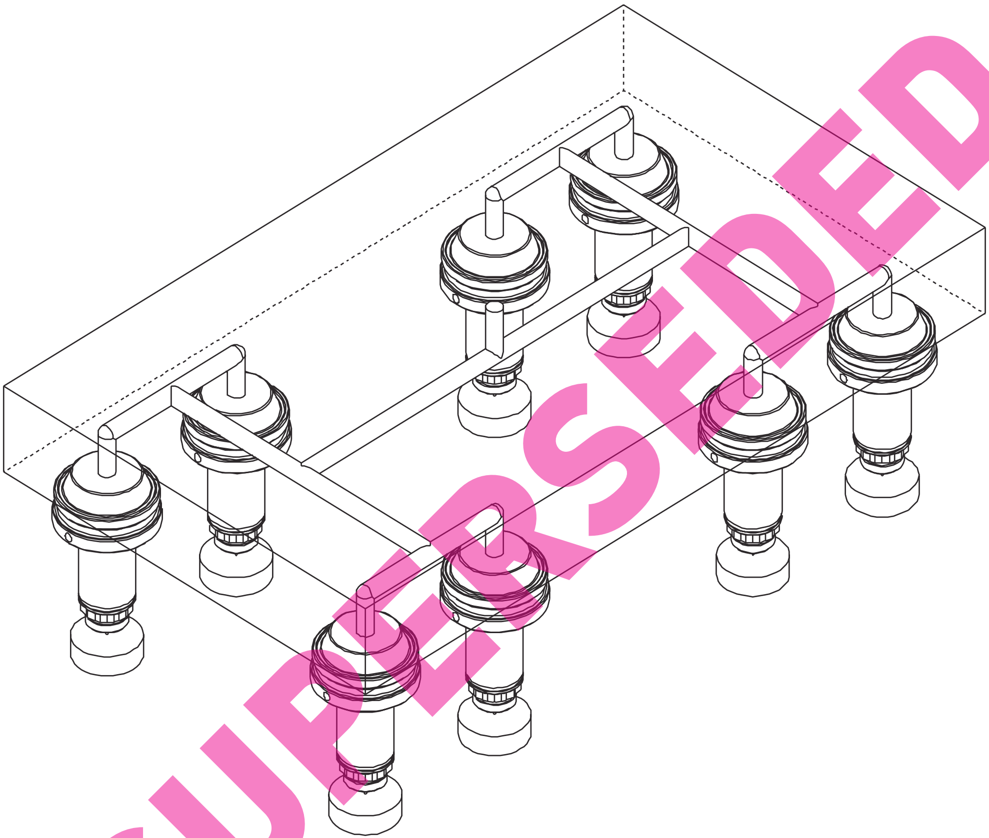
TECHNICAL MANUAL



CATALOGUE 2003

CONTENTS

OVERVIEW

A Hot Runner System is used to maintain a molten flow of plastic from the molding machine nozzle to the gate of a plastic injection mold.

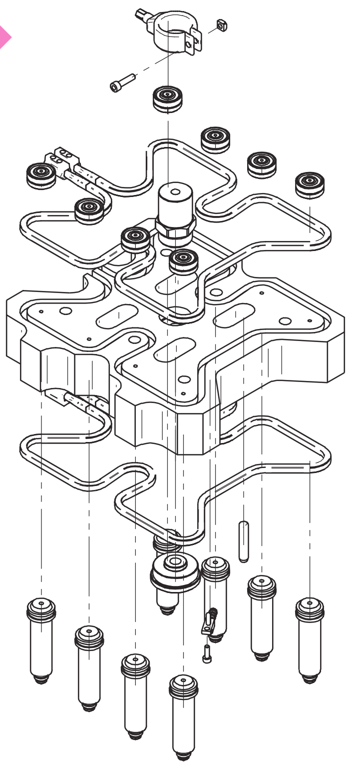
Main Benefits of a Hot Runner System

- Reduces cycle times.
- Eliminates the cold runner that would be either scrap or require regrind.
- Improves part consistency and quality.
- Reduced gate mark.
- Reduces injection pressure.
- Sequential filling and family of parts molds are made possible by using valve gates.
- Increased process control for fine tuning of mold and part.

In general the system is composed of three main parts; the sprue bush, the manifold block, and one or more hot nozzles. The system can also include valve gates which are a method of physically shutting the gate off, allowing larger gates to be used while controlling the gate vestage.

The Critical Areas of Performance for a Hot Runner System:

- Precise temperature control of the molten plastic.
- Balanced flow to all cavities giving even filling of parts.
- Nozzle sizing for maintaining sufficient molten material flow.
- Gate detail required to correctly fill the part and shut the gate.
- No material traps or areas of flow hesitation to ensure quick colour change and prevent material degradation.
- Minimum pressure drop across the Hot Runner System.
- Reasonable melt residence time.
- Maximum cooling of gate area to ensure good shut off of gate and minimise stringing.



NOZZLES

GATE SELECTION

Gate Selection

When designing an injection mold the size and location of the gate is one of the most important considerations for correct molding of the part. Incorrect gate positioning can result in uneven filling, over packing, and dimentional instability of the part. Incorrect selection of the gate size can result in an inability to fill the part, inability to thermally shut off the gate, dimensional instability or internal stresses in the part.

The most common gate type is direct gating, which offers the simplest construction and high reliability. ***MASTIP*** also offers a range of nozzles with other gate options such as Side, Edge and Valve gates. For more details of these refer to the Nozzle Catalogue.

Direct Gating

When considering Direct Gating into the part it is important to consider the Gate Size, Style in combination with the Nozzle Selection. The shape of the gate and gate cavity is also of vital importance to its performance, as the size of the gate land has a large effect on the pressure drop and structural integrity of the gate.

Gate Size

The Gate Size effects the:

- Flow rate.
- Pressure drop.
- Cycle time.
- Thermal gate shut off after filling.
- Cosmetic impact of the gate on the part.
- Cooling in the gate area.

Gate Design

Factors to consider:

- The shot size of the part.
- Material to be molded:
  - Material Flow Index (M.F.I.)
  - Additives.
  - Glass fiber.
  - Flame retardant.
- Cosmetic appearance of the gate.
- Part wall thickness.
- Longest flow length of the part.
- Required cycle time.

Material Category

In general there can be said to be three broad categories of materials related to molding characteristics; easy, medium and difficult. When identifying these consideration must be given to:

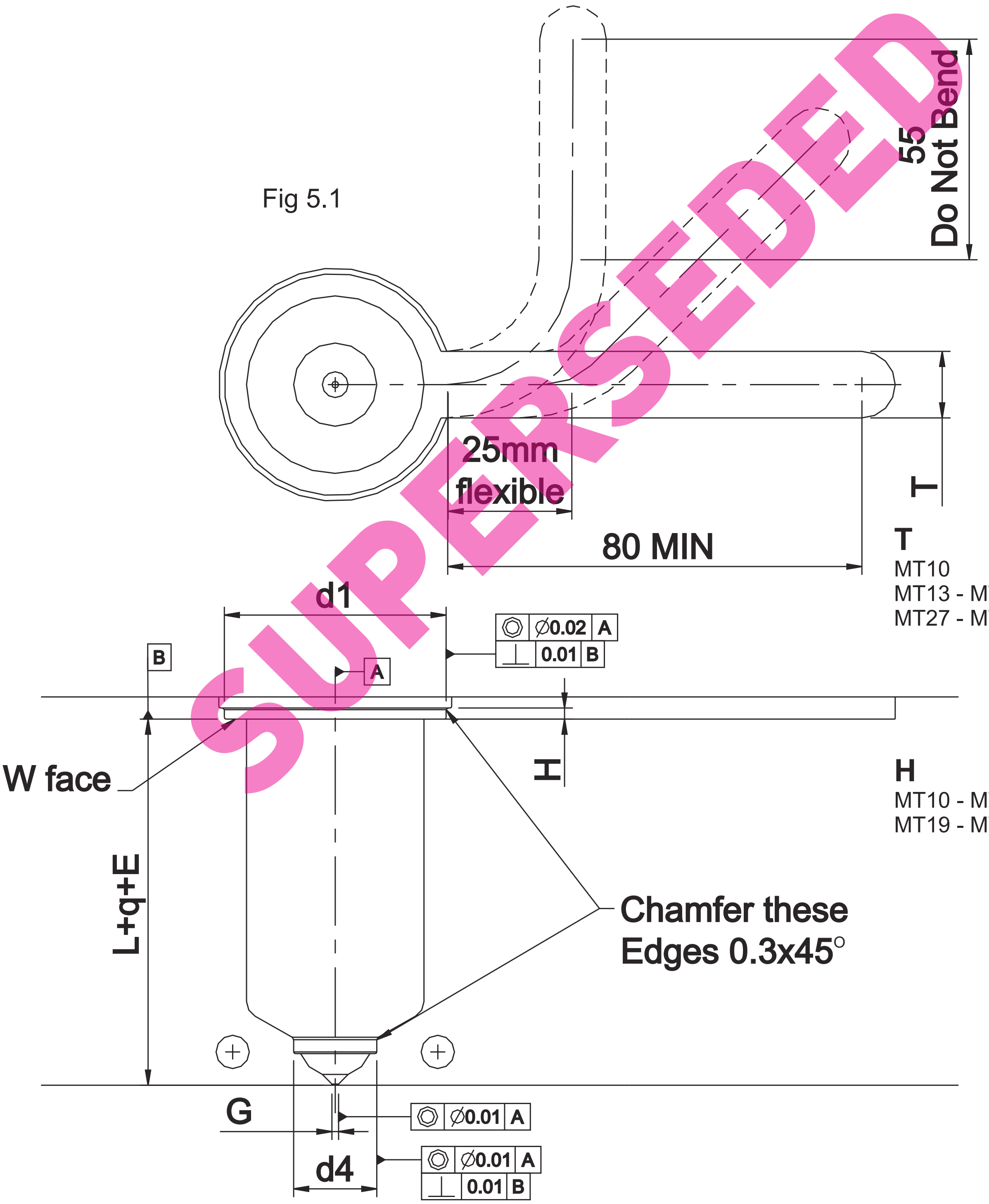
- Materials with large percentages of filler (e.g. >15%) or very low M.F.I. the material effectively moves up a grade i.e. Easy to Medium or Medium to Difficult.
- Parts with very thin wall sections or very long flow lengths will need a larger than normal nozzle and gate to achieve proper filling, this may require increasing the nozzle by one to two series.
- As a general rule the gate should be approximately 75% of the wall section at the injection point. This varies according to material, part design, and application.

GATE DETAILS

Design Stage

- Best results are produced by machining the nozzle seat directly into mold.(i.e. MTT)
- Provide maximum, uniform, and controlled cooling around the gate area
- Allow for the thermal expansion of the nozzle when calculating the cavity overall length (L+q+**E** Refer Fig 5.1)
- The pocket for the nozzle head should be stepped and the dimension H maintained to ensure minimal heat loss and ease of removal. (Refer Fig 5.1)
- Wire channel must be straight for the given length of 55mm, to allow for the heater ferrule, the channel may be curved before or after this portion..

Fig 5.1



T
MT10 = 10mm
MT13 - MT22 = 12mm
MT27 - MT33 = 15mm

H
MT10 - MT16 = 1.5mm
MT19 - MT33 = 2.0mm

GATE DETAILS

Manufacturing Stage

- Concentricity between G and d4 is vital
- Perpendicularity between d4 and W is also vital
- Concentricity between d1 and d4 is important
- Sizing of d4 is important to prevent leaks
- Chamfer points indicated to aid fitting of the nozzle
- Any modification to the gate should be made by conventional machining and not by EDM, as EDM can cause the steel surface to harden and become brittle which may lead to cracking and failure of the gate.

Retro Fitting Nozzle

- It is possible to retro fit the new MT series nozzle into the older SB series cavities with some minor modifications (Fig 6.1) See pages 1.2.5-1.2.6 in nozzle catalogue for details.
- Requires special retro nut
- May require a spacer in the seat area

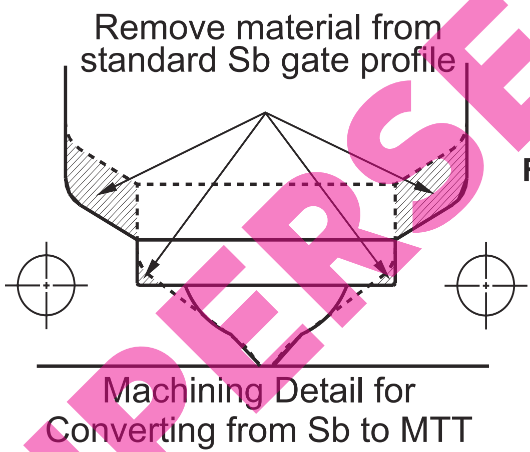


Fig 6.1

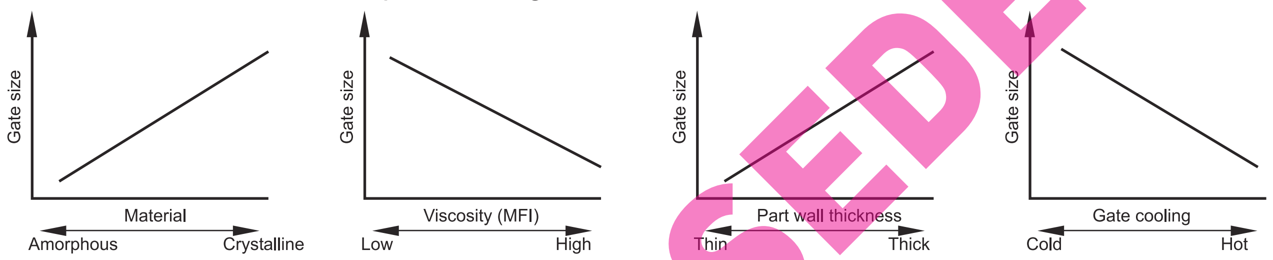
GATE MODIFICATIONS

It can be desirable to enlarge the recommended gate diameter (’**G**’) in the mold to increase the flow of plastic melt for a given nozzle size. It should be noted that **flow increases exponentially with the increase in gate diameter,** hence gate size should be adjusted in small increments.

MASTIP does not recommend increasing the gate diameter(**’G’**) more that 50% above the size shown in the nozzle catalogue. If larger gate is required, a larger nozzle should be considered.

The maximum gate size is dependent on:
- The type of plastic to be molded
- The viscosity (MFI) of the melt.
- The thickness of the wall section to be injected into.
- The amount of cooling around the gate. (Note: gate cooling is a complex variable, cycle time, gate profile and land length are also involved)

These variables interact as per the diagrams below:



It is vital to maintain the gate land (**’q’**) at a **maximum** of 0.2mm for proper nozzle function. If the gate diameter (**’G’**) is to be enlarged then the gate profile must also be modified to maintain the correct land (**’q’**). The gate land (’**q**’) may be corrected by machining the internal 90° angular face.

Increases in the gate land (’q’) will:
- Increase the heating effect around the gate, possibly burning the material.
- Decrease the flow.
- Increase the pressure drop across the gate.
- Cause the gate to freeze off prematurely.
- Leave an enlarged gate mark.

Contact ***MASTIP*** if you require specific details for your application.

Fig 7.1 demonstrates the effect increasing the gate diameter (**’G’**) will have on the gate land (’**q**’ becomes ‘**q+**’), as represented by the dotted lines.

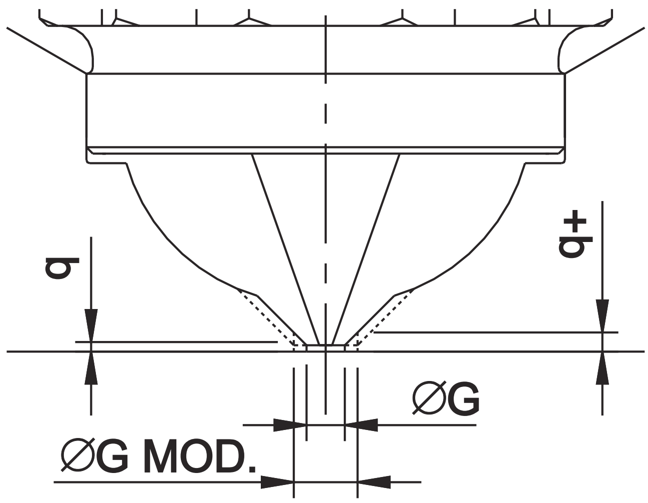


Fig 7.1

GATE MODIFICATIONS BUSH NUT

Gate Modification Considerations:

- Standard MTB nuts are supplied with a parallel gate hole (**’G’**) and a 0.2mm gate land (**’q’**).
- When modifying the nut gate area the gate land (**‘q’**) must be mantained at a maximum of 0.2mm. The land is to ensure a good thermal gate is achieved and minimise the pressure drop across the gate, while maintaining it’s structural integrity.
- Increasing the gate diameter (**‘G’**) of an MTB Bush Nut will increase the gate land (**‘q’**), (refer Fig 8.1). The gate land (**‘q’**) must be reduced to a maximum of 0.2mm by modifying the internal 90° angular face of the nut.
- Any modification to the MTB Bush Nut should be made by conventional machining and not by EDM, as EDM causes the steel surface to harden and become brittle which may lead to cracking and failure of the gate.
- Contact ***MASTIP*** if you require specific details for your application.

Figure 8.1 shows the best way to correct the land length (q) after an increase in gate size (G) for an MTB Bush Nut.

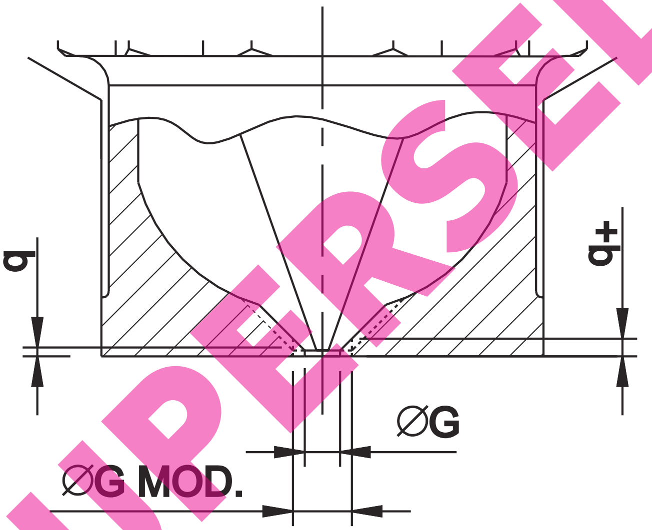


Fig 8.1

Heat Build Up in MTB/MTS nuts

In some MTB and MTS applications plastic may stick to the front face of the nut during operation. This is due to excessive heat build up in the nut as a result of inadequate gate cooling or a rapid cycle time.

This problem can be corrected by using the BNE or SNE nuts which have greater contact area with the mold. The contact area can be adjusted to control the heat loss from the nut by machining a small recess into the nut similar to the standard MTB/MTS nuts. (Figure 8.2)

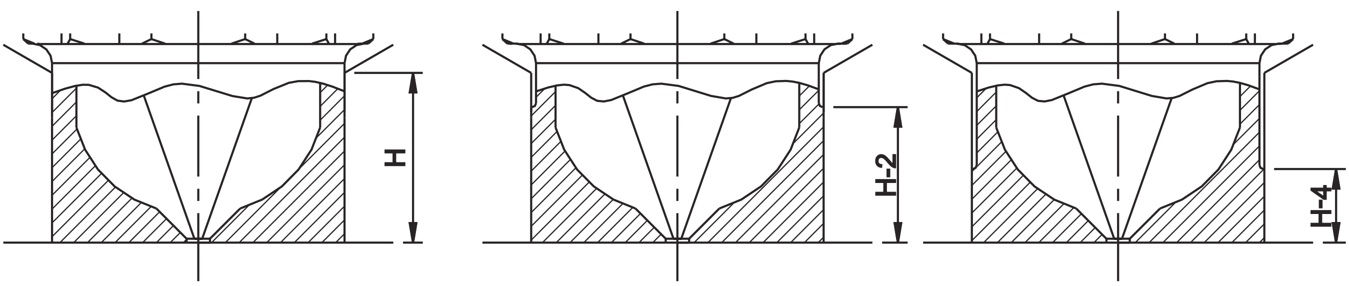


Fig 8.2

GATE MODIFICATIONS SPRUE NUT

Gate Modification Considerations:

- The standard MTS nuts are supplied with a parallel gate hole (**’G’**) 5.2mm deep (shown with dotted lines). The gate hole **MUST** be modified (e.g. taper) to suit the plastic to be used so as to reduce injection pressure and freezing of the gate.
- When modifying the nut gate area the gate land (**‘q’**) must be maintained at 0.15± 0.05mm to prevent a sharp edge forming. This is to ensure a good thermal gate is achieved and minimise the pressure drop across the gate, while maintaining it’s structural integrity.
- Where the gate diameter (**‘G’**) is to be enlarged on an MTS Sprue Nut so that a sprue is to left on the part, extra modifications to the nut are not necessary. (Refer Fig 9.2)
- The MTS sprue nuts are also available in 15mm and 30mm extra long lengths for MT16 - MT33 Series Nozzles. Where these are to be used it may be necessary to adjust the contact area of the nut (**‘H’**) or the mold to prevent excessive heat loss resulting in premature freeze off.
- Any modification to the MTS Sprue Nut should be made by conventional machining and not by EDM, as EDM causes the steel surface to harden and become brittle which may lead to cracking and failure of the gate.
- Contact ***MASTIP*** if you require specific details for your application.

Figure 9.1 shows an example of modifying an MTS sprue nut gating into a cold runner.

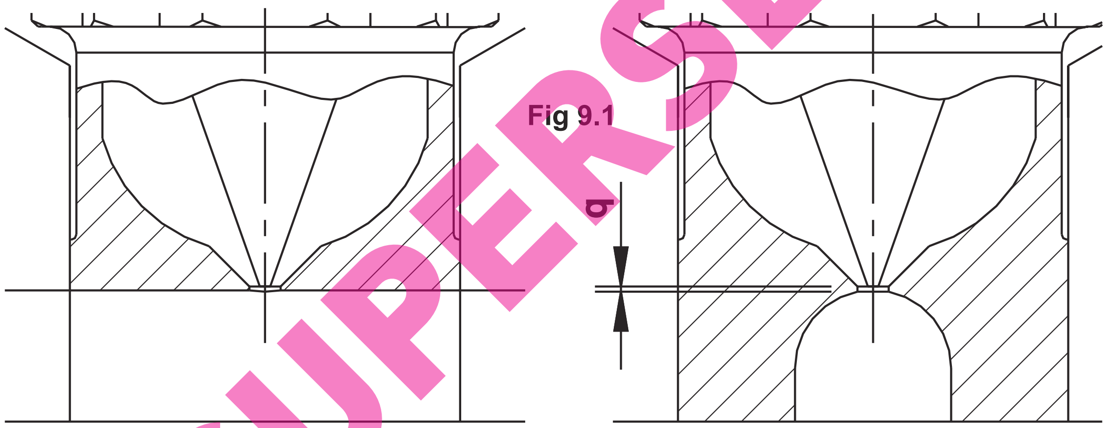


Fig 9.1

FRONT VIEW **SIDE VIEW**

Figure 9.2 shows an example of an MTS Sprue Nut being used to extend a standard nozzle.

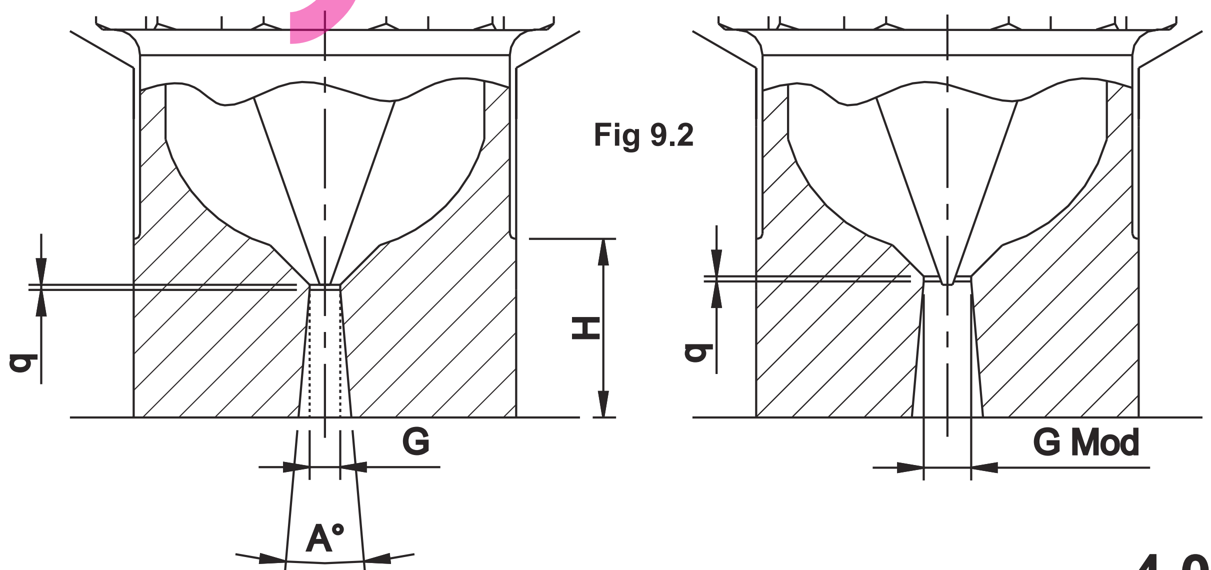


Fig 9.2

MOLD CONSTRUCTION- NOZZLE COOLING

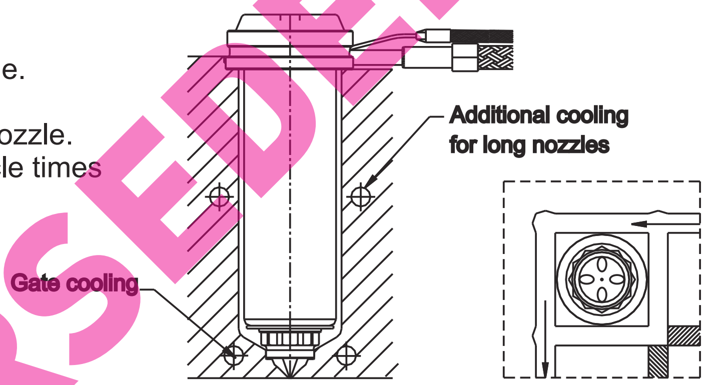
Gate Cooling

- Efficient Gate cooling is vital to obtain the best performance over the widest molding window.
- Insufficient cooling of the gate may result in the gate drooling/stringing and increased cycle times.
- Where high cavity tooling or longer series nozzles are used additional mold cooling is recommended.
- Caution should be taken when using thermally conductive materials (e.g. copper alloys) to machine the gate cavity into. This will result in excessive heat loss from the Hot Nozzle through the nut contact area (‘**d4**’), causing the nozzle to be hard to start and the gate to freeze off prematurely.
- Any modification to the gate well should be made by conventional machining and not by EDM, as EDM causes the steel surface to harden and become brittle which may lead to cracking and failure of the gate.
- Gate cooling circuits should be independant from other cooling circuits for gate temperature control.
- Contact ***MASTIP*** if you require specific details for your application.

Gate Cooling Styles

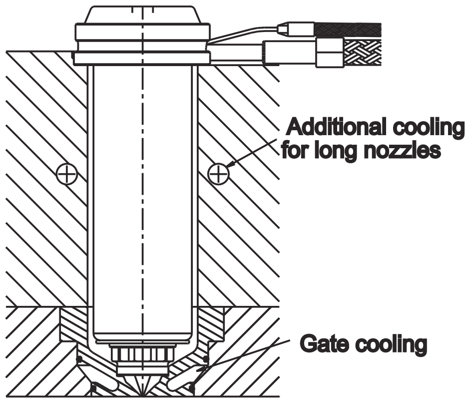
Cooling Channels

- Cooling channels are drilled around the nozzle.
- Difficult to provide cooling directly to gate.
- Cooling may be biased more to one side of nozzle.
- Acceptable where gate cooling and lower cycle times are not important.
- Low level of manufacturing required.



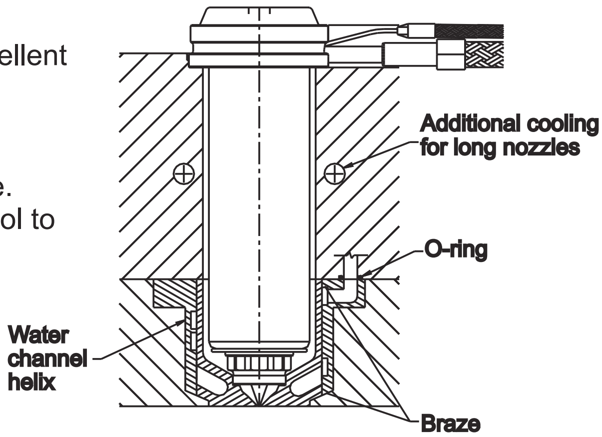
Insert with Cooling Channel Groove

- Grooved cooling channel in insert provides a good level of cooling directly to the gate.
- For applications where good gate cooling is required.
- Requires manufacturing of inserts for Hot Nozzle
- Extra nozzle retaining plates may be added to tool, to aid maintenance and manufacture.
- Requires O-rings to seal cooling channels.
- Medium level of manufacturing required.
- May leave insert witness mark on the part.



Insert with Helical Cooling Channels

- Helical cooling channel in insert provides an excellent level of cooling directly to the gate.
- For applications where a high level of cooling is required to the gate area.
- Requires manufacturing of inserts for Hot Nozzle.
- Extra nozzle retaining plates may be added to tool to aid manufacturing and maintenance.
- Requires O-rings to seal cooling channels.
- High level of manufacturing required.
- May leave insert witness mark on the part.



INSTALLATION

MASTIP Nozzle Installation Notes

- Nozzles should be handled carefully
- Avoid scratching or denting the ground faces
- Clean off anti rust oil with degreasing solution.
- Before fitting Hot Nozzle check the nozzle pocket gate depth is correct and includes expansion allowance.
- Fit nozzles and check for correct and even clearance around the tip and the gate land length is correct.
- Carefully enter the nozzle into the nozzle cavity and gently press in
- Align the wire with the wire slot before fully installing. DO NOT try and turn the nozzle by the wires. Make sure heater and thermocouple wires are not sharply bent or crushed when fitted
- For multi nozzle molds, check that the W face on all the nozzles are the same plane (+/- 0.02)
- Keep nozzle contact to a minimum in areas indicated in Fig 11.1
- Do not fit the o-rings until all the nozzles have been checked for fitting height and the manifold is ready to be assembled in the mold.
- When up to operating temperature check the clearance between the tip and the gate with a piece of soft material to avoid damage, (e.g. soft fuse wire). If there is no or very little clearance at any point (i.e. less than 0.2mm), check calculations for expansion ('**E**'), the gate size, and concentricity of gate to the nozzle location diameter ('**d4**').

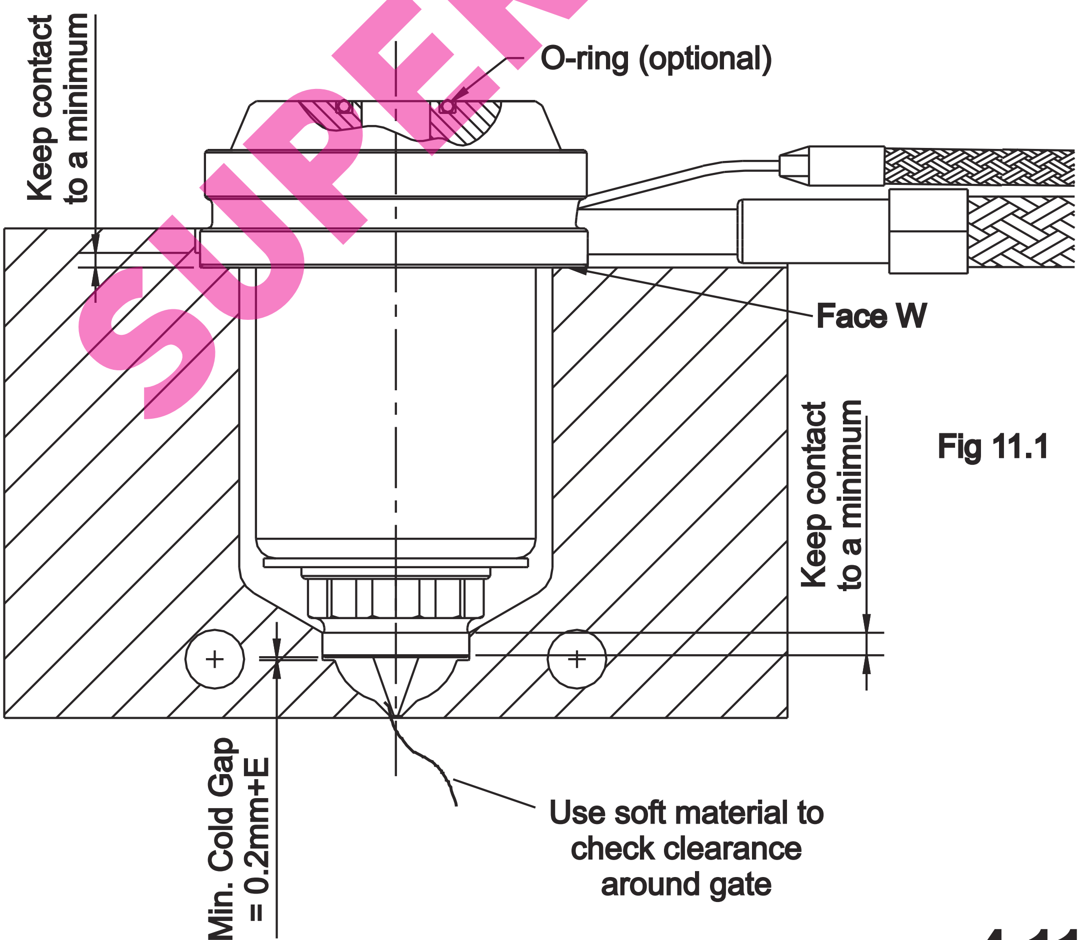


Fig 11.1

START UP AND RESTART

Starting and Restarting a Hot Nozzle in a Single Nozzle Application

1. Ensure "Soft Start" is selected on the temperature controller and the correct operating temperature has been set.
2. Allow a minimum of 10 minutes for the nozzle to heat up to operating temperature.
3. Purge machine barrel before connecting to Hot nozzle.
4. Slowly bring machine nozzle up to hot nozzle to avoid damage
5. When Hot nozzle is up to temperature you are ready to inject the mold
6. Check material comes out the gate and correct if required
7. Adjust nozzle temperature to get suitable molding (Note: nozzle will often need to run hotter than barrel temperature to achieve a good result)
8. If the machine is left idle it is strongly recommended to gently purge the first shot through the MASTIP nozzle.
   This will clear any cool slug that may have formed near the head.

Starting and Restarting a Hot Nozzle in a Manifold Application

Refer to page 4.26

Recommended Procedure for Colour Change

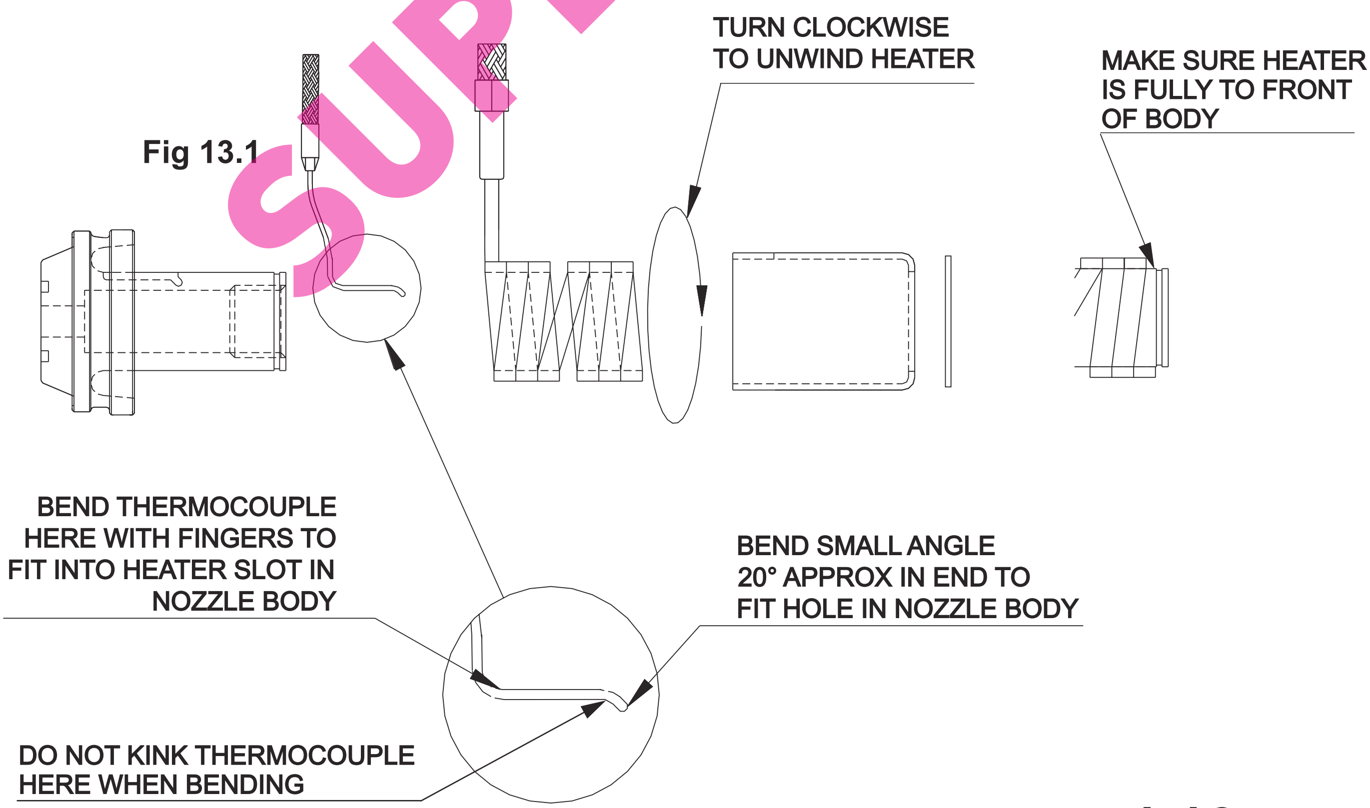
1. Increase mold temperature by 25°C
2. Increase manifold and nozzle temperature by 30°C
3. Retract molding machine nozzle
4. Purge the molding machine as per your standard practice using a purging agent
5. Re-start normal cycle - 6 shots
6. Lower manifold and nozzle temperature 20°C - 1 shot Minimum
7. Lower manifold and nozzle temperature 10°C - 1 shot Minimum
8. Lower mold temperature 25°C
9. Check the next moulded parts for colour consistency & quality, and if required repeat Steps 1-9
10. New colour is now ready

MAINTAINENCE

Heater and Thermocouple Replacement on a Single Nozzle Application

1. Remove Hot Nozzle from mold, ensuring not to damage the Heater or thermocouple wires.
2. Remove circlip and heater cover.
3. Grip body by the head and remove heater by turning the tip end of the heater in a clockwise direction to “unwind” or loosen the heater coils, and at the same time pull the heater off the body.
4. Remove the thermocouple.
5. Check the resistance of the thermocouple with a multi meter, the resistance should be 10 ohms (or less).
6. When replacing the thermocouple you need to bend the end as per figure 13.1.
7. To fit heater push heater as far as it will go onto the body, with bottom heater connection in line with slot on body.
8. Then turn the tip end of the heater in a clockwise direction to “unwind” or loosen the heater coils as you continue to push the heater towards the head of the nozzle. **Make sure heater is fully forward on body Fig 13.1**
9. Refit the heater cover, if the cover is tight check that the heater is not partially unwound.
10. Refit the circlip.
11. Recheck the thermocouple resistance as per 8 above.
12. Refit nozzle into the nozzle cavity in the mold, taking care not to crush the heater or thermocouple wires.

Fig 13.1



MAINTENANCE

Tip Removal

1. Place Hot Nozzle in a three jaw chuck gripping it by the nozzle head.
2. Heat the nozzle up to the plastics processing temperature.
3. Unscrew nut.
4. Remove plastic from the nut and tip taking care not to scratch or damage either one.
5. Remove the tip by inserting a soft ‘dolly’ or bar through the nozzle exit hole from the nozzle head and gently pushing the tip, taking care not to damage the end or internals of the tip.
6. Reassembly of the nozzle is the reverse of steps 5-1,ensuring to use the correct torque setting when tightening the nut.

Nozzle Series	Nut Torque Requirement Lb.ft	N.m
10 SERIES	10 – 12	14 - 16
13 SERIES	10 – 15	14 - 20
16 SERIES	15 – 20	20 - 27
19 SERIES	20 – 25	27 - 34
22 SERIES	20 – 30	27 - 41
27 SERIES	30 – 35	41 - 48
33 SERIES	30 – 40	41 - 54

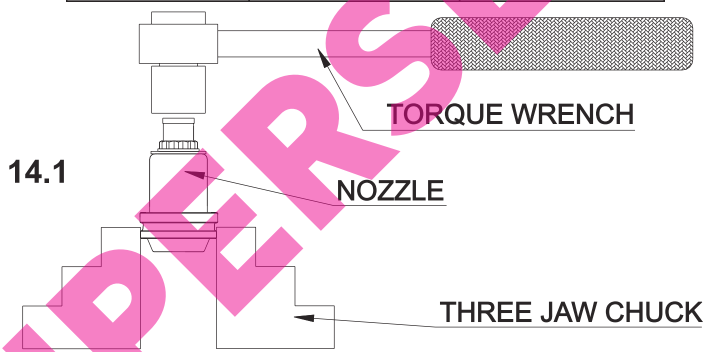


Fig 14.1

Blockage of the Hot Nozzle or Gate

During molding the Hot Nozzle or the Gate may become blocked with foreign matter, such as contaminated plastic melt.

To help prevent contaminated material entering the Hot Nozzle ***MASTIP*** recommends:

- Using virgin material where ever possible for molding applications.
- Storing the material in a clean and dry environment.
- The use of hopper magnets.
- Filtered Injection Machine Nozzles

To clear a contaminated Hot Nozzle it is recommended to remove the Hot Nozzle from the mold and heating to the plastic materials operating temperature to remove the melt and contaminants.

Where the blockage is in the gate it is recommended to remove the Hot nozzle from the mold and use a hot probe to clear any plastic and contaminants from the gate.

Do not under any circumstances attempt to blow out hot plastic with an air gun.

TROUBLE SHOOTING

The following is a list of common problems and answers for hot runner systems.

Problem: **The part is not filling.**
Cause: Melt temperature too low, injection pressure too low, gate too small, nozzle too small, mold too cold, exit from machine nozzle too small, nozzle blocked
Remedy: Raise nozzle and manifold temperature, raise injection pressure, enlarge gate, raise mold temperature, fit larger nozzle, enlarge hole in machine nozzle, clear blockage.

Problem: **Nozzle drooling**
Cause: Insufficient suck back, Melt temperature too high, gate too big, insufficient gate cooling, incorrect Nozzle type selected
Remedy: Increase suck back, lower nozzle and/or mold temperature, reduce gate diameter, increase gate cooling, contact MASTIP for correct nozzle selection.

Problem: **Nozzle not working**
Cause: Heater failure, Thermocouple failure, Nozzle blockage, Incorrect allowance for expansion of nozzle
Remedy: Check/replace heater, check/replace thermocouple, remove clean nozzle, re-machine nozzle cavity.

Problem: **Poor colour change.**
Cause: Incorrect colour change procedure, wrong type of nozzle.
Remedy: See guide for correct colour change, Contact MASTIP for correct nozzle selection.

Problem: **Excessive flash on part.**
Cause: Too high an injection pressure, temperature too high, poor shut off face flatness Insufficient clamp pressure on molding machine, tool plates flexing.
Remedy: reduce injection/pack, lower nozzle/manifold/mold temp, increase machine clamp force, change tool.

Problem: **Burn marks/streaks on part or near gate.**
Cause: Not enough venting in tool, injection speed too high, gate profile incorrect, material not dry
Remedy: Add more venting, lower injection speed, increase “J” dimension on gate profile, dry material.

Problem: **Excessive tip wear in nozzles when using plastics with high glass fill content.**
Cause: Tip material too soft for application
Remedy: Change to MASTIP Carbide tips

Problem: **Gate vestige too large.**
Cause: Gate too large, incorrect nozzle selection, gate profile machined incorrectly
Remedy: Fit bush/sprue nut to reduce gate, Contact MASTIP for correct nozzle selection, check gate machining profile

Problem: **Gate freezing off too soon, or during cycle.**
Cause: Melt too cold, gate too small for material being used, excessive cooling around gate, too much contact between nozzle and mold, gate profile incorrect or incorrect type.
Remedy: Raise nozzle temperature, raise mold temperature around gate, check machining of nozzle cavity and make sure contact is at a minimum, check machining of gate profile and change if needed.

Problem: **Flow lines on large flat part**
Cause: Incorrect nozzle type
Remedy: Use MIT or MOT nozzles.

Problem: **Bloom on part opposite gate**
Cause: Mold too cold, melt too cold, cold slug in part
Remedy: Raise mold temperature, raise melt temperature, use MOT nozzle.

Problem: **Cold slug in part**
Cause: Wrong nozzle selection, head of nozzle too cold.
Remedy: Contact MASTIP for correct nozzle selection, machine cold slug trap opposite gate, ensure contact area on nozzle head is minimum.

Problem: **Intermittent blockage caused by cold slug, tip fails by trying to extrude through nut**
Cause: Too much head loss through nozzle head.
Remedy: Reduce head contact to a minimum, Sit head in thermally insulated material.

Problem: **Plastic sticking to front of bush nut or sprue nut.**
Cause: Not enough contact between nut and mold to dissipate heat.
Remedy: Use BNE/SNE type nut with increased contact area to dissipate heat from nut.

MANIFOLDS

MANIFOLD DESIGN GUIDELINES

BASIC DESIGN STEPS / MANIFOLD SELECTION

- Estimate weight of part and material to be used based on design specification.
- Identify location of gate and suitable gate type.
  This is dependent on:
  - cosmetic appearance
  - wall sections,
  - dimensional stability.
- Identify suitable nozzle series for gate type required noting:
  - Colour change importance
  - Thin walled part or long flow lengths (Increase nozzle series one or two sizes)
  - Abrasive material (hard tips, gate inserts etc)
  - Fast cycle times needed (increased gate cooling required)
  - No flow marks required (MIT or MOT tip)
  - Cosmetically perfect gate required (valve gate)
- Calculate number of parts moldable in tool based on:
  - machine shot size
  - clamp tonnage
  - machine plattern size
  - minimum distance between nozzles.
- Lay out the parts in the mould so that the manifold drop positions are as symmetrical as possible (fig 17.1), refer to the manifold catalogue for standard drop configurations.

Non-symmetrical manifolds are harder to balance and more expensive to design.
Consider all variables of manifold such as:
  - Overall height.
  - Manifold Cavity reqiuired allowing for 10mm recommended thermal insulation gap around manifold.
  - Heater exit, thermocouple connections, and associated wiring
  - Gate, back plate and manifold plate cooling
  - Possible provision of extra split line for maintenance
  - Extra height in tool if valve gating is used
- Select standard manifolds with relevant dimensions and option details from catalogue, or contact ***MASTIP*** for custom design.

If you have any questions do not hesitate to contact ***MASTIP.***

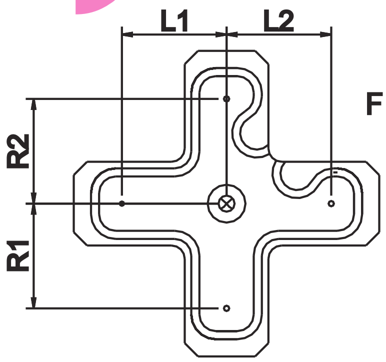
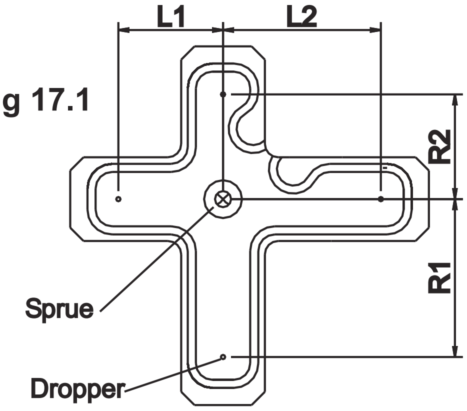


Fig 17.1



Good manifold layout
All runners equal length giving balanced design

Poor manifold layout
Runners un-equal length giving unbalanced design. Extra work is required to balance

TOOL/MANIFOLD DESIGN FEATURES

Design guidelines for High Production /Long Life Tooling

- Use tool steels for nozzle retainer plate and back plates to increase rigidity and reduce hobbing (recommended minimum of P20, 30HRC, 800MPa Yield Strength).
- Use thick nozzle cavity plate with longer nozzles for better rigidity and longevity. Make provisions for extra water cooling in middle of plate around nozzles.
- Machine manifold cavity from one piece of solid steel, add provision for water-cooling.
- Use thick back plates (Minimum 40mm thick for small to medium size moulds).
- Provide adequate manifold clamping between backplate and nozzle cavity plates to ensure sealing between manifold and nozzles, ***MASTIP*** recommends three bolts per drop with a minimum of two bolts per drop as close to manifold as possible. (see page 4.20).
- Ensure accuracy is maintained for the nozzle head seating faces (W and d1), nozzle nut sealing area (d4) and maintain correct L, q and E values (see page 1.5.1).
- Ensure all expansion of Manifold and Nozzles has been allowed for.
- Ensure adequate cooling around the gate area (page 4.10).
- Where possible, use extra split line to allow servicing of nozzle and gate without having to strip down hot half.
- Make sure wiring is not exposed to the direct heat of the manifold, use aluminium shields over the wiring troughs if needed.
- Manifold Cavity should allow for a 10mm minimum air gap between the mould and the manifold to ensure adequate thermal insulation between the two.

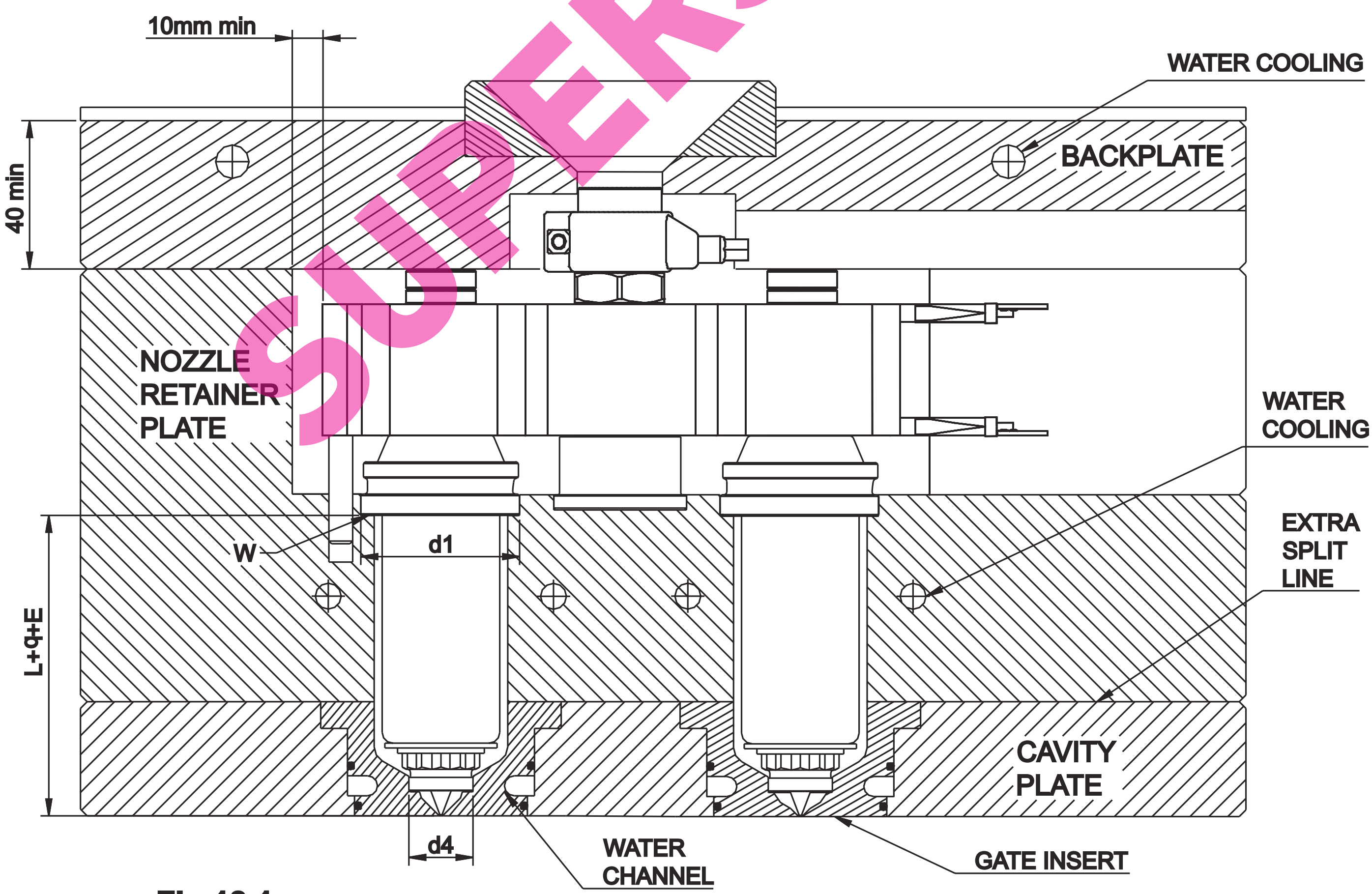


Fig 18.1

MOLD CONSTRUCTION

Spacer Plate Layout

- Basic layout for easy manufacturing of Fixed Cavity side
- The Back, Spacer, and Cavity plates are separate.
- No split line for Nozzle maintenance
- Weak mold construction due to lack of support in center of mould.
- Not Recommended by ***MASTIP***.

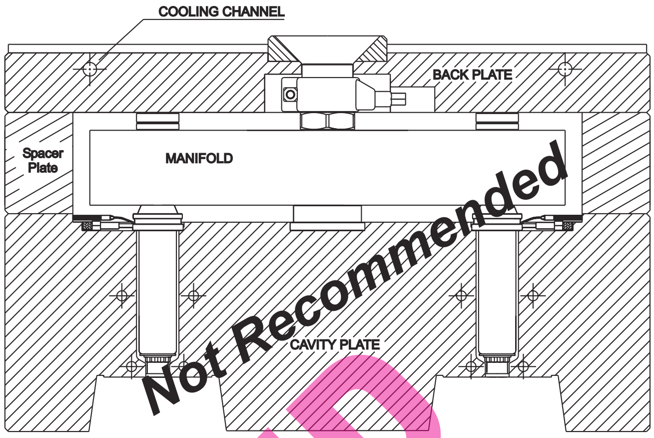


Fig 19.1

Manifold Cavity Layout

- Simple Layout of Fixed Cavity side requires relatively easy manufacturing.
- Hot Runner cavity is machined into the cavity plate.
- The back and cavity plates are separate
- No split line for Nozzle maintenance
- Mold strength dependant on Hot Runner pocket and amount of support added.

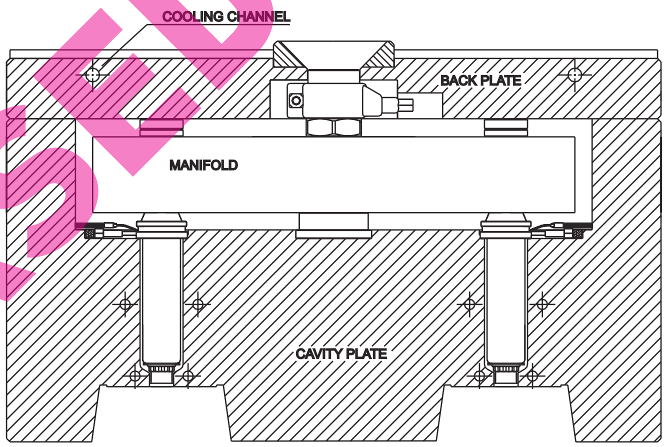


Fig 19.2

Hot Half Layout

- Complex layout for Fixed Cavity side requires more manufacturing time.
- Hot Runner cavity is machined into the cavity plate.
- The Back and Nozzle Cavity plates are separate.
- Split line added for Nozzle maintenance
- Mold strength dependant on Hot Runner pocket and amount of support added.

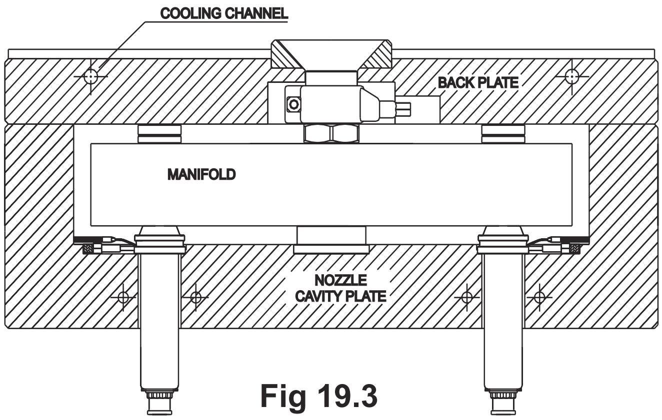


Fig 19.3

MOLD CONSTRUCTION - CLAMPING

Back Plate Clamping around a Manifold

- Clamping bolts are required to help the mold resist movement due to injection pressure, and thermal expansion of the manifold and nozzles.
- ***MASTIP*** recommends a minimum of two bolts per drop, placed as close as possible to the drop.
- The size of clamping bolt is dependant on the size of the system and injection pressure. Mastip recommends using a minimum of Grade 8.8 M10 or equivalent bolts on smaller molds, increasing the bolt size as the mold size or injection pressure increases.
- Keep clamping bolts as close as possible to manifold to ensure good sealing.
- Do not expose clamping bolts to direct heat from manifold.

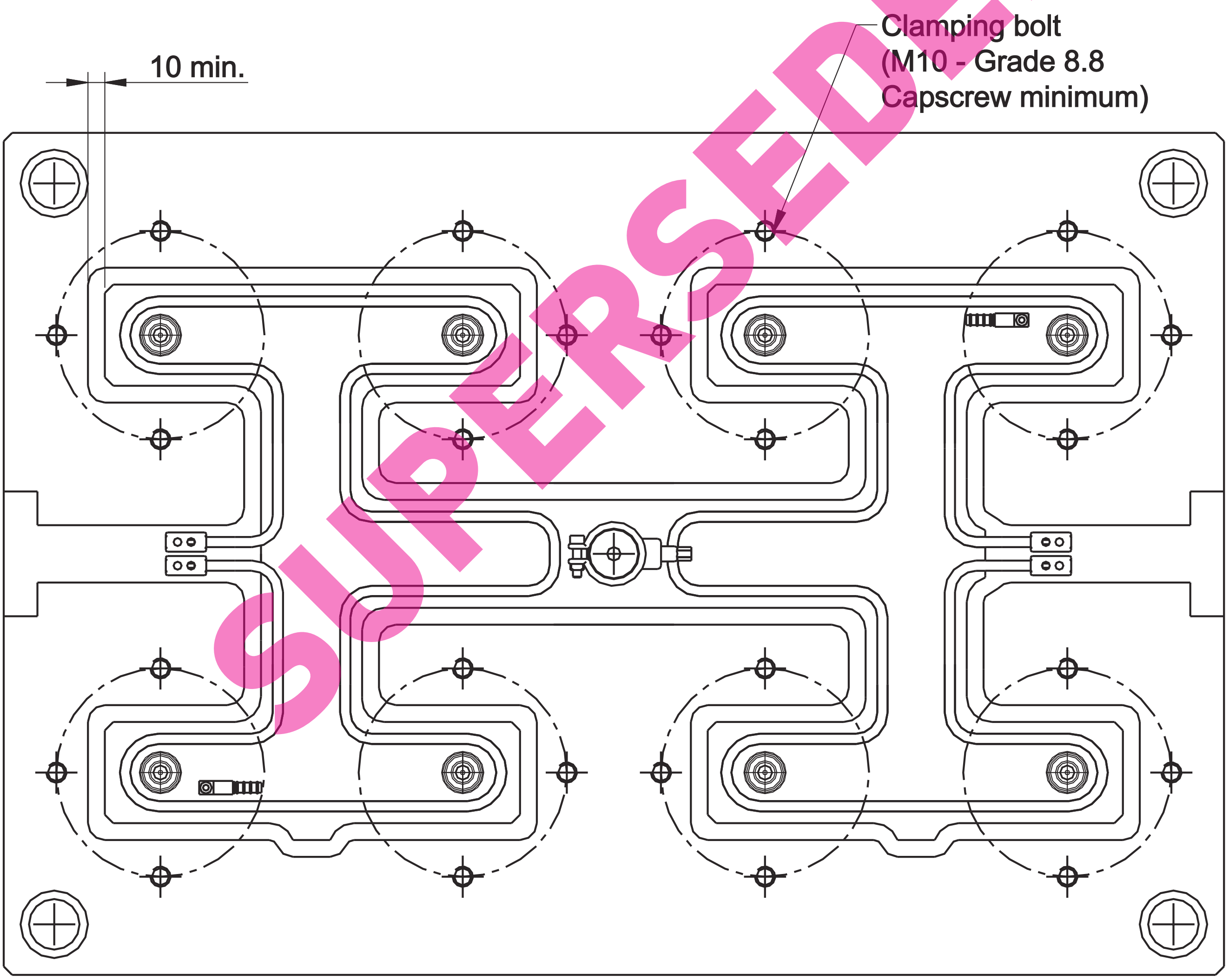


Fig 20.1

MOLD CONSTRUCTION - COOLING

Mold Cooling

Adequate cooling for the mold is essential to remove heat which is added to the mold by convection and conduction from the Hot Runner system, and the molten plastic entering the mold cavity. If not removed this additional heat can result in incorrect thermal expansion allowances in the mold resulting in leaking from the Hot Runner system, dimensional instability in the molded parts, longer cycle times, and damage to the mold components and moving parts where clearances need to be maintained. Heat can also be transfered to the Injection Molding Machine which can cause inaccuracy and mechanical instability.

Points to note when adding cooling:

- Sufficient cooling must be provided to the Back Plate, Manifold and Nozzle plates, and the gate to ensure optimal performance of the Hot Runner System.
- Cooling Channels should not be too close to the manifold spacers, as this can cause excessive heat loss from the manifold affecting its performance.
- When using valve gates supply cooling around the cylinders to improve seal life, and avoid seizing due to excessive expansion of the cylinder components.
- Thermal insulation board may be used between back of mold and machine platen to reduce heat transfer where required.
- Cooling entry and exit connections should be made away from all electrical components.

Fig 21.1 shows typical cooling channels in the back plate of the tool.

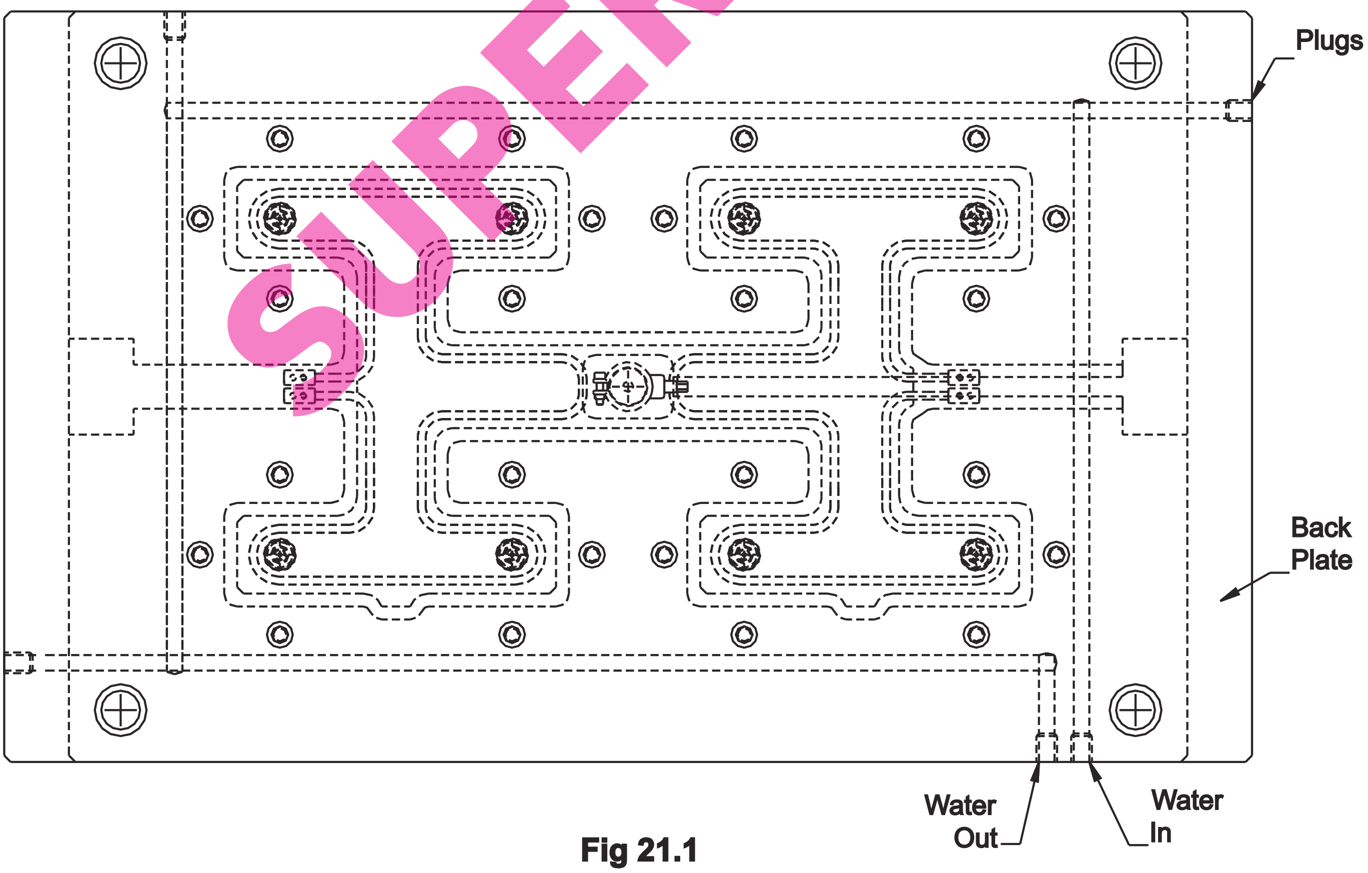


Fig 21.1

MOLD CONSTRUCTION - WIRING

Hot Runner Wiring Points:

- The wiring slots for the nozzles must be of sufficient size, refer to nozzle catalogue.
- Especially note the length required to accommodate the nozzle heater ferules.
- If heater wiring is to be bent sufficient room must be allowed. Refer Fig 22.1 (1)
- Where the wiring troughs meet, allow for a larger slot to accommodate the bundled mass of wires Refer Fig 22.1 (2).
- Provision should be made to clamp the wires in place, as loose wiring can come in contact with the hot manifold and be damaged by the manifold heat. Refer Fig 22.2
- For maximum life and reliability, or where running temperatures for the manifold are above 260°C a shield should be used to cover the wiring channels and protect the wires from the heat. Refer Fig 22.1 (4)
- Make sure there are no sharp edges to damage the nozzle wires, and that the wires are not crushed. Refer Fig 22.1 (5)
- Allow a cutout for wiring to enter the mounting box. Refer Fig 22.1 (6)
- Never rotate the nozzle by the heater or thermocouple wires.

Figure 22.1 - Cutaway view of an 8 drop manifold cavity plate to illustrating the wiring grooves for Hot Nozzles

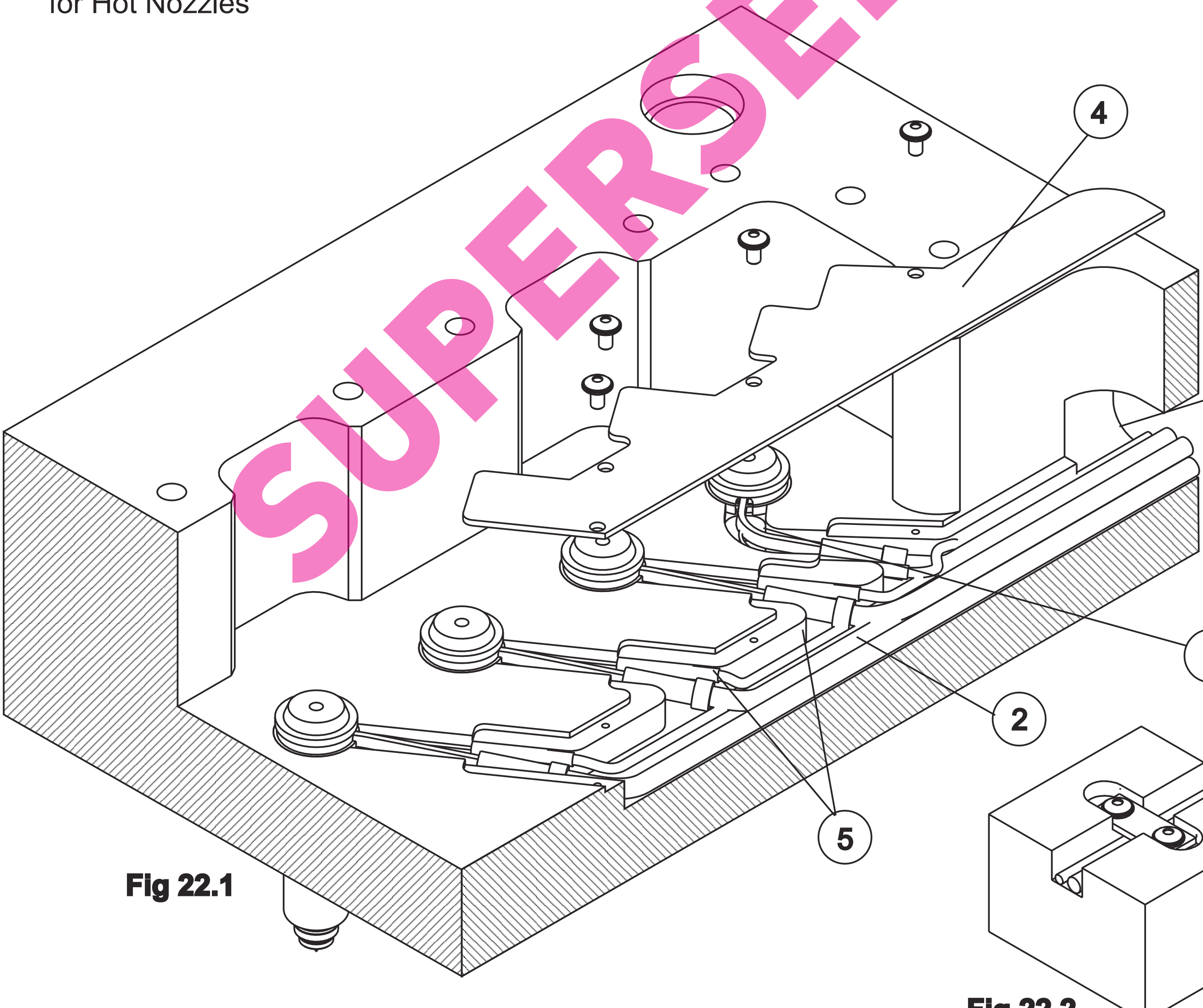


Fig 22.1

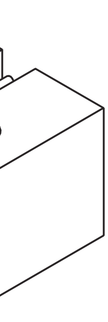
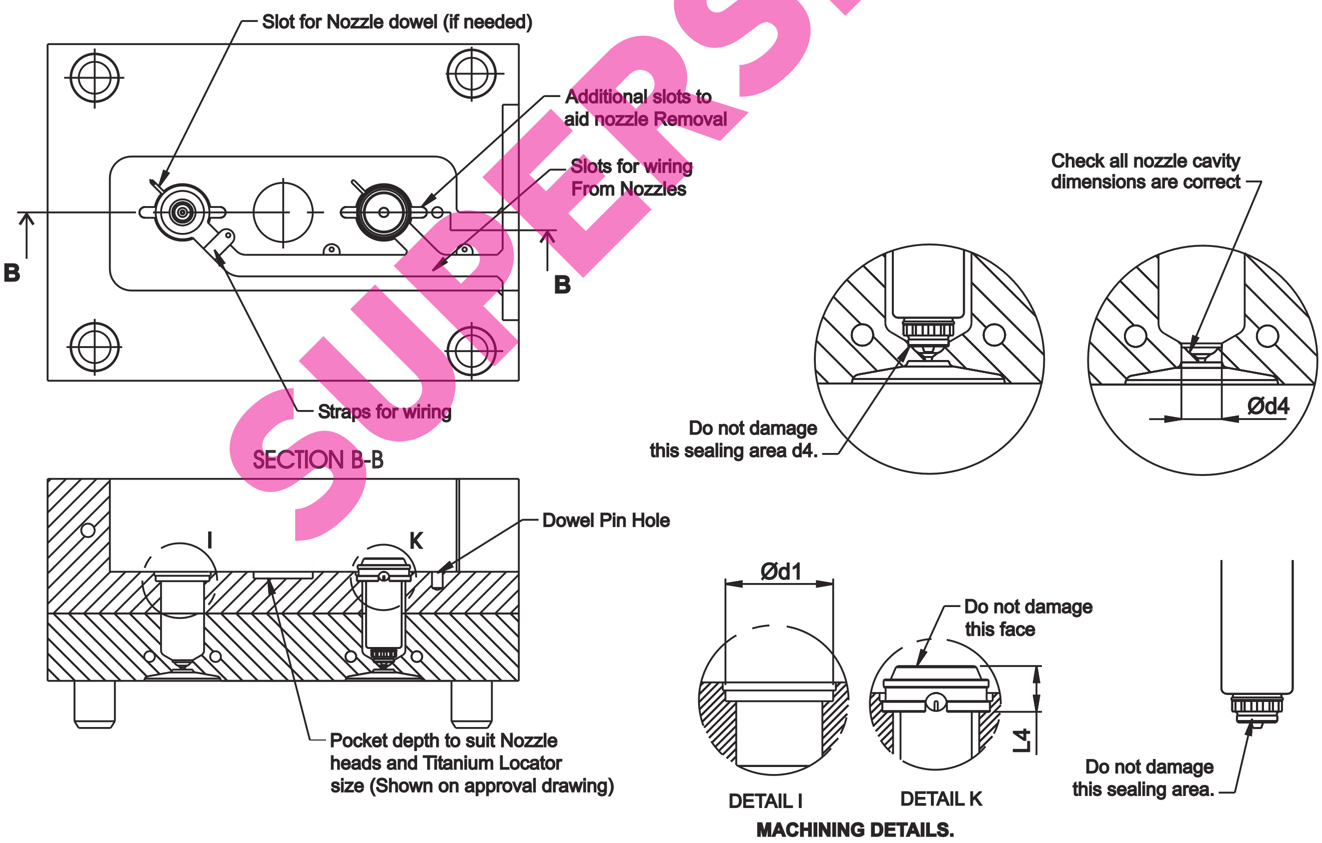


Fig 22.2

INSTALLATION

Fitting *MASTIP* Hot Nozzles

- ***MASTIP*** nozzles should be handled carefully to avoid damaging the nozzle tip or ground sealing faces. Any damage may result in leakage or affect the performance of the nozzle.
- Clean the protective oil from the nozzles with a degreasing agent before fitting.
- Check nozzle cavity dimensions to ensure all sizes and tolerances are correct.
- Ensure allowance has been made for expansion of the nozzle in the mold cavity.
- Make sure that contact between nozzles and mold cavity is minimal in order to reduce heat loss.
- Introduce the nozzle into cavity until it is in contact with bottom sealing diameter (d4) and then gently press the nozzle to the pocket. Never use excessive force.
- Fit the nozzles one at a time, then check the height to the top of the back faces, they should all be equal to within 0.02mm (L4 in Nozzle Catalogue).
- Check clearance between the Hot Nozzle tip and the gate.
- Additional slots may be added opposite each other around the nozzle head to facilitate easy nozzle removal from the cavity with the assistance of two die levers
- Where a dowel is to be used ensure the dowel slot is aligned with the heater wire slot to avoid damage to the heater and thermocouple.



INSTALLATION

Manifold Pocket Thermal Expansion Allowance

As the Hot Runner System and mold operating temperatures are extremely different thermal expansion allowance must be built into the Manifold and Nozzle pockets in the cold condition. If the expansion calculation is incorrect the Hot Runner System and/or the mold may be damaged, and can leak. MASTIP manifolds have steel spacers which can be ground to make adjustments for correct expansion allowance.

The procedure to calculate the adjustments necessary are as follows:

- Measure and note down the overall heights of manifold, the steel and titanium spacers, and the Nozzle head height ('**L4**').
- Measure and note down the height of the manifold and nozzle cavity, (i.e. the height from face W to the backplate).
- NOTE: The height of the steel and titanium spacer will measure more than is shown on the ***MASTIP*** approval drawing. ***MASTIP*** supplies the steel spacer with 0.3mm grinding allowance to ensure the correct allowance is added.
- At operating temperature there should be 0.05mm interference between the manifold titanium spacer and the mold back plate, which may be achieved by grinding the steel spacer to suit.

Example:
Nozzle = MTT16036 (L4=15.0mm)
Manifold Height = 44.0mm
Titanium Spacer = 6.5mm
Steel Spacer = 5.3mm
Hot Runner Cavity = 11.5+44.0+15.0 = 70.50mm
Hot Runner Operating Temperature = 255°C
Mold Operating Temperature = 40°C

Expansion for Cavity Depth
E=70.50 x 0.0000132 x (255-40) = 0.20mm

Hot Runner Height Required
70.50mm + 0.05mm (interference) = 70.55mm
70.55mm-0.20mm = 70.35mm

Hot Runner Height Supplied
H =15.0mm+44.0mm+5.3mm+6.5mm= 70.80mm

Material Required to be Ground from Steel Spacer
70.80mm - 70.35mm =***0.45mm***

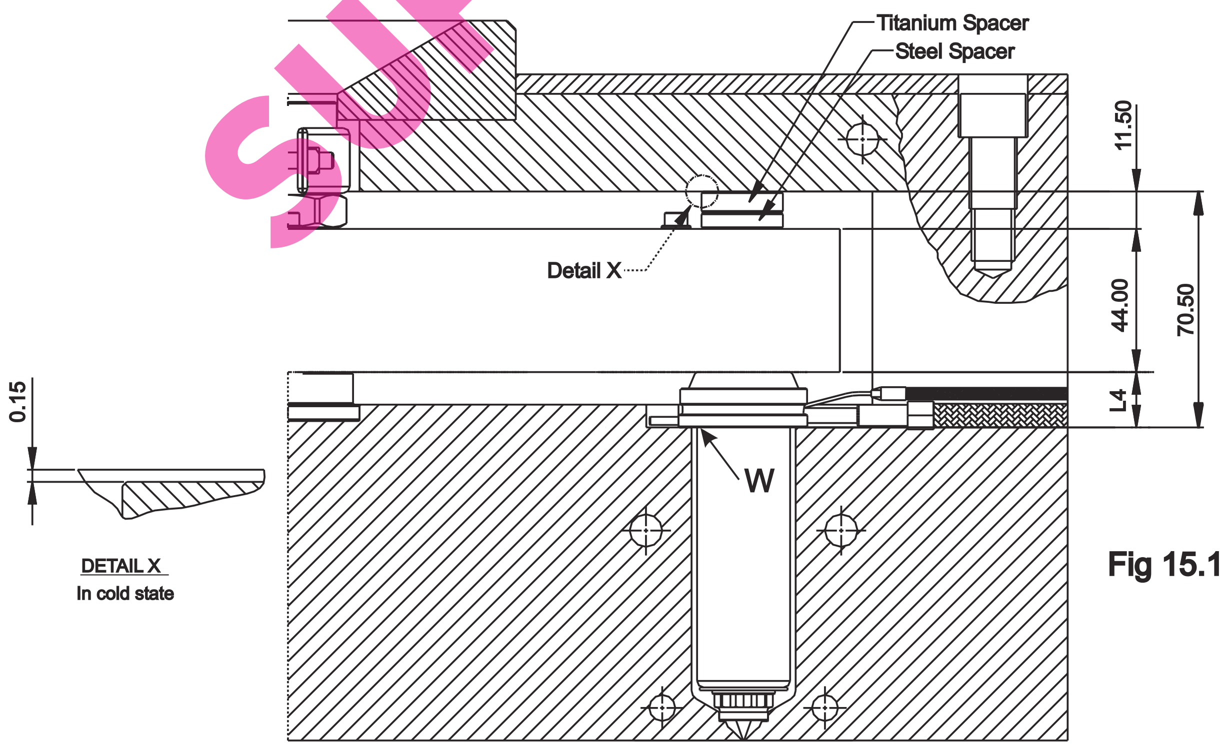


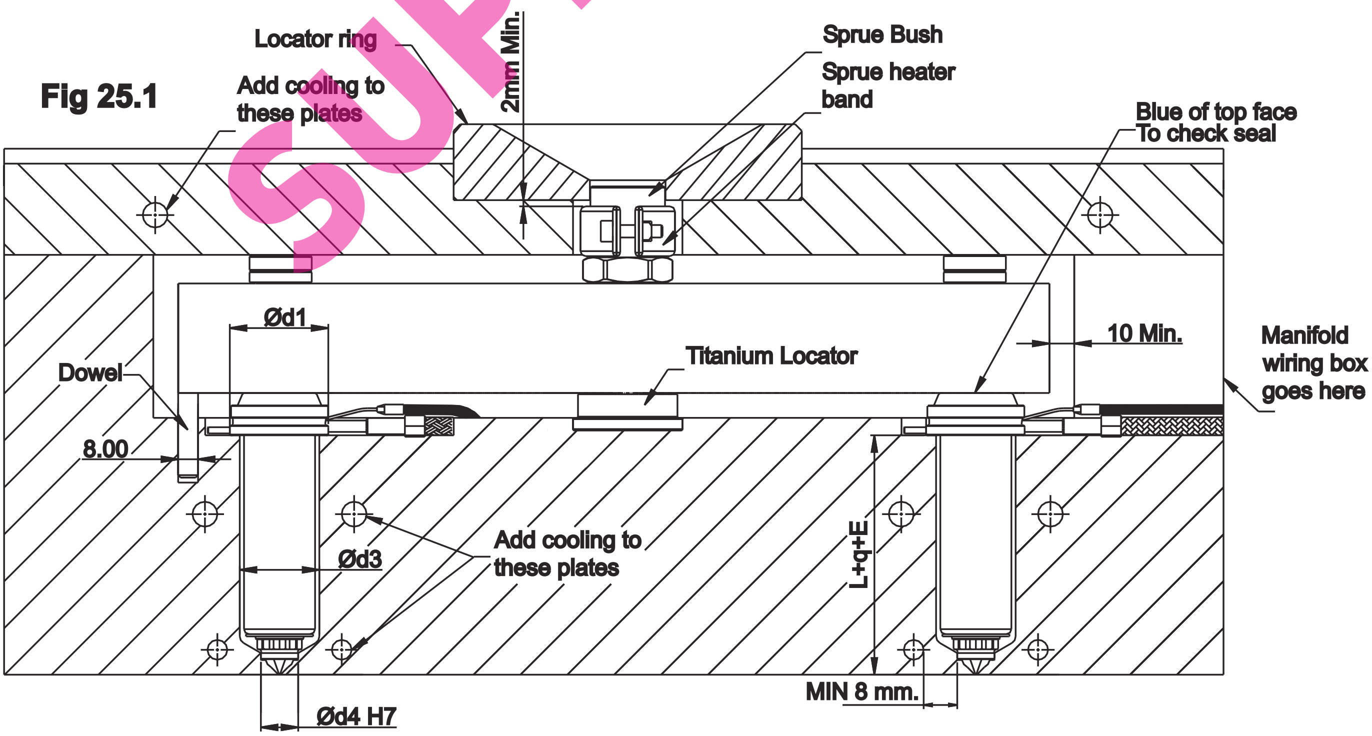
Fig 15.1

INSTALLATION

Installing the Manifold

- Fit the titanium locator and dowel pin into mold, line up manifold and assemble with mold. Mark out, drill and tap fixing holes if needed.
- Always make sure all threads have a smear of anti-seize grease to aid in disassembly. Note that the fixing holes are an assembly aid only, they are not intended to hold the manifold against the nozzle and so replace the spacers. Do not over tighten fixing bolts as this could cause bolt failure when the manifold is heated, and damage to Hot Runner System or mold.
- Use location dowels to maintain alignment between the mold plates when assembled.
- Make sure suitable wiring channels are provided for the nozzles, thermocouples, and manifold heaters. Wiring should be directed to a terminal box, located typically on the top of the mold.
- Wires should not be crushed or excessively been, and should be secured with clips or a cover.
- Clean down the manifold with de-greasing solution before assembly to remove protective oils.
- Bearing blue the top of the nozzle faces, fit the manifold and check all the nozzles are in full contact with the manifold surface.
- If applicable assemble the 'o' ring to the nozzles.
- If applicable tighten any hold down bolts, using belleview type washers to allow for thermal expansion.
- Check clearance between back plate and sprue bush heater, there should be no contact.
- Check that the locator ring of the mold has sufficient clearance around top of sprue. (0.4mm min)
- Wire up the manifold heaters and thermocouples, and perform the final check.(Care should be taken to prevent any fatal shock caused while wiring. This procedure should only be carried out by someone with correct training in electrical equipment).
- Note: Toolmakers should carefully inspect all stack heights, nozzle and manifold dimensions against ***MASTIP*** Catalogue and approval drawings.
- Contact ***MASTIP*** about any questions BEFORE assembly.

Fig 25.1



START UP & RESTART

Starting and Re-starting a Hot Nozzle and Manifold

1. Ensure "Soft Start" is selected on the temperature controller for both nozzles and manifold and the correct operating temperature has been set.
2. Allow 20-30 minutes for the system to heat up (depending on size).
3. Purge machine barrel before connecting to manifold sprue.
4. Slowly bring machine nozzle up to sprue to avoid damage.
5. When system is up to temperature you are ready to inject into the mold.
6. Check material comes out the gate and correct if required.
7. Adjust ***Nozzle*** temperature to get suitable molding (Note: nozzle will often need to run hotter than barrel temperature to achieve a good result) Manifold temperature should remain constant.
8. If mold is left idle and needs to be restarted, raise nozzle temperatures to make gates“live” again. ***Do not increase manifold or nozzle temperatures by large amounts*** as increases of temperature above the design figures can damage the sealing faces of the manifold and nozzle due to excessive expansion.

MAINTAINENCE

Manifold Maintenance:

When properly installed ***MASTIP*** manifolds will operate trouble free. If a problem occurs it is usually due to heater or thermocouple failure or melt contamination.

Replacing Manifold Heaters and Thermocouples

- Let the tool cool down
- Disassemble the fixed side of the mold taking care when un-torqueing, not to bow or distort manifold or the mold plates
- Remove manifold from mold.
- Remove the screws holding in the heater and remove heater.
- Where replacement heaters are required contact your local ***MASTIP*** representative with the manifold's approval drawing or the engraved serial number.
- Spare heaters must be stored in a warm dry environment.
- New heater should be installed in groove with the use of a soft hammer. **Do not use excessive force**. Take care when installing new heater not to bend or distort the element as this will damage the internal heating element.
- Test heater insulation then reassemble fixed side of mold.
- Start new manifold heaters using a slow "soft start" setting.

Cleaning the Manifold Runners

- Let the tool cool down
- Disassemble the fixed side of the mold taking care when un-torqueing, not to bow or distort manifold or the mold plates.
- Remove the manifold from the mold plates.
- Locate and remove the End Plug M4 location grub screws from the top or bottom faces, (may require heater removal if located at bottom of heater groove).
- Remove the End Plug locking screw from behind the End Plug.
- Remove the End Plug using a slide hammer attached to the M6 thread in back of End Plug, (it may be necessary to heat manifold to aid in loosening the screws and plugs).
- Heat the manifold to the *Lower* range of its processing temperature and use a hot wire with a hook on the end to hook out the melt just as the outer layer of plastic melts in the runner. **Take extreme care not to scratch bores.**
- If this is not successful, heat the manifold to full operating temperature and allow to soak for 20-30 minutes and use a tight fitting rod of soft material (e.g. Aluminium), to push out the plastic from the runners.
- If the manifold has deviation plugs, contact ***MASTIP*** before attempting disassembly.
- **Do not under any circumstances attempt to blow out hot plastic with an air gun.**
- Carefully refit end plugs, locking and locating screws, making sure alignment of end radii is correct. Apply high temperature anti-seize compound to all threads upon reassembly.
- Reassemble manifold and mold in the reverse sequence as specified above.
- Torque all bolts to recommended figures.

TROUBLE SHOOTING

The following is a list of common problems and answers for hot runner systems.

Problem:	**Manifold will not come up to temperature.**
Cause:	Thermocouple is loose, thermocouple is faulty, heater is shorted, heater wiring is loose or shorted.
Remedy:	Check thermocouple is tight and functions correctly, check heater circuit.
Problem:	**Manifold slow to heat up**
Cause:	One heater shorted or wiring is loose, insufficient manifold air gap, too much cooling above spacers, thermocouple is loose
Remedy:	Check both heaters, increase air gap to 10mm min or use insulation board, Add insulation board to back plate or reduce coolant flow to backplate, check thermocouple.
Problem:	**Manifold temperature not stable**
Cause:	Thermocouple is loose
Remedy:	Check thermocouple
Problem:	**Metal contamination in melt**
Cause:	Debris from plastic material, damaged machine screw.
Remedy:	Check purge for metal particle and repair machine screw. Check plastic for contamination
Problem:	**Manifold leaks from nozzle faces**
Cause:	Incorrect allowance for temperature expansion, machining of W face heights inconsistent, backplate material too soft, manifold run at very high temperature for short time, O-ring installation faulty
Remedy:	Recheck calculations and correct, check and correct W face heights, change backplate, check for Damage and replace damaged or crushed parts, replace O-rings.
Problem:	**Manifold leaks from deviation plug**
Cause:	No spacer fitted
Remedy:	Fit spacer

VALVE GATES

GATE DETAILS

Why use a valve gate?

Advantages of using a Valve Gate System

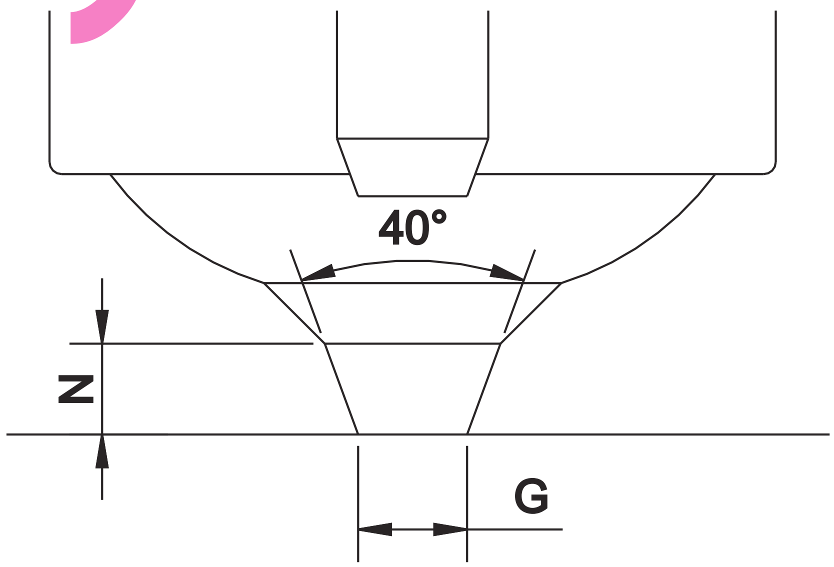
- Less pressure to fill part due to larger gate size.
- Part will fill faster, and so cycle time may be reduced
- No protruding gate mark or vestige
- No possibility of gate drool
- No cold slug from thermal gate
- Control of gate shut off determined by molder, not by gate design or cooling etc
- Sequential or independent control of multiple gates is possible
- Insensitivity to changes in materials

Dis-Advantages of using a Valve Gate System:

- Cost
- Extra height and size in tooling
- Extra complexity due to actuators and control systems
- Pin will leave small ring on part
- Plastic can stick to larger pins, marking part

Gate Details for *MASTIP* Valve Gate Systems.

- Gate profiles incorporate a 40^0 included taper in the front of the gate to seal and align the pin.
- The end user must machine this taper on the supplied pins to suit mold height.
- The gate profile in tool should be made from a hardened steel, to allow for the action of the pin on gate taper.
- ***MASTIP*** Standard Gates and Valve Gate profiles are not interchangeable (ie you can not machine 40^0 taper into an existing MTT gate and fit a valve gate system).
- The gate diameter ('**G**') should only be changed if absolutely necessary. If the gate diameter ('**G**') is modified care must be taken to ensure there will still be enough contact on the N dimension to support the taper and provide a seal.



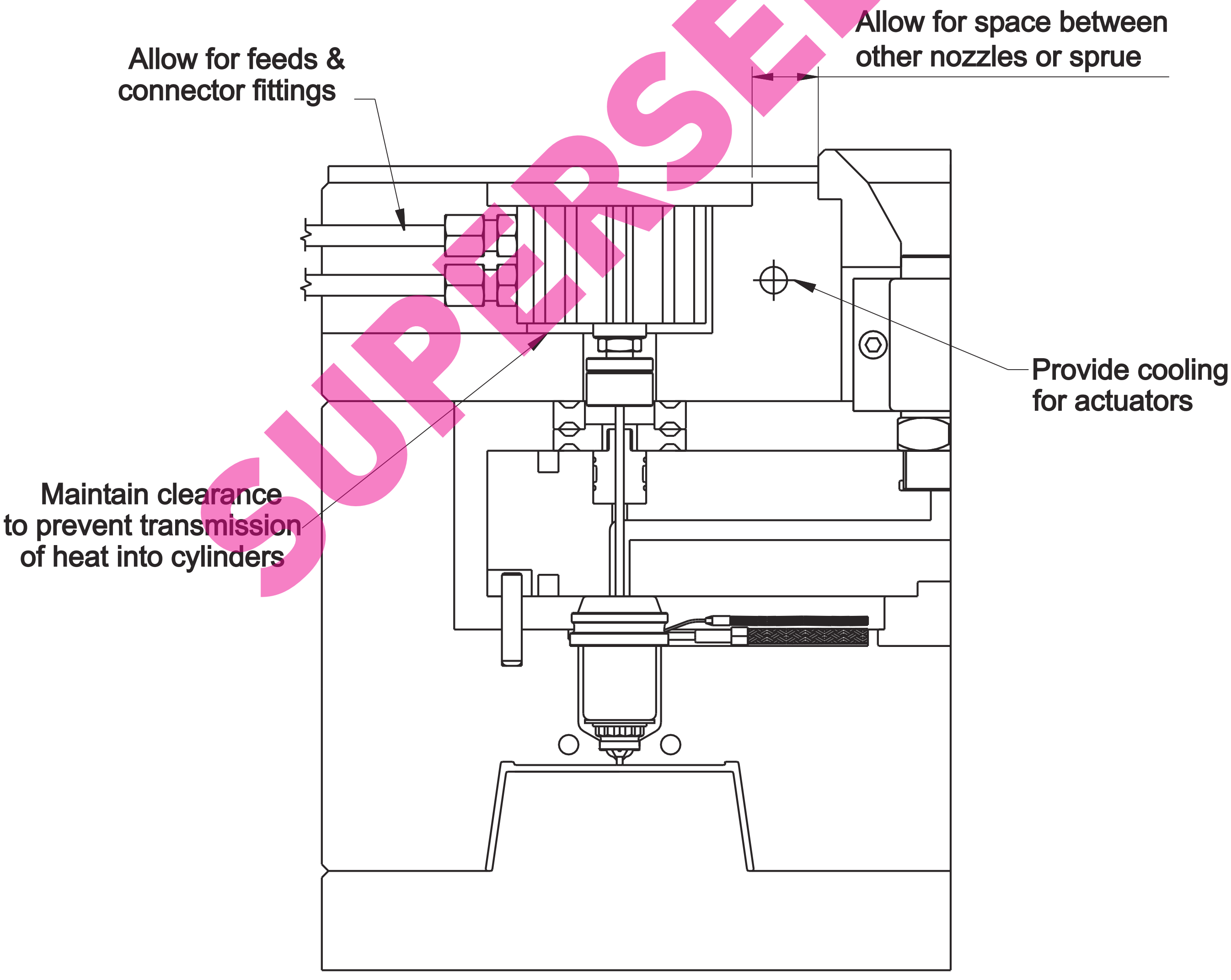
MOLD CONSTRUCTION

Mold Design for Valve Gate Applications

Consideration in the Mold Design must be made for:

- The Back Plate must be thicker to allow for mounting the actuators.
- Channels must be included in the mold for pneumatic / hydraulic feeds to actuators.(fittings, piping, etc)
- Distance between nozzles must be sufficient to allow mounting of cylinders and the cylinder back plates
- Cooling should be provided in backplate to reduce cylinder temperatures. This will prolong the life of the seals and avoid the cylinder mechanism binding from excessive thermal expansion.
- For very large manifolds it may be necessary to mount the cylinder(s) on columns direct onto the manifold, due to large thermal expansions (Contact ***MASTIP*** for details)

For specific details see pages in Nozzle catalogue.



INSTALLATION

1. Assemble the ***MASTIP*** nozzle as per the Nozzle technical section.
2. Assemble the ***MASTIP*** manifold, pin guide bush, steel spacer and titanium spacer, (refer Fig. 32.1). The pin guide bush should be a snug fit in the manifold bush hole (Dia. D), with a maximum clearance is 0.02mm. The top face of the bush should be slightly proud of the manifold top face (0.01-0.05mm) to aid sealing. See Fig 32.2. The shut-off pin should be an extremely snug fit in pin guide bush, having a slight frictional resistance to the movement of the pin.

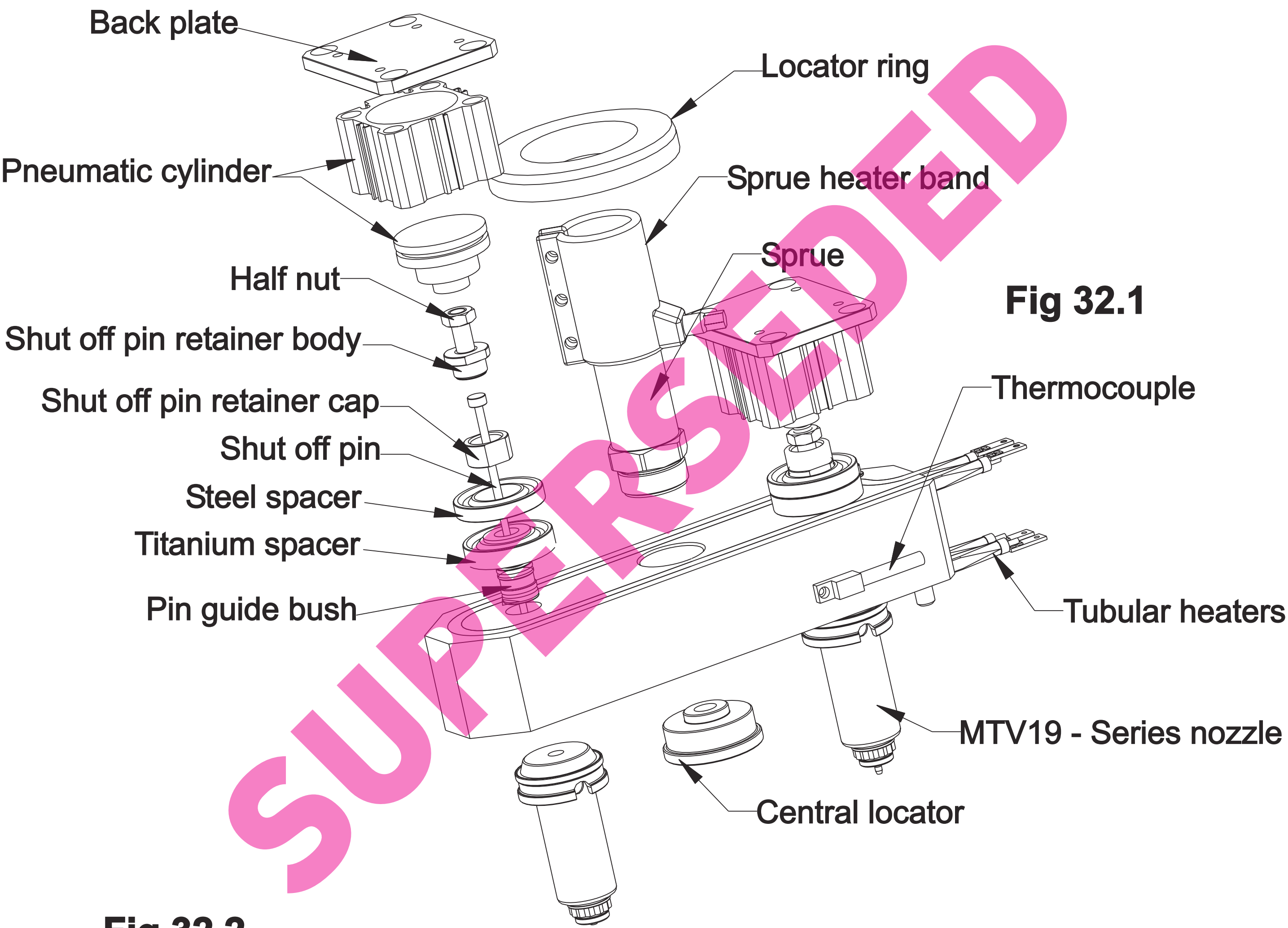
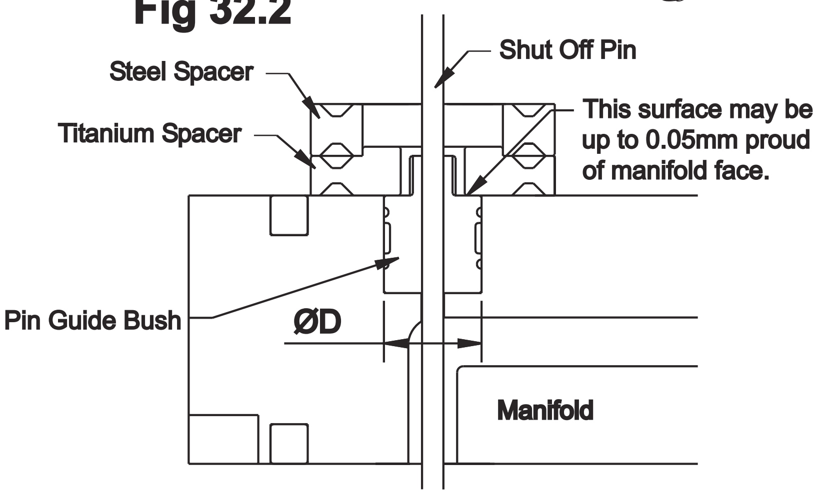


Fig 32.1

Fig 32.2



INSTALLATION

3. A cold clearance between the steel spacer and the mold is necessary to protect the manifold components from collapsing due to thermal expansion when the system is at operating temperature.The procedure to calculate this is similar to that on page 4.23-4.25.
   Measure the distance from face W to the underside of the back plate.
   Measure and compare this to the stack height of the manifold and spacers and L4 dimension of the nozzle.
   There should be 0.05mm of interference between the titanium spacer and the backplate at full working temperature.

   Moldmakers should carefully inspect all stack heights and pocket dimensions against the *Mastip* approval and catalogue drawings. Any questions should be discussed immediately with the nearest *Mastip* hot runner systems representative.

Example:
Nozzle = MTV16056 (L4=15.0mm)
Manifold Height = 44.0mm
Titanium Spacer = 6.5mm
Steel Spacer = 8.5mm
Cavity from face W to back plate = 74.00mm
Nozzle manifold operating temp = 260°C
Mold temperature = 60°C

Expansion for Cavity Depth
E = 74.00 x 0.0000132 x (260-60) = *0.20mm*

Hot Runner Height Required
74.00 + 0.05 (interference) = 74.05mm
74.05 - 0.20 = *73.85mm*

Hot Runner Height Supplied
H = 15.0 + 74.0 + 6.5 + 8.5 = *74.00mm*

Material Required to be Ground from Steel Spacer
74.00 - 73.85 = ***0.15mm***

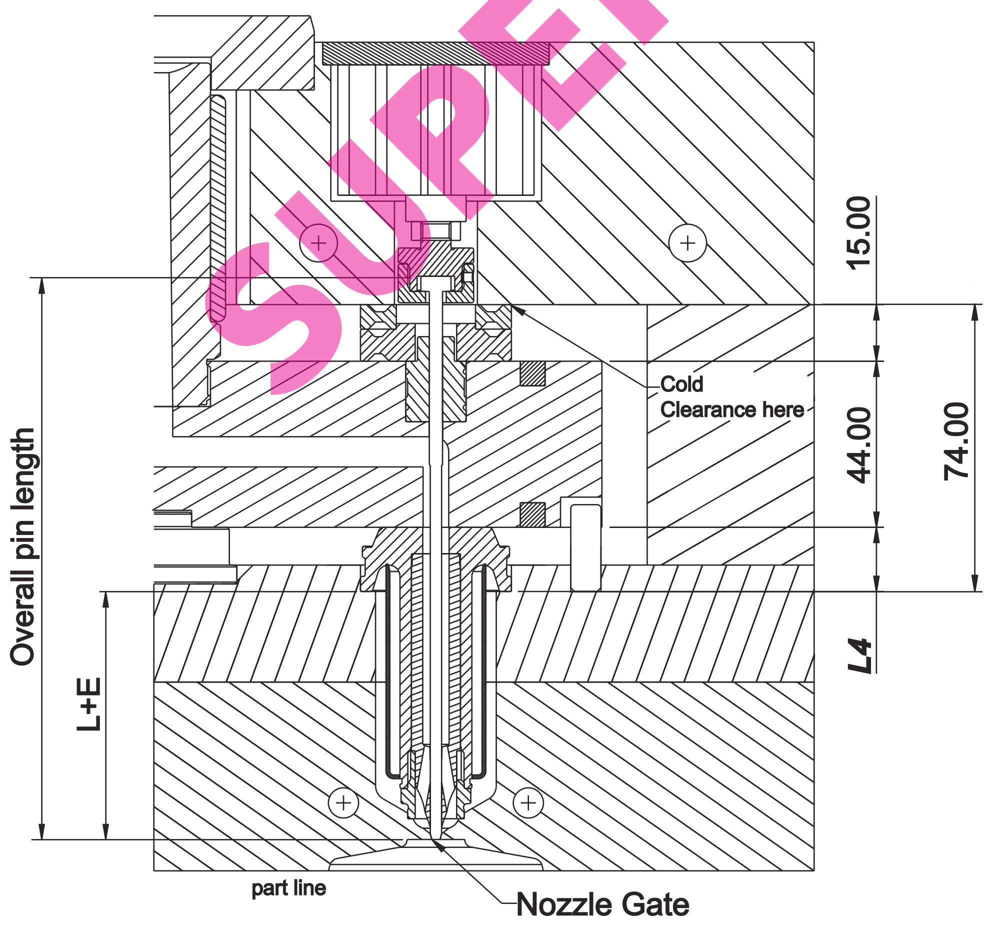


Fig 33.1

INSTALLATION

4. Approximate pin lengths can be determined from the formulas shown on pages 1.3.11-1.3.14 of the nozzle catalogue.
   Note: the E values for these lengths uses the length of the ***shut off pin.***
5. Cut pin to length and grind 40° taper on end of pin, make sure taper is a good fit in gate taper with bearing blue.
6. The cylinder pockets in the mold back plate should be aligned with nozzle gate hole. Misalignments between mould plates and manifold can cause excessive wear on the shut off pin(s).
7. It may be necessary, in some cases, to machine the slot for feed lines right through the back plate to allow for ease of fitting from the back of the tool. Fig 34.1
8. Assemble the manifold and nozzles as per instructions for the standard manifold.
   DO NOT fit the O-rings yet
9. Assemble the Valve gate cylinder assembly, which consists of:
   shut off pin, half nut, pin retainer assembly, cylinder (hydraulic or pneumatic) and backing plate. Make sure the half nut has a 2mm adjustment gap as indicated in Fig 34.2

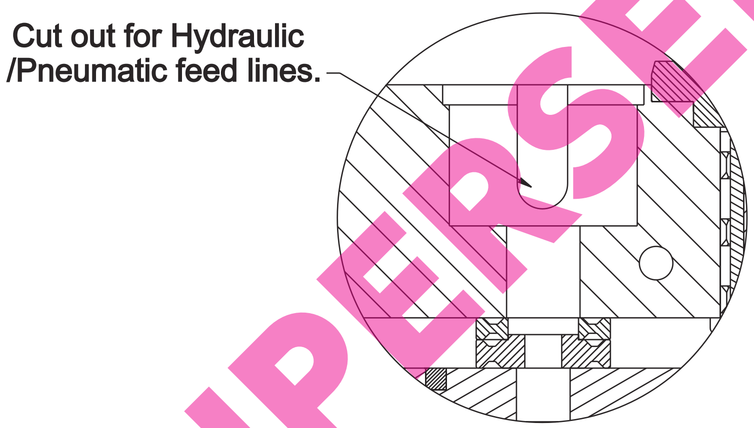


Fig 34.1

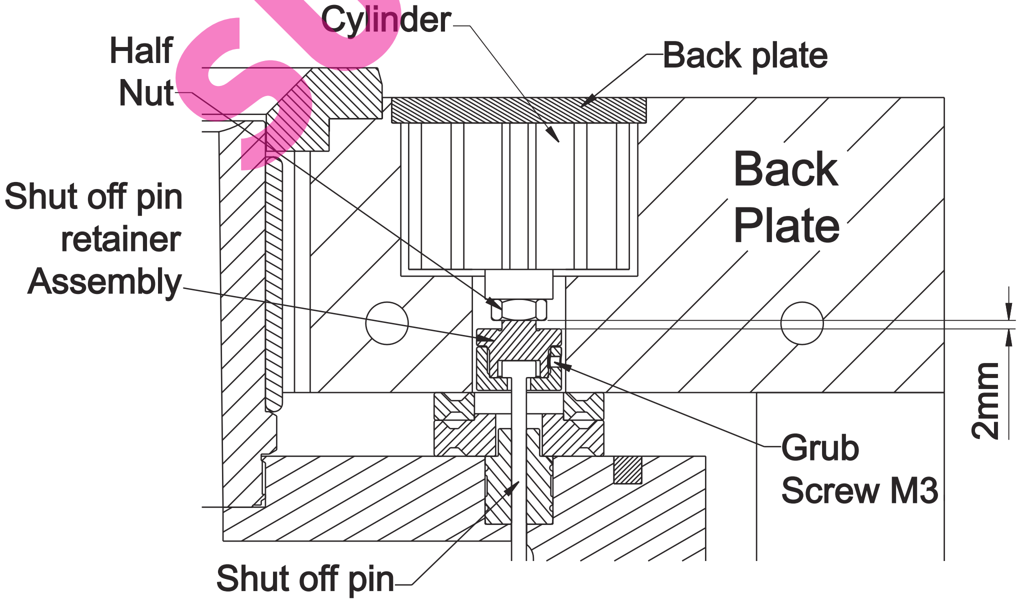


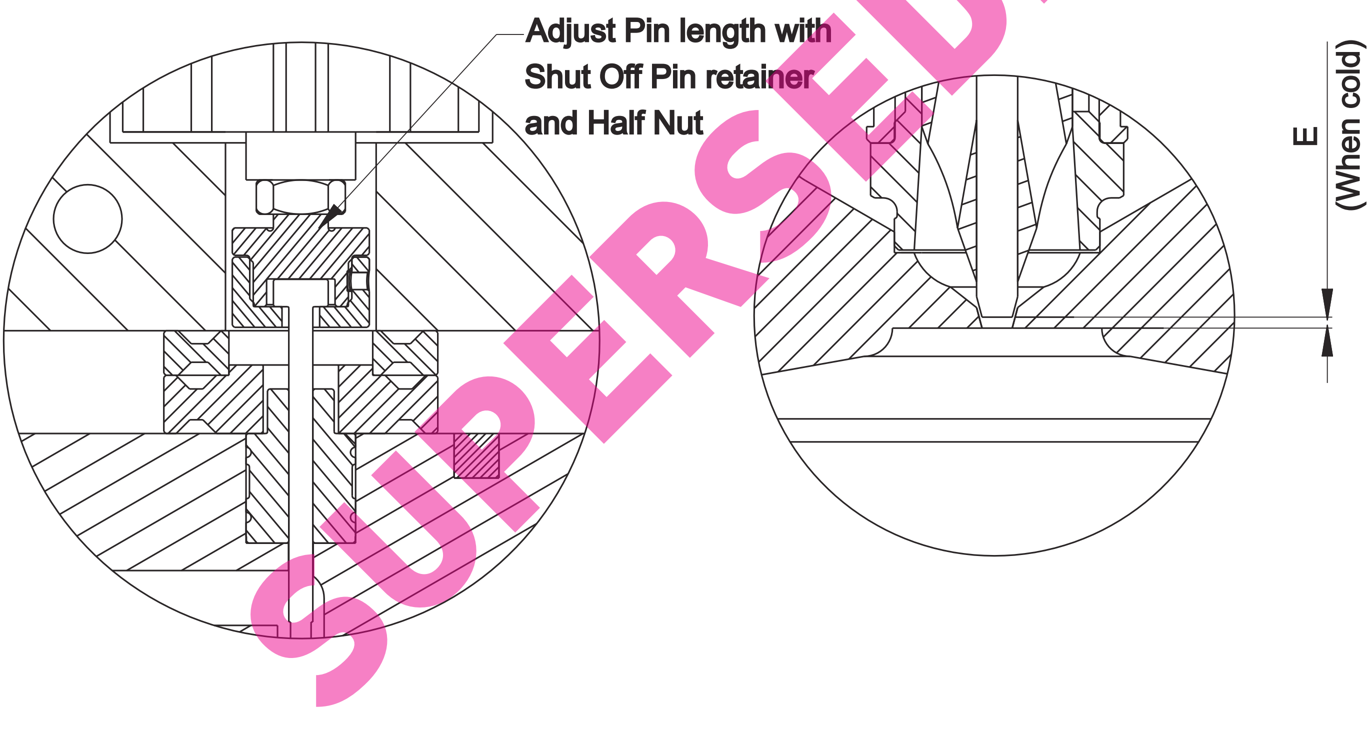
Fig 34.2

Valve Gate Cylinder Assembly

INSTALLATION

10. Assemble the back plate on the tool.
11. Place tool in position so the valve gate cylinder assembly can be fitted into the back of the tool, and the front face of the gate is visible as well.
12. Insert valve gate assembly into back of tool so the valve gate assembly back plate is properly located, screw down valve cylinder back plate.
13. Apply LOW pressure air to cylinder to bring cylinders forward and then measure the gap at front of gate to the front face of pin (fig 35.1) with a depth micrometer. The gap should be equal to the shut off pins E value, if not remove valve cylinder assembly and adjust pin retainer and half nut until correct
14. **The gap between the gate and the pin in cold state is critical. If there is too much gap there will be a poor gate vestige and perhaps drooling from the nozzle. If the gap is too small the pin can strike the gate and will damage it.**

Fig 35.1



15. Now dis-assemble valve gate cylinder assembly from tool and remove backplate. Remove the manifold, fit O-rings to the nozzles and re-assemble
16. Before you install the valve gate cylinder assembly within the tool, fit the hydraulic/pneumatic piping and fittings to the cylinder.
17. For hydraulics, we recommend the use of quick connect fittings with shut-offs to prevent hydraulic fluid losses when the mold is disconnected from the hydraulic power source.
    Always use solid piping whenever possible, if in doubt seek expert advice.
    Care should be taken to check the maximum operating pressures and temperatures in the tool prior to trial to ensure unit will not be damaged.
    The hydraulic cylinders should not be used with more than 50 bar of pressure to avoid possible damage to gate.

MAINTENANCE

The ***MASTIP*** valve gate system should give trouble free operation provided a few simple maintenance procedures are followed

- Make sure pneumatic air is clean and free from water or oil.
- Make sure hydraulic fluid is properly filtered and changed regularly
- Minimum air pressure ***at cylinder*** should be 6 bar.
- Maximum hydraulic pressure should be 50 bar
- Break down tool and inspect for the following every six to twelve months depending on use:
  - Service cylinders (contact ***MASTIP*** for seal kits)
  - Inspect shut off pins and shut off pin bush for wear and possible leakage

TROUBLE SHOOTING

The following is a list of common problems and answers for hot runner systems.

Problem: **Cylinders do not work**
Cause: No air / oil flow to cylinder, Cylinder seized, Not enough pressure in system
Remedy: Check lines, fitting pipes, and pump for leaks and blockages etc, Inspect cylinders, Too many bends in feed pipes, restrictive fittings or valves

Problem: **Cylinders seized**
Cause: Alignment of cylinder, manifold and nozzle incorrect, Too much heat in backplate.
Remedy: Check alignments, supply more cooling around cylinder

Problem: **Cylinders jam when hot**
Cause: Alignment of cylinder, manifold and nozzle incorrect, Too much heat in backplate, Spacers rubbing on shut off pin retainer
Remedy: Check alignments, supply more cooling around cylinder, re-align spacers

Problem: **Melt leaks from around shut off pin bush**
Cause: Bush too loose in manifold
Remedy: Check diameters of bush and manifold hole, check height of bush and manifold hole.

Problem: **Melt leaks from between bush and pin**
Cause: Wear, MFI of melt too high, pressure too high
Remedy: Check alignments of system, replace pin and bush **as a unit,** check melt MFI, reduce fill pressure.

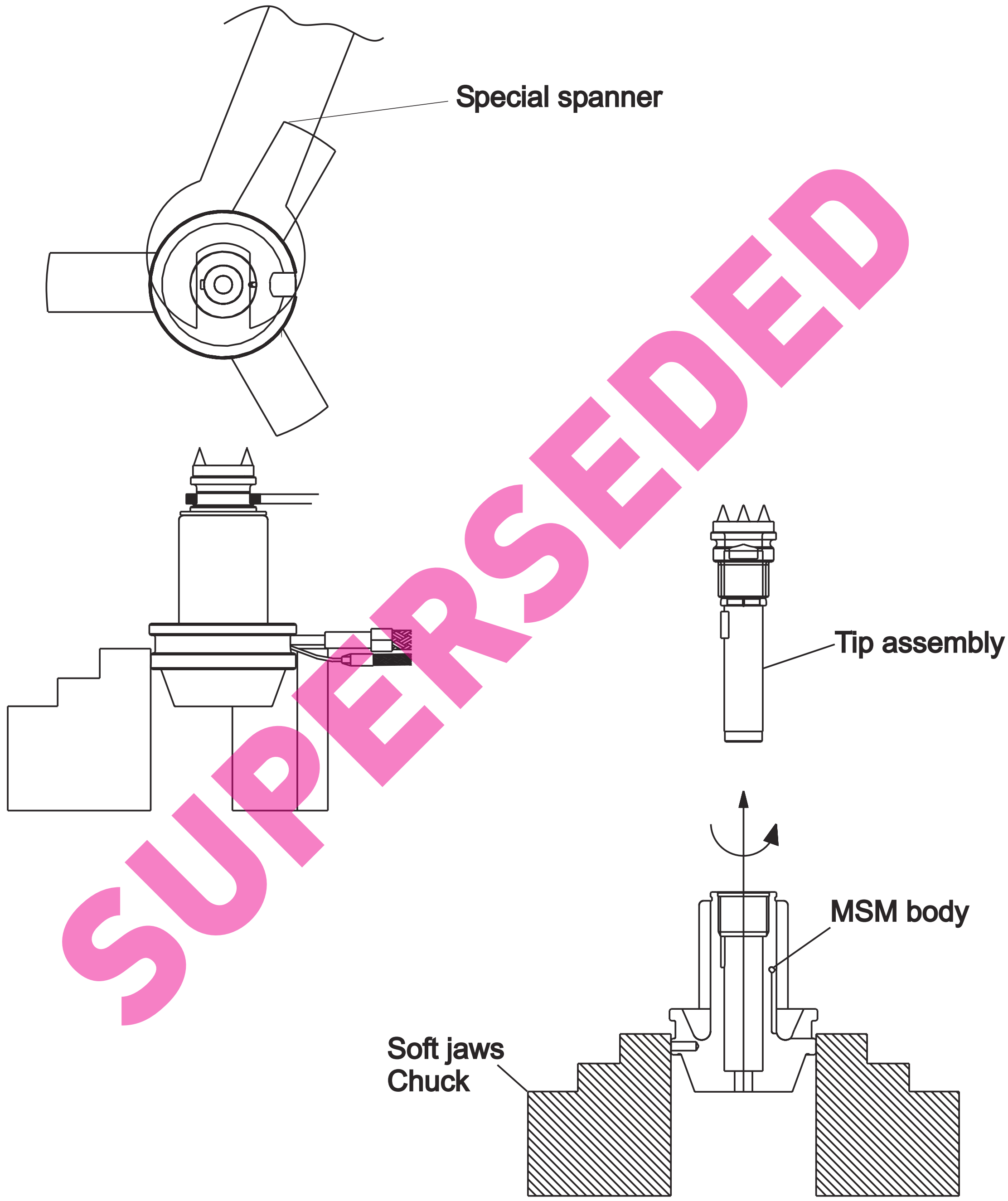
Problem: **Melt sticks to front of pin**
Cause: Too much heat in pin
Remedy: Reduce nozzle and gate temperature, increase cooling time

Problem: **Pin does not shut off or bush nut is damaged using MTVB or MOVB**
Cause: Nozzle operating at temperature different to one used to calculate E expansion
Remedy: Adjust pin position with pin retainer and half nut

MULTI-TIP NOZZLES

MSM TIP ASSEMBLY INSTRUCTIONS

Step 1
Hold the nozzle assembly firmly in a three jaw chuck with soft jaws.

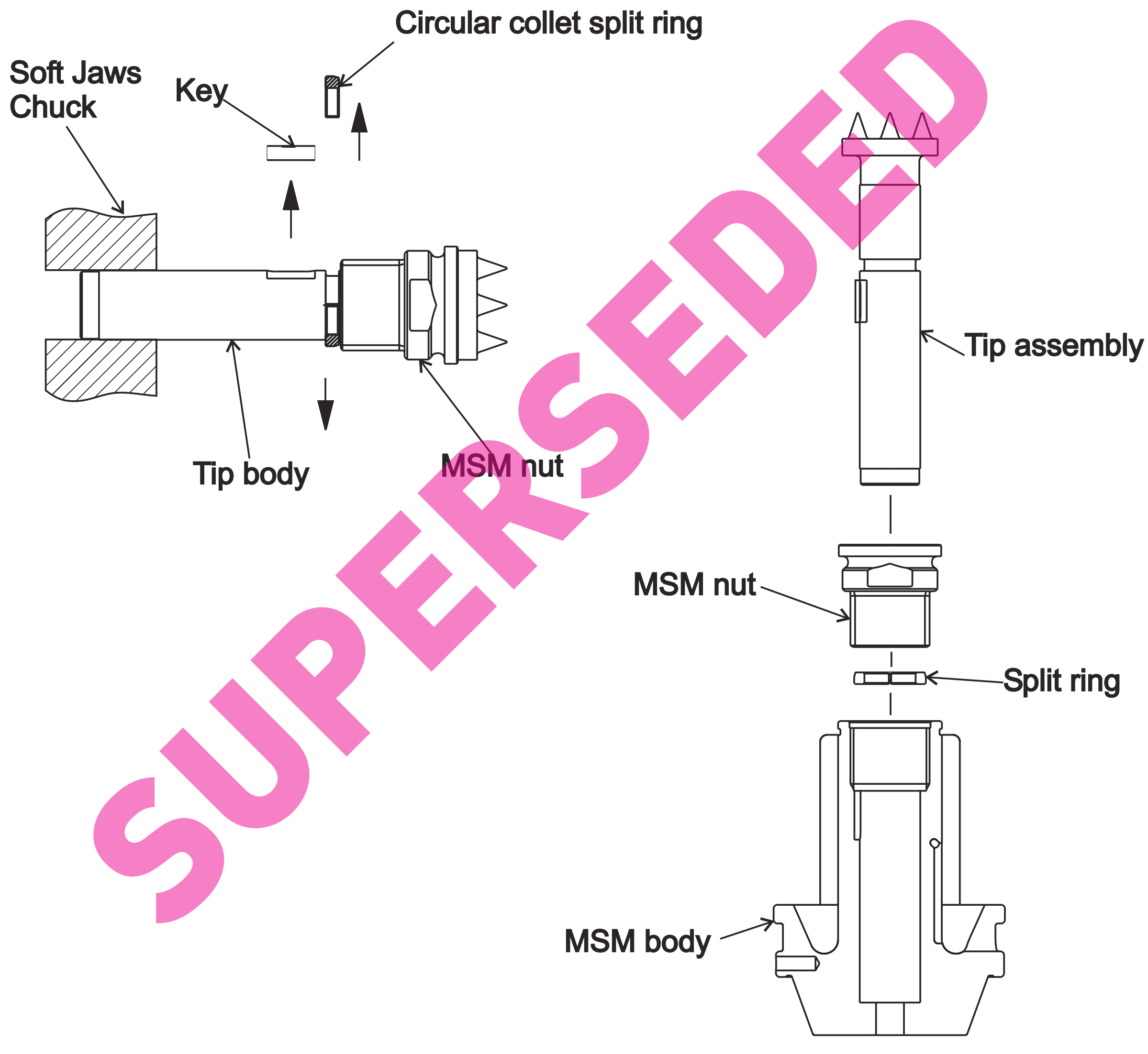


Step 2
Unscrew the nut and remove the tip from the nozzle body using a special open end spanner.

MSM TIP ASSEMBLY INSTRUCTIONS

Step 3

- Firmly hold the tip assembly with a three jaw chuck with soft jaws.
- Remove the key from the tip assembly.
- Carefully remove the collet halves from the tip assembly and remove open nut.



Step 4

- Replace tip with new MSM tip.
- Assemble unit in reverse order, take care to align the key in the nozzle body.

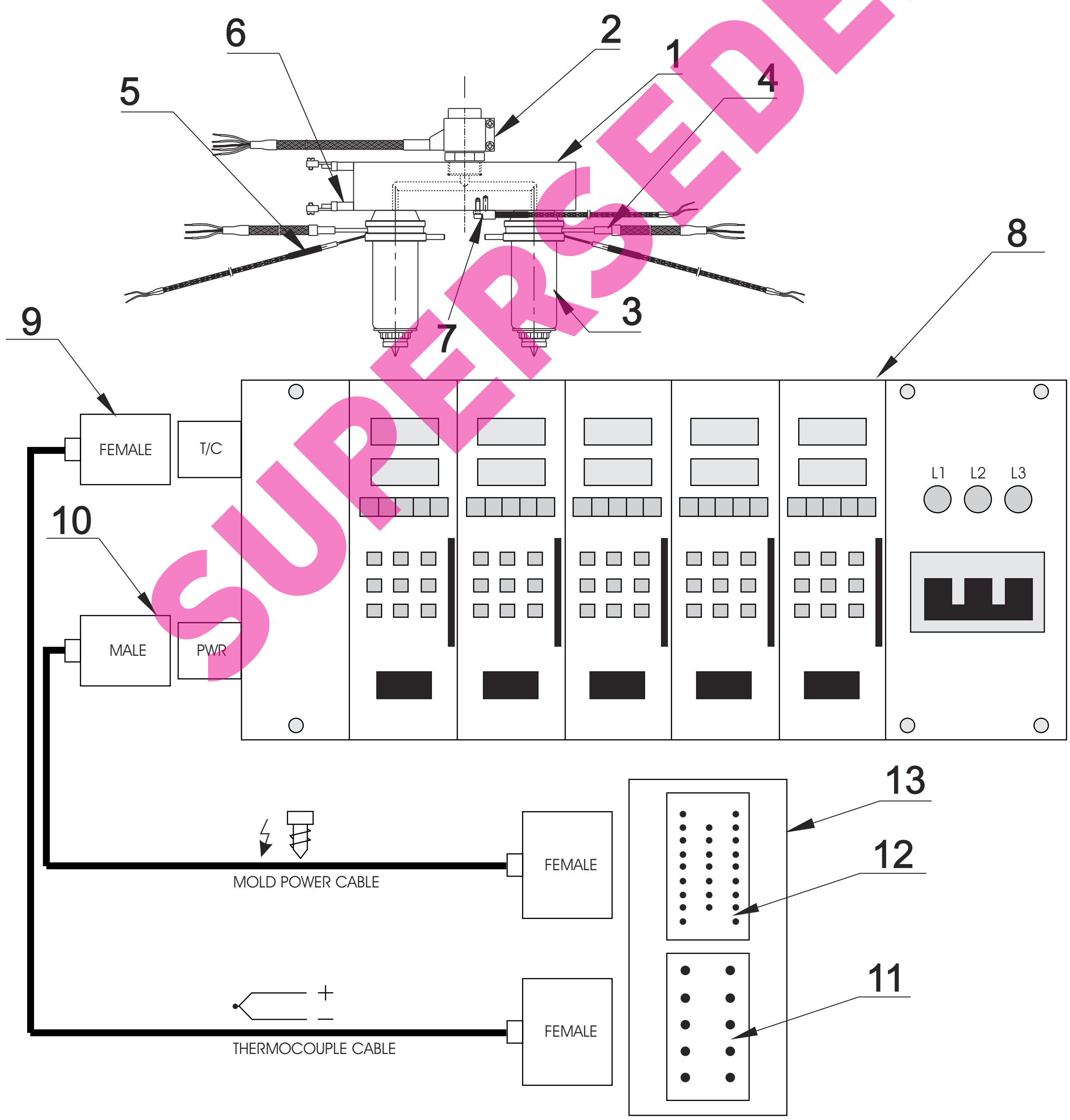
TEMPERATURE CONTROLLERS

WIRING DIAGRAM

Connection of Hot Nozzles, Thermocouples and Sprue Bush Heaters to the Temperature Controller

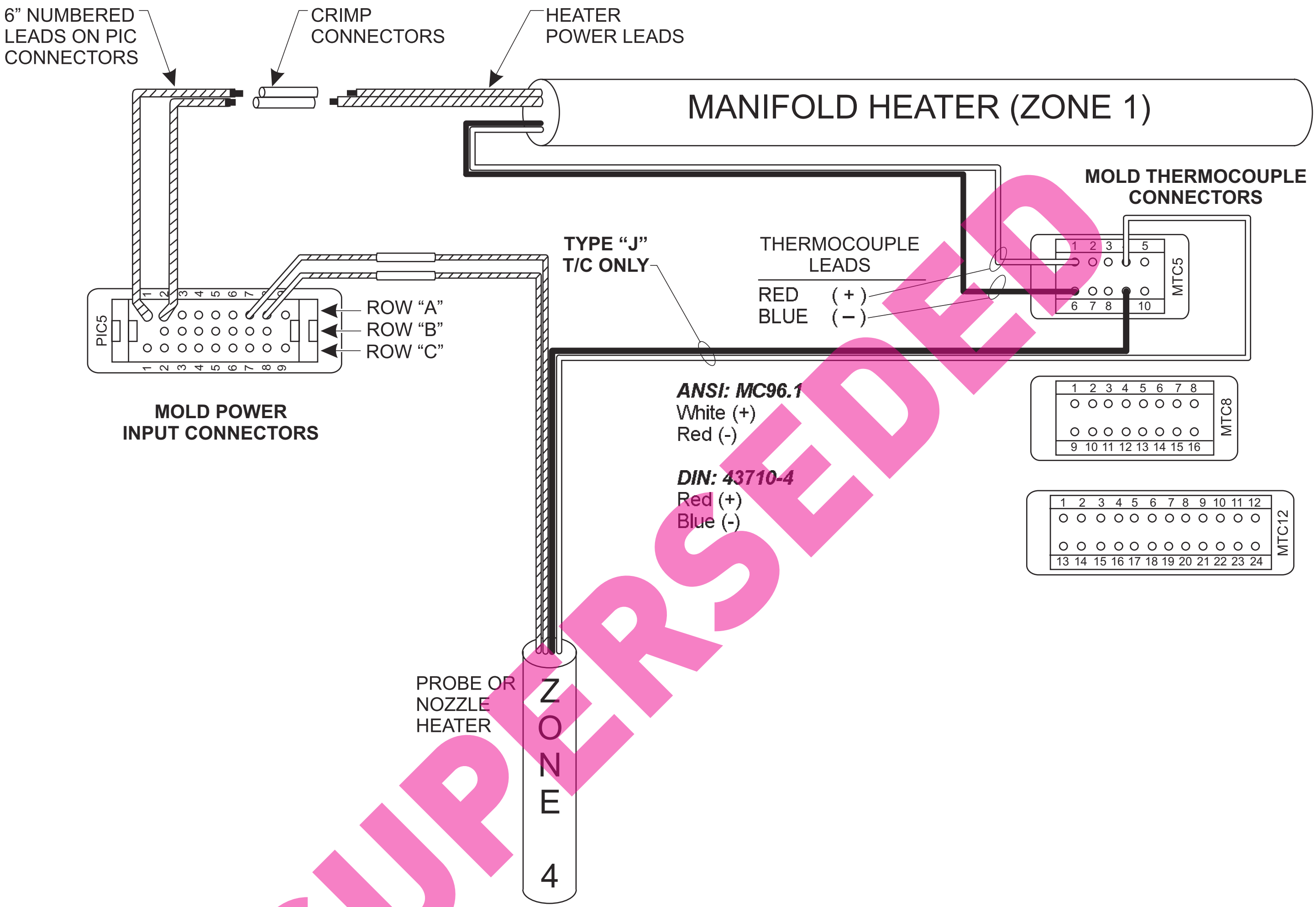
The diagram below is an example of the wiring diagram for a typical two drop manifold with sprue bush heater and thermocouple.

1. Manifold Block
2. Sprue Bush Heater with Thermocouple
3. MTT Series Nozzle
4. Nozzle Heater
5. Nozzle Thermocouple
6. Manifold Heater
7. Manifold Thermocouple
8. Controller
9. TC cable
10. Power Cable
11. TC Connector
12. Power Connector
13. Terminal Box



MAINFRAME TO MOLD WIRING DIAGRAM

Wiring Diagram for a Runnerless Molding System



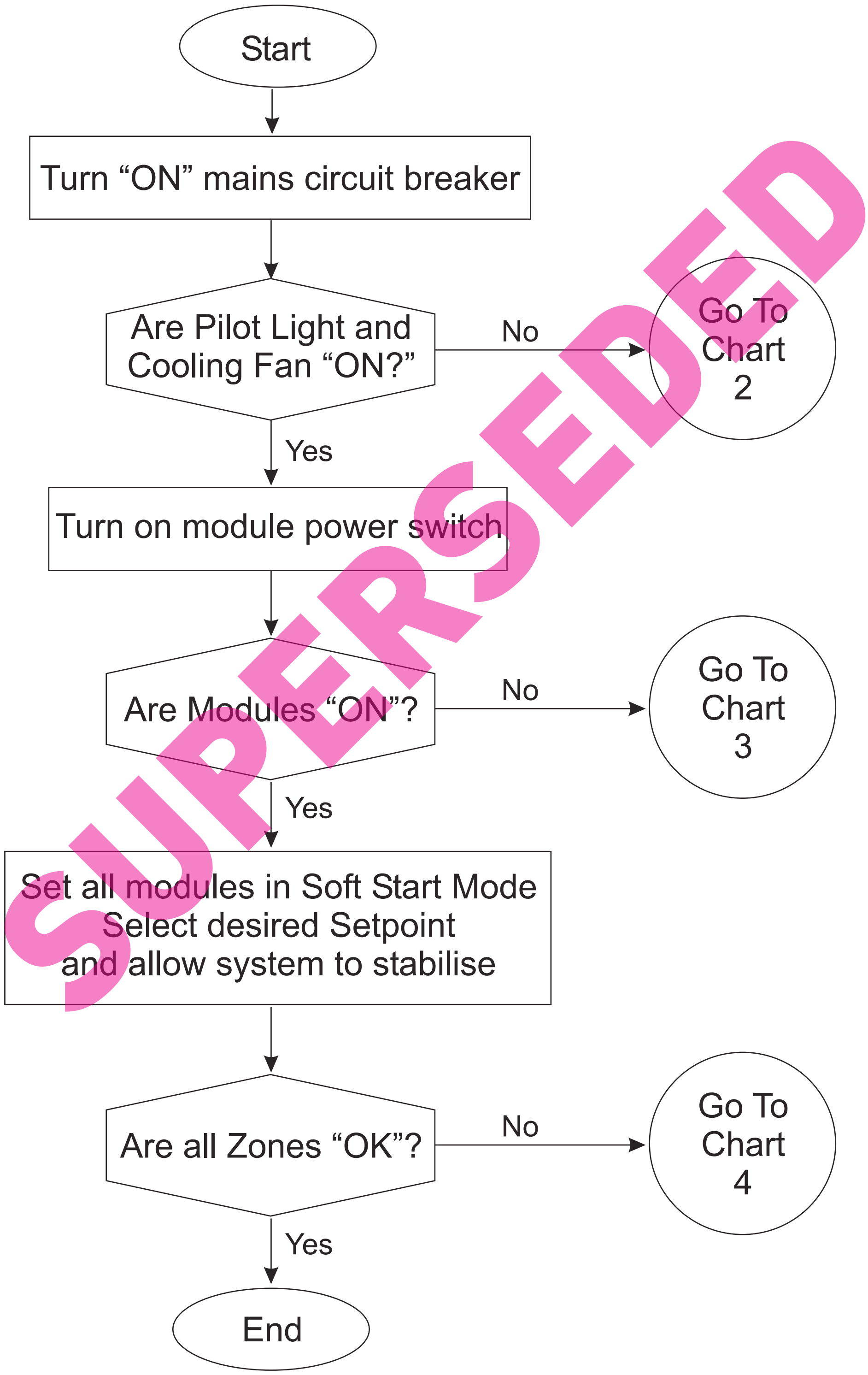
WIRING CONNECTIONS			
ZONE 1	ROW "A"	TERMINALS	1+ 2
ZONE 2	ROW "A"	TERMINALS	3+ 4
ZONE 3	ROW "A"	TERMINALS	5+ 6
ZONE 4	ROW "A"	TERMINALS	7+ 8
ZONE 5	ROW "B"	TERMINALS	2+ 3
ZONE 6	ROW "B"	TERMINALS	4+ 5
ZONE 7	ROW "B"	TERMINALS	6+ 7
ZONE 8	ROW "C"	TERMINALS	1+ 2
ZONE 9	ROW "C"	TERMINALS	3+ 4
ZONE 10	ROW "C"	TERMINALS	5+ 6
ZONE 11	ROW "C"	TERMINALS	7+ 8
ZONE 12	ROW "A + C"	TERMINALS	9
ROW "B" TERMINAL 8 IS NOT USED			

	5 ZONE		8 ZONE		12 ZONE	
ZONE	RED	BLUE	RED	BLUE	RED	BLUE
ZONE 1	1	6	1	9	1	13
ZONE 2	2	7	2	10	2	14
ZONE 3	3	8	3	11	3	15
ZONE 4	4	9	4	12	4	16
ZONE 5	5	10	5	13	5	17
ZONE 6			6	14	6	18
ZONE 7			7	15	7	19
ZONE 8			8	16	8	20
ZONE 9					9	21
ZONE 10					10	22
ZONE 11					11	23
ZONE 12					12	24

CONTROLLER TROUBLESHOOTING

Temperature Controller Trouble Shooting

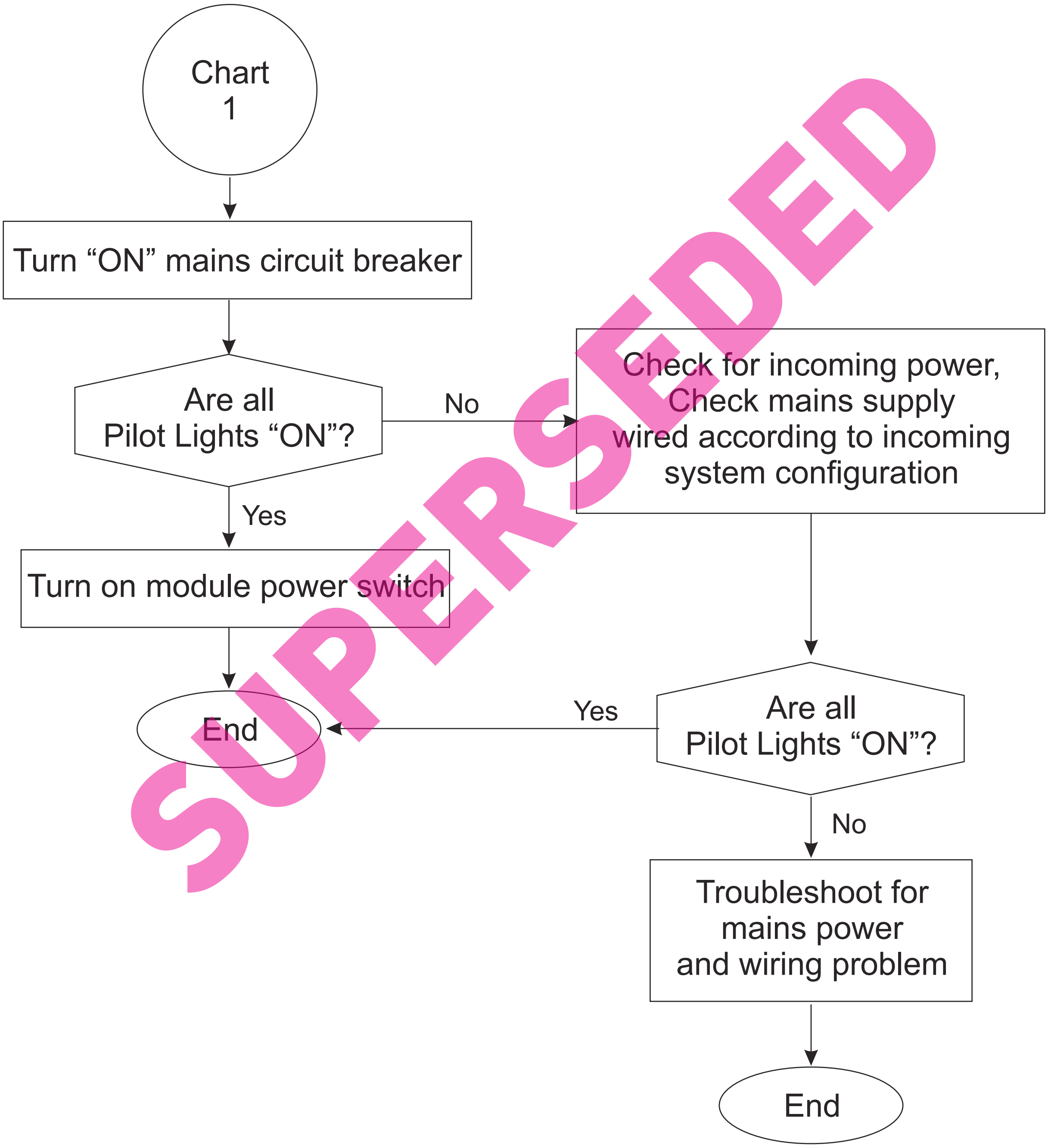
Chart 1



CONTROLLER TROUBLESHOOTING

Temperature Controller Trouble Shooting

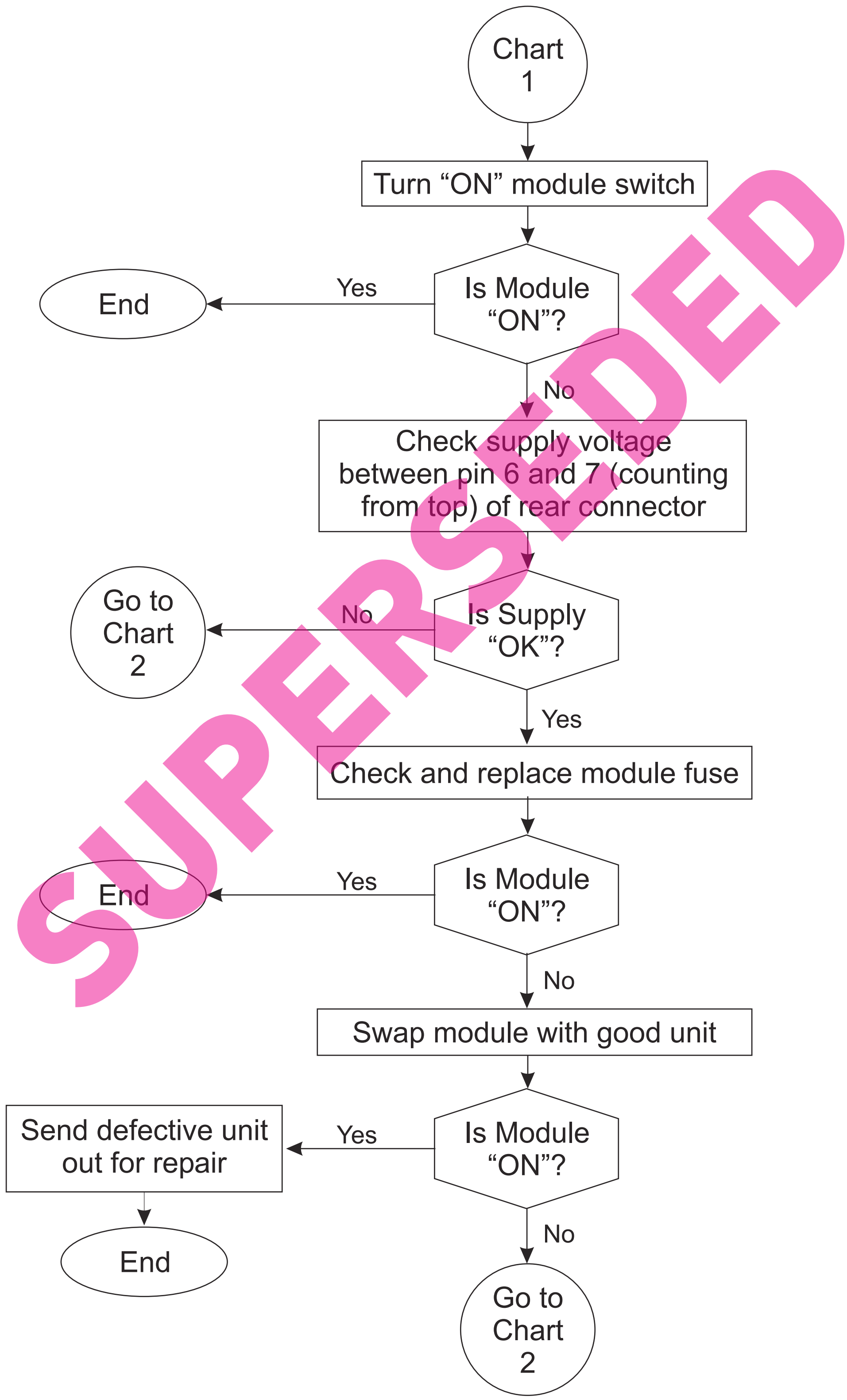
Chart 2 - Power



CONTROLLER TROUBLESHOOTING

Temperature Controller Trouble Shooting

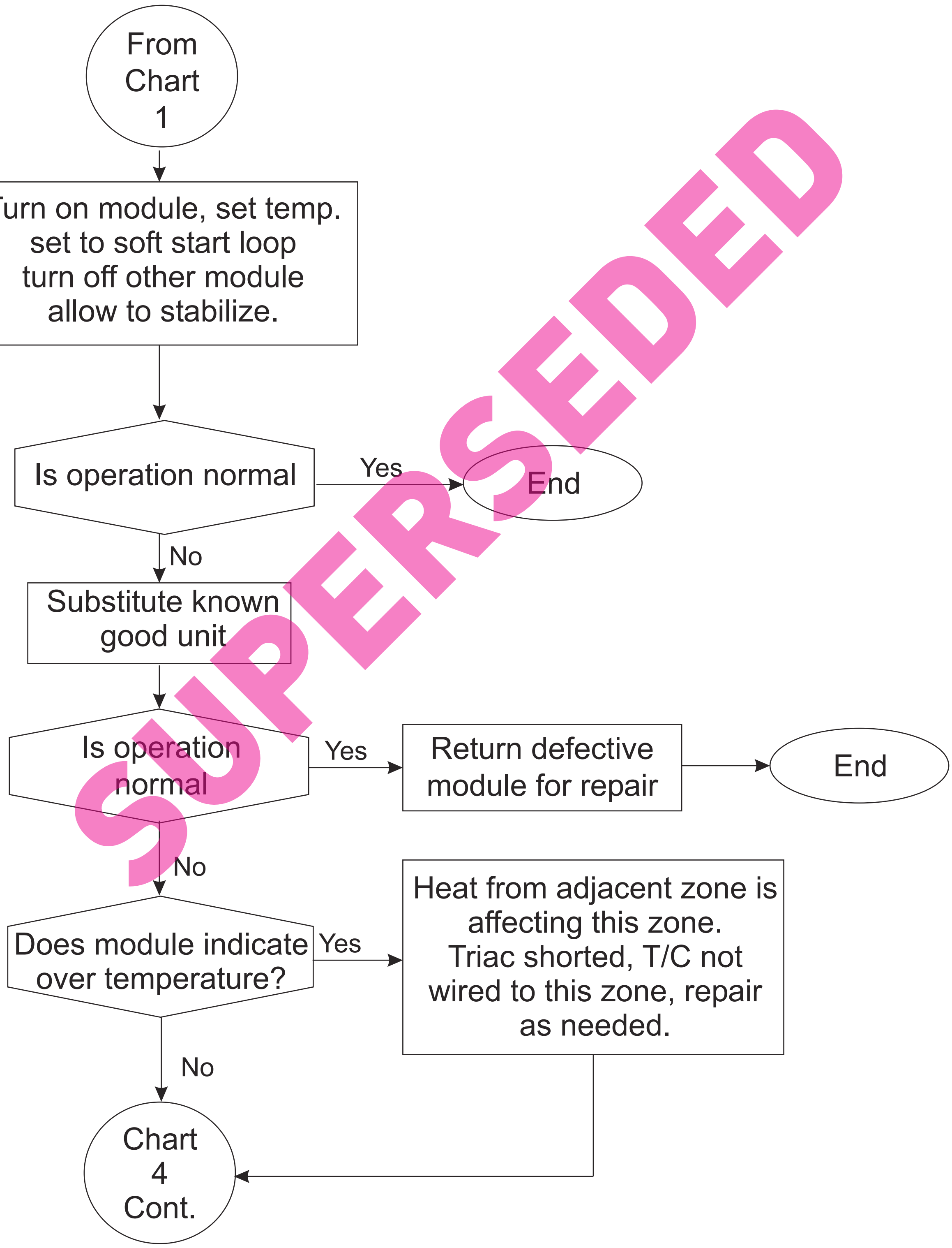
Chart 3 - Module



CONTROLLER TROUBLESHOOTING

Temperature Controller Trouble Shooting

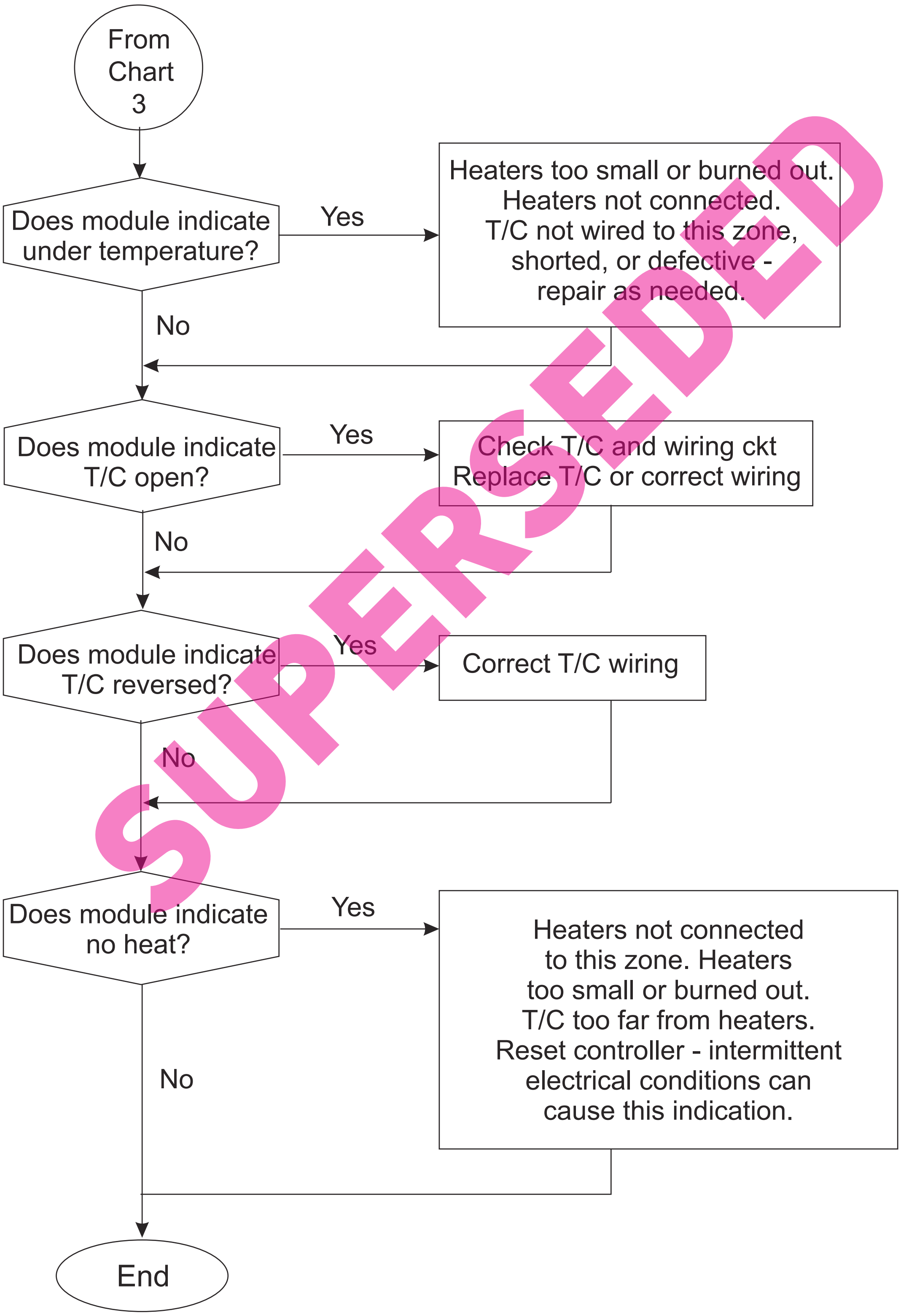
Chart 4 - Module



CONTROLLER TROUBLESHOOTING

Temperature Controller Trouble Shooting

Chart 4 - Module (Cont.)



TEMPERATURE CONTROLLER TROUBLESHOOTING GUIDE

Symptom	Probable Cause	Check	Corrective Action
Controller Dead,No Display	No supply voltage	Verify 120/230Vac input	Restore power
	Blown Fuses	Check fuses F1 & F2	Replace with ABC15 fuse only
	Failed Power Transformer	Check continuity through power transformer pin 1& 4, it should be 600ohms ±20%	Replace power Transformer
	Missing/wrong Voltage jumper	Verify jumper JP101	Install proper jumper as per your supply system
	Loose power switch/display ribbon	Check for loose ribbon connectors	Correct connection
	Voltage Regulator	Check for input & output of Voltage regulator IC, For MAS15A, U103 (IC MIC29371), i/p =9V, o/p For MAS15, U6 (IC 7805), i/p =12V, o/p 5V	If faulty replace
No heating	Open Heater or htr circuit	Check heater and wiring	Replace bad Htr, correct wiring
	Open TC or TC wiring	Disconnect TC from controller and measure TC resistance, should be 0 ohm to max 100ohms	Replace TC, Correct wiring
	Defective triac driver	Check IC U3 (MOC3020),	Replace IC
	Open Triac - Q102	Check Triac	Replace
Full output, No control	Reverse TC connection Short TC lead wire	Check TC polarity and lead wire short.	Connect correctly
	Triac Shorted	Disconnect power & Load, Measure resistance between heater output tracks. Should read infinity,	Replace Triac Q102(BTA 41-600) for MAS15A or Q1 & Q2 (MAC223) for MAS15 series modules
Reads only "otc"	Thermocouple open	Check TC continuity	Replace defective TC
	Open TC ckt fuse	Check for TC ckt fuse F3 & F4	Replace open fuse
Reads only "rtc"	Reverse TC connection	Check TC polarity	Use correct polarity

SUPERSEDED