housings shall be provided with water/vapor tight hinged side access doors designed to drain solution back into the wash/rinse stages respectively. These doors shall be located opposite the tank extension and shall be sized such as to permit easy access to all spray nozzles, risers, and headers without requiring a man to enter the washer.

4. Drip pans shall be provided for at least three (3) tray positions after the washer. Drain piping from the low point of each pan to a designated location (not to exceed 30 feet) shall also be provided. Piping shall be 1 -1/4" diameter and include crosses at all 90 ° F bends for cleanout.

5. All welding on the housings shall be continuos, on both sides to make the housing water tight and shall conform to the standards of the American Welding Society.

C. Tanks

1. Wash and rinse tanks shall be fabricated of 1/4" minimum thickness mild steel plate, unless otherwise specified.

2. Wash and rinse tanks shall be double welded on all seams, welded inside and outside, and shall be tested for leaks in the suppliers plant.

3. Wash and rinse tanks shall be provided with tank extensions (2.5 feet wide minimum).

4. All tanks shall include marine type, or approved equivalent, cleanout doors in sufficient size and numbers to permit cleaning from outside the machine.

5. The bottom of each tank shall be sloped towards a 3" gate valved drain. All drains shall be piped to a single point for utility connection.

6. All tanks shall be sized to have at least 3 times the flow of the pump at the operating pressure.

7. To assure disposition of heavy solids in an area accessible for removal, spent solution shall be directed to the end of the tank farthest from the pump suction, then flow through the tank extension to the pump to assure circulation of the entire contents of the tank.

8. All tanks shall be insulated such that no part of the outer skin of the tank exceeds a temperature 20° F (11° C) above ambient.

D. Pumps

1. The washer shall be supplied with vertical submerged pumps with the bearings located above the mounting plate.

2. "C" flanged motors, barrel mounted to the pump, are preferred.

3. Acceptable pump suppliers are Carver, Gusher, Deming, or approved equivalent.

4. The pump motor shall not overload throughout the entire range of flow for the particular impeller.

5. Pumps shall be supplied with flanged discharge pipes which shall be located outside the tank to facilitate easy pump removal.

E. Pump Screens

1. Each tank shall be supplied with a double set of removable pump screens.

2. The screens shall be fabricated of perforated metal for ease of cleaning. The screen shall have a trough at the bottom to collect screened particles.

3. The screen openings shall be smaller than any orifice in the spray nozzles.

4. The screens shall be sized to provide at least 2 sq. ft. of surface area, per screen, for each 100 GPM of pump rating.

5. All screens shall extend above the normal solution level and shall be provided with suitable frames and handles.

6. All of the tank solution will pass through the screens before entering the pump inlet.

F. Solution Heating System

1. The solution heating system shall be designed to heat the total flow of the spray pump with a temperature differential of 14° F (8° C).

2. The washer solution will be heated with a shell and tube heat exchanger or plate coils. Acceptable heat exchangers are Graham Heliflow, American Standard, Kerr Machinery Thermic Cannulat, or other approved sources. Acceptable plate coils are Mueller and tranter.

3. Temperature controllers shall be a powers or trerice self-operating controller, with a dial thermometer.

4. Valves shall be 150 lb. Union Bonnet Gate type for steam service. The approved sources are Stockham, Lunkenheimer, or and approved alternate.

5. Gauges should be Marshalltown bottom-mounted for 150 service with 1/4" NPT minimum with protective syphons.

6. Check valves shall be brass swing type for 150 lb. service.

7. Steam traps should be Armstrong No. 813 and 3/4" NPT minimum with an orifice to suit head requirements.

8. Strainers should be Armstrong for 250 lb. service with blow down valve.

G. Steam and Condensate Piping.

1. All steam piping shall be assembled using a high temperature pipe dope.

2. All steam fittings and piping shall be schedule 80, black iron.

3. All joints shall be thoroughly tightened to prevent leakage. Any leaks in the washer supplier's piping, when the washer is installed in our plant, shall be rectified by the supplier at no charge to Delphi Saginaw Steering Systems.

4. All steam and condensate piping shall be a minimum 3/4" NPT and piped to a single point for utility connections.

H. Solution Level Control

1. The solution level in the tank shall be maintained by constant level water make-up control valve.

2. The control valve shall be of the type that uses pilot water pressure to open or close the diaphragm valve in the water supply line.

3. The control valve shall be located in the tank extension, to facilitate easy access to the float ball adjustment and all parts of the diaphragm valve.

4. All make-up and quick fill lines shall terminate above the tank top. City water piping shall be galvanized.

5. A quick fill line capable of filling each stage in 30 minutes shall be provided.

6. The float shall be of the vertical slide rod type. They shall be adjusted from above the tank only.

7. The solution level control and fill piping shall terminate above the top of the tank to prevent siphoning.

8. All fill water supply piping shall be 3/4" minimum NPT and piped to a single point for utility connection.

I. Spray Application

1. Spray headers shall be easily removable through washer housing access doors.

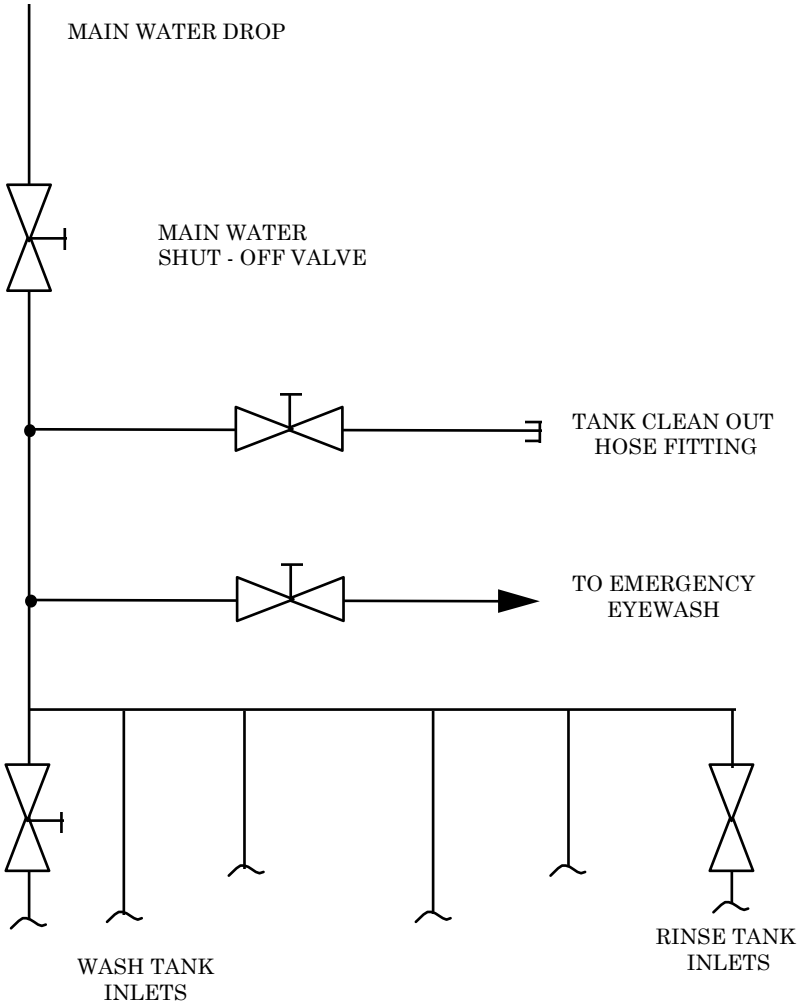
2. Spray nozzles shall be of the non-clogging stainless steel type, and be mounted so as to permit full 180° adjustment in both horizontal and vertical planes. They should also be selected in conformance with capacity and pressure requirements. The nozzles should also be placed to facilitate complete spray coverage of parts. Approved spray nozzle suppliers are Steinman, Delaman, and Vee Jet.

MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

J. Emergency Eyewash

1. An emergency eye and body-spray station is to be located next to or between the chemical mixing devices but, in no case, further than 30 feet away. An approved spray nozzle is the Haws Laboratory Emergency Spray Nozzle 8901, with an aerated quick-release that can be purchased from National Safety Products. The station is to be installed for easy access by the operator, have a shield to prevent dirt from accumulating on the nozzle, and piped, without a shut off valve, directly to the outlet side of the main water inlet valve to the washer.



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MANUFACTURING EQUIPMENT PURCHASE SPECIFICATION

DELPHI SAGINAW STEERING SYSTEMS
GENERAL MOTORS CORPORATION

TITLE FURNACE HEAT TREAT EQUIPMENT NUMBER SD-1001
ISSUED BY Randy P. Bal DATE 12/11/95 APPROVED BY
REVISION REV. DATE SHEET 105 OF 107

XIV. REVISION SHEET

PAGE	SYMBOL	REVISION	DATE	ISSUED BY	APPROVED BY
1-107	--	Released	12/11/95	Randy Bal	David M. Hitz