

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

TABLE OF CONTENTS

F.1	General & Machine Concept.....	Page 2
F.2	Structural Design.....	Page 4
F.3	Ventilation.....	Page 4
F.4	Access	Page 4
F.5	Wear Surfaces	Page 5
F.6	Bushings.....	Page 5
F.7	Work Height.....	Page 5
F.8	Transfer Machines.....	Page 5
F.9	Lubrication	Page 5
F.10	Finish Specification.....	Page 5
F.11	Machine and Tool Identification	Page 6
F.12	Documentation Shipped with Machine.....	Page 6

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

F.1 GENERAL & MACHINE CONCEPT

1.1 The Designer/Builder must have a thorough understanding the *Design in Health and Safety Specification* for all DTS machine and tool design.

1.2 Details required for model change-over, the ability to sharpen and/or are high maintenance, shall be designated as tooling requiring a separate tool number and B/M.

1.3 Refer to **Ergonomic Section** for all required dimensional data with respect to safe work positions, lifting loads, reach, etc.

1.4 Vibration analysis of new or rebuilt equipment shall be specified and defined by the Manufacturing Engineer responsible for purchase of same. Refer to **Vibration Section**.

1.5 Equipment and/or tooling requiring any type of control must have a sequence of operation included in the drawing set.

1.6 Movement of any machine component, slide, etc., shall be verified by the use of a position sensor that monitors the machine component position.

1.7 Blind dowels shall not be designed in unless absolutely necessary. When necessary, pull dowels shall be utilized.

1.8 Tapered dowels shall not be used without DTS approval. Roll pins may be used for non-precision details (handles, handwheels, etc.).

1.9 All bearings, ball, needle, roller, etc., shall be readily available and be manufactured to AFBMA (*Anti-Friction Bearing Manufacturing Association*) Standards to insure inter-changeability.

1.10 All designs shall use standard springs wherever possible. Any deviation will require complete specifications of spring used. (Wire diameter, coils/inch, free length, lbs., inch, material and manufacturer.)

1.11 Guards fabricated from aluminum extrusions shall be one of two manufacturers:
80-20 or Bosch

1.12 Documentation will show & define any other equipment or processes that the proposed tool or machine may interface with. I.E.: Is the machine part of a larger cell or system? How are parts transferred and presented? Are interlocks present between pieces of equipment? Etc

1.13 Documentation will show & define any special requirements for installing the equipment on the plant floor. E.G.: Max load levels, trenches, pits or special clearances.

1.14 Documentation will show & define how the equipment will interface within the plant environment E.G.: Machine footprint, available utilities, utility connections, ventilation, noise, etc.

1.15 Machinery & equipment will be designed to operate in cells where product moves CCW. Right to left.

1.16 Documentation will show & define changeover and location of changeover details, gages, and any tools required. Changeover must be demonstrated and approved by Delphi project engineer.

1.17 Documentation will show & define how parts are presented E.G.: Orientation, rate, buffer sizes, etc.

1.18 Documentation will show & define workplace organization to provide a safe, clean, neat arrangement that provides a specific place for everything, including spare tooling.

1.19 Lockout points for various power sources (electrical, pneumatic, hydraulic, etc) are to be placed near each other - usually near rear of machine. Delphi project engineer preapproval required.

1.20 Supplier is responsible for updating drawings with all changes incorporated in subsequent machine(s) when multiples are ordered

1.21 Documentation is to be to Delphi standards. Mistakes in supplied originals do not alleviate the responsibility of supplier to deliver revised documents to standards.

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

1.22 Machines are to include a covered documentation box (6001509) on outside on main electrical enclosure. Top of box is to be 48" from floor. All documents shipped with machine must be held inside. If one box as specified does not fit all documents then multiple boxes on a larger box may be required. Delphi project engineer preapproval required.

1.23 Space left blank.

1.24 Where compressed air is used for cooling or blow off:

1.24.1 Each work head is to have its own nozzle. System must have a flow balanced design.

1.24.2 Each station is to have its own solenoid shut off.

1.25 Ultrasonic Welders:

1.25.1 Must be laid out so power cable lengths are kept equal & less than 30 feet each.

1.26 Heater Core Test:

1.26.1 Must be shielded from any components that could create quick changes in ambient temperature or create airflow near the core in its tested position.

1.27 WorkSmart Construction & Cells:

1.27.1 Support sheet metal for wire way to be 10 gauge and supported so it does not bow.

1.27.2 All fittings are to be plastic except where aluminum fittings are needed.

1.27.3 Tubing is to be .125" wall non-anodized, may be purchased from local non-WorkSmart suppliers.

1.27.4 All rail ends used to move pallets must have aluminum caps (7006468) with 1/8" rounded edge to prevent wheel damage. All other ends may be capped with plastic caps.

1.27.5 Cart rails to be secured with knurled steel rivnuts - not tapped or with other type of rivnuts - rivnut tool must be used to install.

1.27.6 Cart rails to be supported every 4' or less.

1.27.7 Fans to be tipped towards operator by 30 degrees and have safety cable attached. Cap end of cord is to be removed & discarded. Cord is to be extended so operator may reach it.

1.27.8 Holder bars for job instructions (JI's) (7006888) will be provided.

1.27.9 When date labelers are used then a date labeler holder (7006869) will be incorporated.

1.27.10 Quality critical stations will have Cart Hold downs (7007299) incorporated. Friction brakes supplied by WorkSmart are not robust and should be avoided.

1.27.11 Include RFID brackets (7006862) for stations with antenna.

1.27.12 Machined aluminum fittings must be pinned.

1.27.13 Part presentation not directly attached to cell will be on casters and have alignment guides that lead it into position and a latch to keep it from backing away. Must be secure from moving side to side and back and forth.

1.27.14 Carts must be protected from falling off ends of rails. Cart stops at end of rails must stop carts when mating rails are not in position. This may be accomplished with a pendulum stop or modified cart stop.

1.27.15 Fixtures on carts must be able to swivel 360 in each station unless Delphi project engineer preapproves.

1.27.16 Placement of components is to be shown. Delphi project engineer preapproval required. Delphi project engineer must approve final position of operator box, lights, fans, and other components interfacing to operator and equipment. Operator interface is to be mounted so that the highest reach or item viewed is 62" to floor and no more than a 25" reach.

1.28 Ink Markers:

1.28.1 Tips must be covered with a yellow cap when not in use.

1.28.2 Guard to prevent accidental part contact with ink marker required.

1.28.3 Ink marker cap holder with sensor (6001554) required.

1.28.4 Ink pump & reservoir must be placed where service personnel may access without interrupting operator and where spills are easily cleaned up. Delphi project engineer preapproval required.

1.28.5 Ink marker must have spring loaded head to accommodate part and tip wear variation.

1.29 Fixtures & Hand Tools:

1.29.1 No through holes on fixtures where screws/debris may gather or lodge.

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

1.29.2 If fixture changeover is required then it must require no tools and be less than 1 cycle time.

1.29.3 Break all sharp edges and corners

1.29.4 Hand held tools & connectors should have corners and edges radiused (rounded), not just broken. This must be shown on model and not just noted on drawing. This does not apply to edges required for tool functionality.

1.30 Cylinders must be allowed to travel fully to a hard machine stops and not stop on part or other objects that may cause variable stroke.

1.31 If lockout devices are required, other than locks & scissors, then supplier will supply them

1.32 Pin cylinders to tooling to prevent turning apart.

1.33 Mount machine and panel on common base. Place hinge for panel door away from machine so that back of machine and controls may be viewed simultaneously. The panel door shall not block the access to the machine. The document box when mounted to the panel door must allow door to open fully. 4' flash safety distance must be maintained from all objects on or near machine. If machine is too big for one common base then major sections are to interlock to avoid lengthy alignment before lagging.

1.34 Design must take into account partial and full manual backup of automatic operations.

1.35 The machine shall be designed to operate 24 hours/day, 240 days/year for 10 years

1.36 Hardened tooling that touches production parts must be polished to prevent part damage.

1.37 All bogeys, masters and equipment required for calibration, checking calibration & auditing machine must be supplied and documented.

1.38 All vertical facing light curtains must be protected from damage by using Plexiglas guards. Only lower curtains require guards.

F.2 STRUCTURAL DESIGN

2.1 Structural design shall be adequate to provide the rigidity and strength necessary for the

application. Strength and deflection calculations must be provided for high load and/or speed applications. Minimum safety factor acceptable shall be 4 to 1. Frames must be stiff and free from wobble & sway.

2.2 Rigidity and inherent dampening shall be sufficient to permit operation at quoted speeds, feeds, and tolerances without excessive chatter or vibration. Standard bearings, chains, belts, and gears shall be utilized within the manufacturer's specifications for speeds and loads.

2.3 Provisions must be made for slings, hooks, fork slots, or skids adequate to handle machine sections and tooling during installation and maintenance. When lifting points are critical, they shall be marked or indicated.

2.4 Finish surfaces shall be accessible to check level of each section of equipment, without removing machine components and/or fixtures, after equipment is installed and ready for production.

2.5 All bolts used to secure fittings & miscellaneous other devices must use Nyloc nuts or removable Loctite or lock washers.

2.6 All tube & extrusion ends must be capped.

F.3 VENTILATION

3.1 Consideration shall be given in the design or process machinery to incorporate means by which ventilation ductwork can be readily and conveniently added to it by DTS. Machine mounted collectors to be designed and supplied by vendor.

F.4 ACCESS

4.1 Easy access must be designed in at concept and shall be provided for servicing, adjustments, and replacement for all mechanical, hydraulic, lubrication, coolant, pneumatic, electrical components, and for changing tools and dies. **It shall not be necessary to remove one component to service another. This includes opening machine guards.**

4.2 Operator must have free physical access & line of sight to parts & displays when loading, unloading and operating machine.

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

F.5 WEAR SURFACES

- 5.1 Sliding surfaces shall be made from material pairs resistant to scoring.
- 5.2 No non-metallic materials shall be used for ways or gibs. Exception to this will be approved on an individual basis.
- 5.3 Scrapers and/or way covers must be provided where contamination could cause premature wear.
- 5.4 All guide pins and shot pins shall be hardened, ground and provided with hardened and ground trapped replaceable bushings.
- 5.5 Wearable work head interfaces should be modularized and be designed for quick disconnect & replacement without tools.

F.6 BUSHINGS

- 6.1 All bushings, drill, bronze, etc., shall be readily available and built to national and/or international standards to insure inter-changeability.
- 6.2 Where practical, clamp style bushings are preferred over press fit.

F.7 WORK HEIGHT

- 7.1 The correct work height shall be determined using ergonomic standards.
- 7.2 Two inches should be provided between the machine base and foundation to allow for leveling pads. The machine base must have jacking screws and hold-down provisions. Where applicable locking style casters shall be provided.

F.8 TRANSFER MACHINES

- 8.1 Transfer accuracy shall be adequate to permit fixture pickup and prevent damage to locating surfaces and/or holes.
- 8.2 All efforts shall be made to minimize chip interference with transfer mechanisms and transfer

mechanisms should not interfere with chip disposal through machine.

8.3 All transfer mechanisms must have controlled acceleration and deceleration. Shock absorbers shall be provided where no other means of control is possible.

8.4 All transfer bars should be supported and confined.

8.5 Pinned connections shall not be used for rotating transfer bars.

F.9 LUBRICATION

9.1 Lubrication of wear surfaces shall be provided as required to insure equipment maintainability and sufficient life expectancy.

9.2 Pneumatic cylinders and devices shall be designed and specified as permanently lubricated. Air line lubricators shall be permitted only at the point of application as required

F.10 FINISHES SPECIFICATION

10.1 Each detail must have its finish (color / finish) specified on the drawing even if "none required". See Finish chart at bottom of document.

10.2 Delphi project engineer preapproval required for color/finish.

10.3 All finishing materials are to be applied by spray techniques to a clean, dry and properly prepared surface. There shall be a minimum of one primer and finish coats. All coating shall be applied in a neat and workmanlike manner. Nameplates, wear surfaces, etc. shall be carefully masked to prevent paint coverage.

10.3.1 Guarding - All guards are to be painted High Visibility Yellow. Expanded metal guards are to be painted flat black with the outside frame painted High Visibility Yellow.

10.3.2 Intentionally Left Blank.

10.3.3 Sheet metal must be painted.

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

10.3.4 Paint reject tables and chute tops red and then cover with Lexan to protect finish. Use flat head screws so surface is flush.

10.3.5 Exposed tooling is to have a black oxide or clear / black anodized finish

F.11 MACHINE & TOOL IDENTIFICATION

11.1 All machines, tools and components are to be labeled with their identifying numbers.

11.2 Machine labels are to be attached to the door of the operator panel(s) and on the main electrical enclosure in close proximity to the main electrical disconnect switch. This label is to display the machine name and the mechanical and control tool numbers.

11.3 Tools & components are to be tagged, stamped or machine/laser etched. Do not freehand etch.

11.4 Tags, Labels, Legends & Signage

11.4.1 All Tags, Labels, Legends & Signage must be shown on drawings in the location of use (not just a general note) and also specified on a separate drawing sheet.

11.4.2 All Tags, Labels, Legends & Signage must be to scale, show actual text and mounting holes. Colors & materials are to be specified. They must include a note to “mechanically fasten” (riveted, screwed, or metal tacked). Adhesives are not to be used.

11.4.3 Tags shall be placed on mounting surfaces not on the components.

11.4.4 Pertains to all mechanical & controls components whether inside or outside of panels

11.4.5 Brass asset tag (6001703) will be provided and mechanically affixed. Unique number to be supplied by Delphi project engineer. Tag is to be shown on documentation mounted to the upper right corner of the main electrical enclosure door.

11.4.6 Part presentation is to be labeled with part name & number being presented on it. Label(s)

to be placed so that supplier and receiver may see them. Construction may vary, but typical construction is computer printed on paper and then sealed in thin, clear & flexible lamination. These are then assembled with clear tape. 1” tall black text. Background for presentations of parts suitable for use will be light green; light red for reject part presentations

11.4.7 A laminated label plate will be provided for “calibration label” for each calibrated item inside electrical enclosures.

11.4.8 Hoist tooling must be certified & stamped.

11.4.9 Machines requiring periodic audits will have a steel & Plexiglas holder for 8.5” x 11” audit documents.

11.4.10 Sign holders & supports for all signs must be incorporated & documented.

11.4.11 Lockout points will be tagged.

11.4.12 Customer property tags / markings per customer requirements will be provided.

11.5 Delphi project engineer pre-approval required before manufacture of all Tags, Labels, Legends & Signage.

F.12 DOCUMENTATION SHIPPED WITH MACHINE

12.1 One hardcopy of approved operation and service manual in an 8.5”x11” binder. See “Delphi Thermal Systems Machine Manual Outline”. Electronic copy will be provided to Delphi project engineer.

12.2 Hardcopies of component manuals & miscellaneous documentation. Electronic copy will be provided to Delphi project engineer. All hardcopy information must be included in electronic copy.

12.3 One complete covered set of mechanical dwg’s (11x17) and BM’s (8.5x11) in document box. Use Pentaflex 13206 or similar 11x17 cover.

TOOL DESIGN - MANUFACTURING DESIGN SPECIFICATIONS FOR TOOLING AND EQUIPMENT

SECTION F - MACHINE DESIGN

- 12.4** Two complete covered sets of controls dwg's (11x17) and BM's (8.5x11) in document box. Use Pentaflex 13206 or similar 11x17 cover.
- 12.5** Machine Control Programs, Documentation & Licenses. Licensed to Delphi.
- 12.6** One hardcopy Lockout Placard (8.5"x11"). Electronic copy will be included as last sheet of electrical drawings.

FINISHES CHART

Machine Detail	Surface	Manufacturer	Finish	Code / Part #
Frame & Machine Base	All	Sherwin Williams	Sesame Brown DTM Acrylic Gloss.	B66-100 Series
Alternate Frame & Base	All	Sherwin Williams	1234 Blue DTM Acrylic Gloss	Code B66-100 Series, P/N F77XXL0182
Electrical Enclosure Body	Outside	Sherwin Williams	Color to match Frame & Machine Base	B66-100 Series
Masc. Sheet Metal	All	Sherwin Williams	Color to match Frame & Machine Base	B66-100 Series
Electrical Enclosure Body	Inside	Sherwin Williams	Color to match Frame & Machine Base	B66-100 Series
Electrical Enclosure Door	Inside	Sherwin Williams	Air-O-Jet White	Code B54-WF-401, 6016-10934
Electrical Enclosure Door	Outside	Sherwin Williams	Color to match Frame & Machine Base	B66-100 Series
Alternate Electrical Enclosure Door	Outside	Sherwin Williams	Air-O-Jet Safety Orange	Code B54-EF-403, 6016-10892
Tooling	Steel	Various	Hot Black Oxide	Various
Tooling	Aluminum	Various	Clear / Black Anodized	Various
Fixtures (Final Assembly)	Various	Various	Color Keyed to Assembly Positions	Various
Fork Truck Lift Points	All	Sherwin Williams	Air-O-Jet Safety Orange	Code B54-EF-403, 6016-10892
Reject Tables / Chutes	All	Sherwin Williams	Air-O-Jet Safety Red	Code B54-RF-402, 6016-10918

Note: Recent form changes highlighted.